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INDEX TO VOLUME XLVI

January 1 to July 31, 1917

EXPLANATORY NOTE

Illustrated articles are marked with an asterisk (•), book notices with a dagger (†). Cross references to a particular initial word may apply also to its derivatives. The cross references condense the matter and assist the reader but are not to be regarded as complete or conclusive. So, if there were a reference from "Milling" to "Jigs and fixtures," and if the searcher failed to find the required article under the latter topic, he should look through the "Milling" entries, or others that the subject might suggest, as he would have done had there been no cross reference.

Following is a list of the pages included in the several number of the volume, by date:

A

An Uptodate Wheel Shop

By Frank A. Stanley

SYNOPSIS—The general arrangement of the shop, machines and motors, hoisting devices and yards of a new railroad wheel shop that handles 2,500 pairs of wheels a month. The operations of tire-boring, turning journals and facing hubs, tire-turning and wheel boring are shown in detail.

The new wheel shop of the Minneapolis, St. Paul & Sault Ste. Marie Railway Co. at Shoreham, Minneapolis, Minn., contains many features of interest both in connection with the arrangement of the equipment as a whole and in the character and operation of certain special apparatus. A detailed account of this department is well worthy of presentation in these columns.

Two general views of the exterior of the shop are given in Figs. 1 and 2. Both of these illustrations are of importance, as they bring out, in addition to the general appearance of the shop, certain special features that go far toward making the operation of the department effective and economical.

Referring to Fig. 1, it will be seen that there is a broad platform extending past the northern face of the building, carrying a series of tracks to accommodate a large number of wheels. Alongside this platform there is a depressed track at such a level below the surface as to bring the car bodies at the same height as the platform tracks. Material to be handled in the shops is brought from the road onto this depressed spur track, whence it is transferred to the series of storage tracks along the side of the shop. Similarly, car wheels and axles that have been overhauled in the shops, and new wheels and axles, are transferred from the building and when ready for shipment are loaded on cars on this depressed spur.

The handling of this material to and from cars is greatly facilitated by a 5-ton gantry crane adapted to travel the full length of the building over the storage tracks and depressed siding. The crane's bridge extends from the runway along the northern wall of the shop to a point directly over the shipping track, so that axles and wheels may be picked up bodily and loaded or unloaded conveniently.

At the outer end of the gantry will be noticed a special sling, in which are shown suspended two pairs of wheels and axles. This sling is so constructed that it may at one time handle four axles with their wheels, holding them in exactly the same relative position that they will occupy when dropped onto the platform of the car. At the time this photograph was taken there happened to be only two sets of wheels and axles suspended from the hooks; but the open end of the sling, which ordinarily picks up four such units at once, will be clearly seen and its purpose will be understood from the explanation given.

FIG. 1. SHOREHAM WHEEL SHOP OF MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RAILWAY CO.

The platform just referred to has a total width of 50 ft. At the south side of the shop there is a similar platform 40 ft. in width with a depressed spur track along its outer edge, where scrapped wheels and axles are handled and stored after they have passed through the shop. A view along the south and west walls of the building is presented in Fig. 2, giving some idea of the amount of material handled in the establishment.

The building itself is 150 ft. long by 60 ft. wide with monitor the full length, and with the maximum possible amount of wall space devoted to window lights. At each

end of the building at the bottom of the north wall there is a wide, low swinging door, the one at the eastern corner being clearly shown in Fig. 1. These doors are pivoted horizontally at the top and swing freely upward to allow providing entirely satisfactory protection against severe weather conditions.

The interior features of construction, the arrangement of machinery and the location of tracks, cranes and trol-

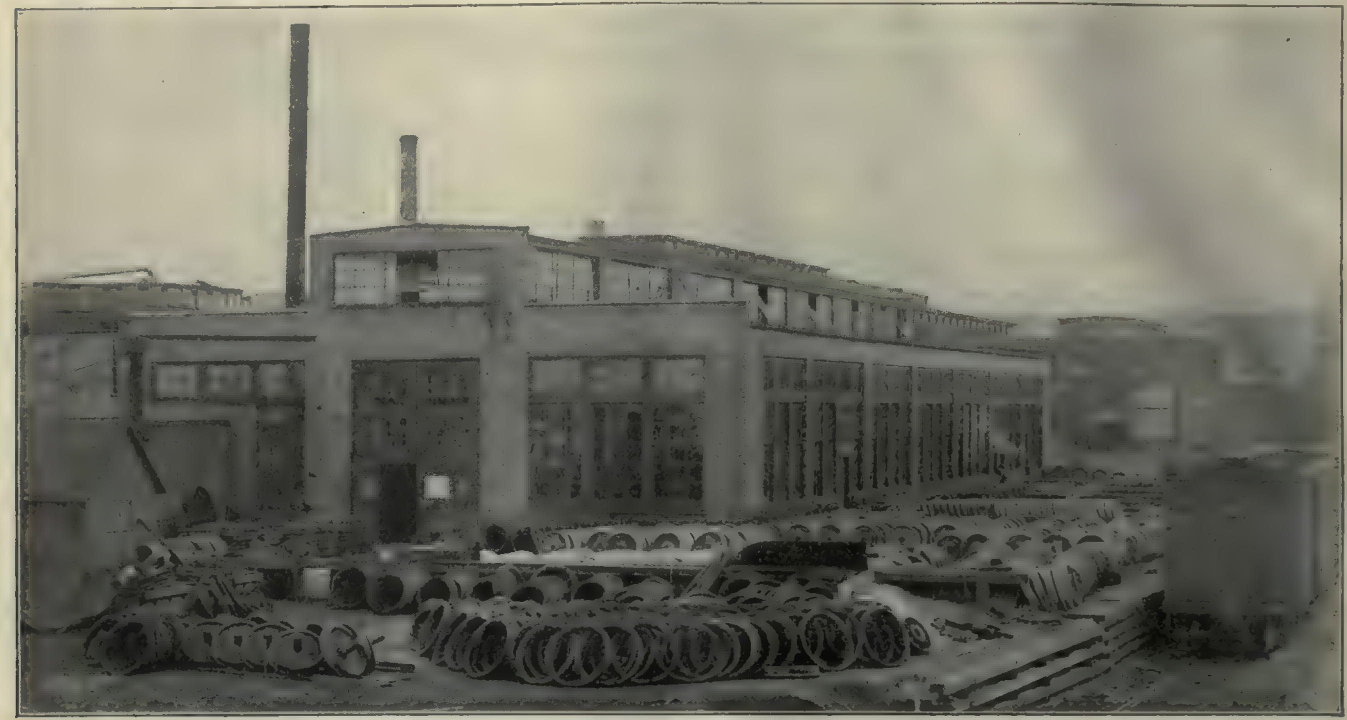


FIG. 2. ANOTHER VIEW OF THE WHEEL SHOP AND ITS YARD

FIG. 3. INTERIOR OF WHEEL SHOP

wheels and axles to be rolled directly in and out of the shop without the necessity of having large doors of the usual type swung open to permit the passage of work. The doors are of light but substantial construction, with bodies of wood, sheathed on both sides with sheet metal and faced with weather strip, so that the instant a pair of wheels is rolled through the door swings shut, thus

leys are all clearly illustrated by Figs. 3 and 4, the latter being a floor plan on which the positions of all tools and handling equipment are accurately indicated. This floor plan also shows the location and proportions of the two swinging doors previously referred to.

It will be seen upon studying this plan that the machines are all driven by individual motors, and that each

machine is served by a jib crane or by a trolley that operates along a rail extending the full length of the shop at a distance of 15 ft. from the south wall. The plan view further illustrates the two cross-tracks on which material

The turning of journals and the facing of hubs inside and out are two operations performed in the lathe shown in Fig. 6. This machine has four tool slides, two on each carriage, and four cuts may thus be taken simultaneously

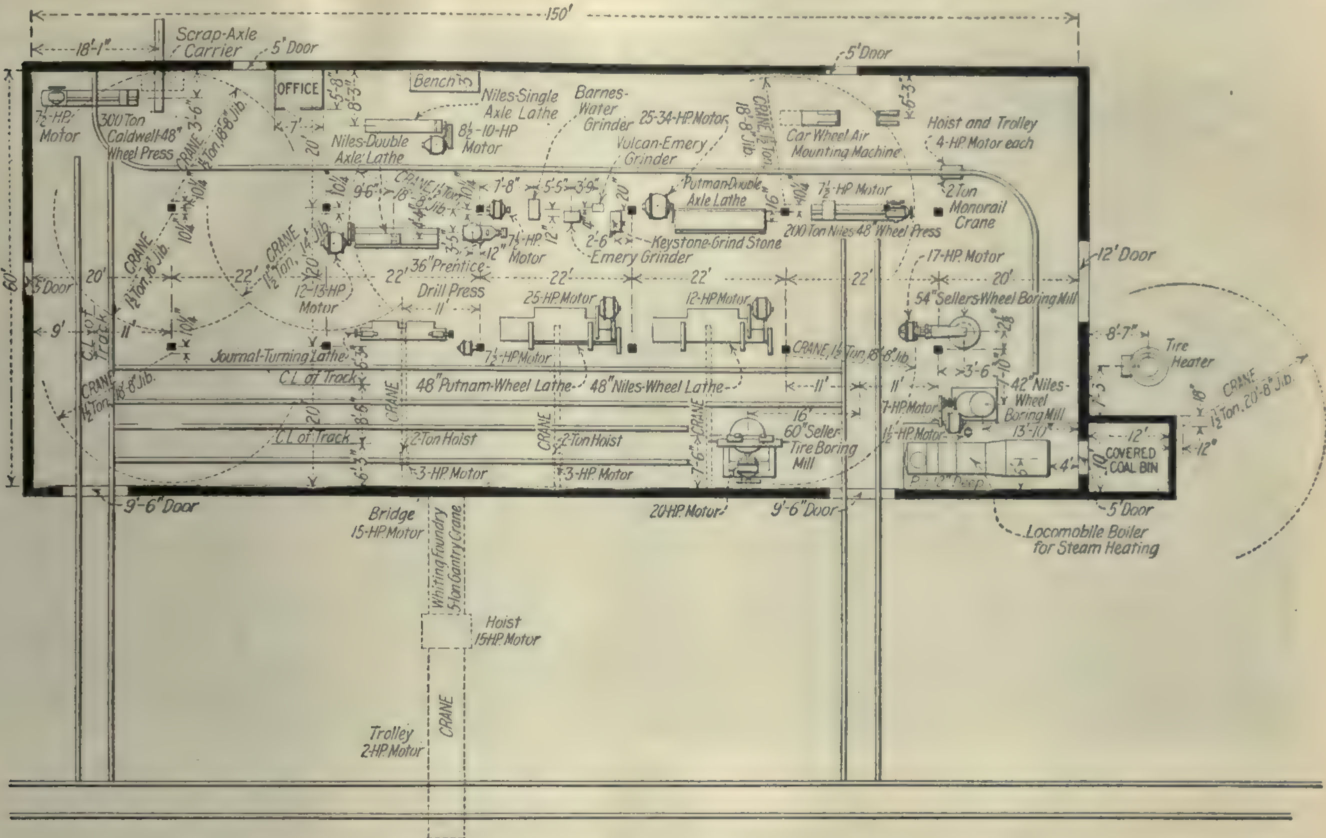


FIG. 4. PLAN OF WHEEL SHOP, SHOWING MACHINES, MOTORS AND CRANES

is rolled in and out of the shop, and the longitudinal tracks near the north side where wheels and axles are passed along as desired, as indicated in Fig. 3.

The wheels as rolled into the shop pass directly to the dismounting press for removal from their axles. This press is located in the southeast corner of the building directly opposite the cross-track shown to the left in Fig. 4, and it has so many unique features of construction that a special description of its operation and of the method of dismounting wheels, and passing wheels and axles out of the shop, will be given in another article. A few of the other machines of interest, with work in operation, are illustrated in Figs. 5 to 8 inclusive.

These views are of value, illustrating as they do the methods of holding the work in the machines, the application of the tools to the cuts, and the heavy rates of feed made possible by the use of suitable machinery, adequate holding devices and proper types of tools. In certain of these illustrations the heavy cuts and coarse feeds are clearly indicated by the tool marks upon the surface of the work.

Fig. 5 represents the boring of a steel tire under a two-head vertical mill where the work is gripped securely and held against possibility of chatter by clamping jaws that seize the tire by its tread and draw it down rigidly upon its seats by means of hooked clamps swinging over and acting upon the upper face of the flange. In boring out these steel tires the work is rotated at a peripheral speed of 13 ft. per min., and the tool is operated under a $\frac{3}{16}$-in. cut with $\frac{3}{16}$-in. feed.

when desired. Each tool slide has independent feed, and it is thus possible to feed tools independently or in unison across hubs and over journals.

At the back of the machine is suspended a convenient sling for picking up axles and wheels for placing in the lathe and for removing the finished work. This device is in the form of a double hook on a steel A-frame with the lower ends widely spaced to balance the work properly and with the upper or supporting end hung by a spring connection from a trolley hoist overhead. This spring connection enables the sling to be swung under the axle in the lathe to take the entire load before releasing the work from the machine, without placing stress upon the machine as would be the case if a rigid sling were employed: and similarly, in putting a pair of wheels into the machine, the same advantages of a certain degree of flexibility in the apparatus are secured.

The driving of the work, it will be noticed, is by means of a belt running directly on the tread of one of the tires.

Tire-turning is accomplished with the equipment shown in Fig. 7, where the coarse rate of feed as evidenced by the tool marks is clearly brought out. In roughing down these steel tires the turning is done at a rate of 13 ft. per min. with a ⅜-in. cut and ⅜-in. feed. The finishing is accomplished by broad-face forming tools, one of which will be seen on the cross-slide at the center of the illustration. These broad facing tools, like many of the other tools used, are of Midvale steel. They are made of rectangular stock and are rigidly secured ~~to~~ very heavy

holders. On an average seventy tires are turned to one facing of the tool. Mushet steel is principally used for axle turning.

The final picture in this article, Fig. 8, illustrates the boring of car wheels and shows alongside the machines the facilities in the way of cranes and special hooks for handling the work in and out of the chuck jaws. In boring hubs of cast wheels of the type here illustrated, a cutting speed of 60 ft. per min. is employed, with 0.2-in. feed and $\frac{3}{16}$-in. cut.

This article covers only a few of the many important features of the shop, several others of which will be described later. It will be of interest to point out at this time that this new wheel shop with a small number of workmen can regularly handle in the course of a month about 2,500 pairs of wheels and axles, these including several hundred steel-tired wheels, and in addition to the machine work necessary, take care of the unloading and loading of all classes of wheels, the inspection of new and scrap material, the checking of work and all accounting that may be required in the various departments.

From this it will be seen that the work is not only well arranged but the handling facilities are such as to make it possible to route the work through the shop processes with little or no inconvenience or delay.

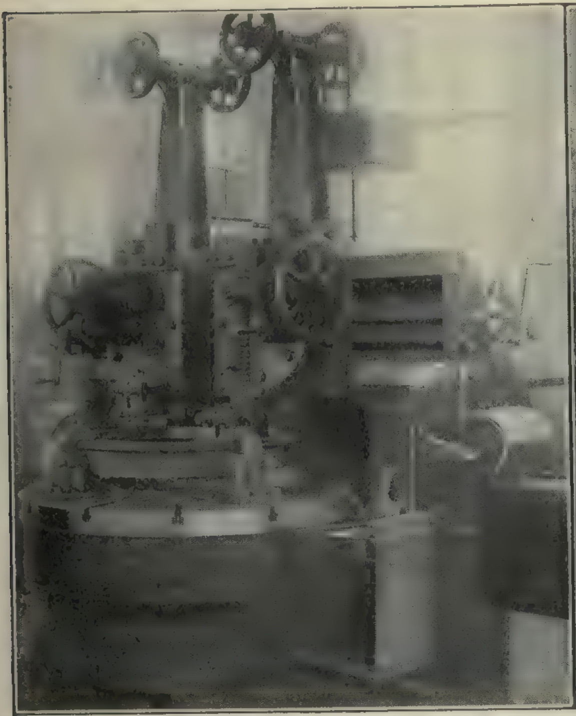


FIG. 5. BORING STEEL TIRES ON A TWO-HEAD VERTICAL MILL

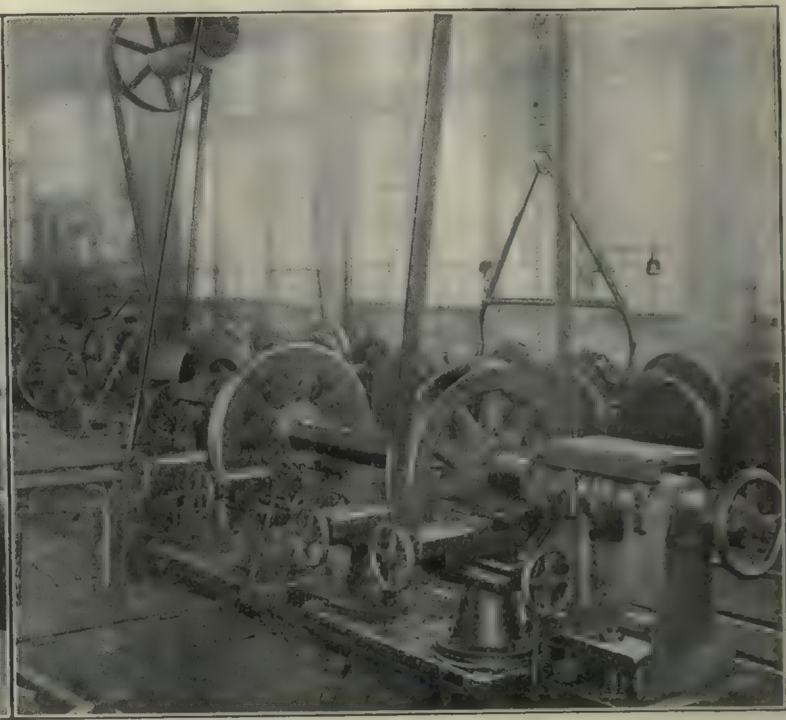


FIG. 6. TURNING JOURNALS AND FACING HUBS WITH FOUR SIMULTANEOUS CUTS

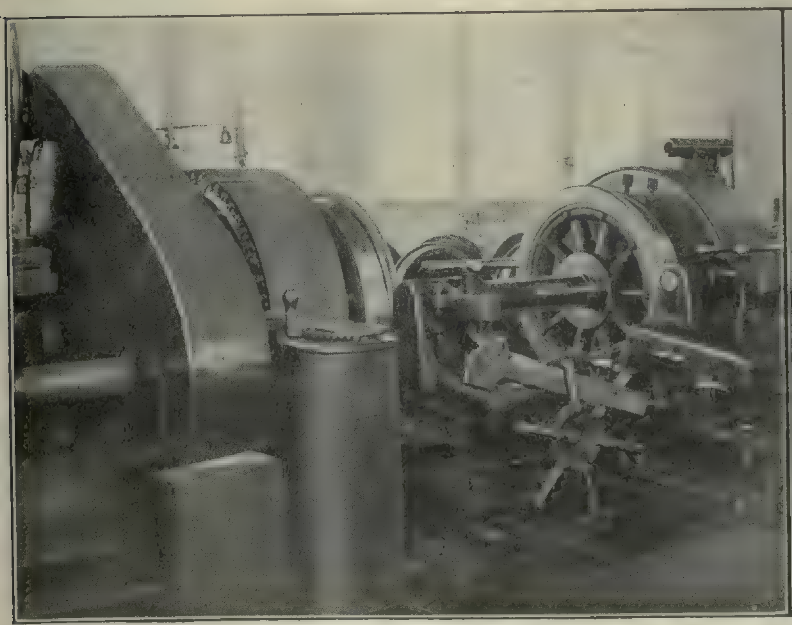


FIG. 7. TIRE-TURNING EQUIPMENT

FIG. 8. BORING CAR WHEELS

Railroads in Technical Schools

One would scarcely expect to find a railroad system within the limits of a technical school, even though a course in railroad engineering were a part of the curriculum. The new Massachusetts Institute of Technology has a real railroad system running within its laboratories and recitation rooms. It is an industrial track installation, and in place of locomotives hauling loaded freight cars, one finds upon these tracks laboratory tables being transported from preparation rooms to auditoriums.

FIG. 1. A PREPARATION ROOM

FIG. 2. LECTURE ROOM, SHOWING THE TRACK

FIG. 3. THE TURNTABLE

A chemistry preparation room is shown in Fig. 1. The apparatus, which will be used for demonstrating the day's chemistry lecture, has been prepared. At a moment's notice the table may be rolled into the auditorium shown in Fig. 2. The turntables as illustrated in Fig. 3 are provided to cover the entire range of laboratories, preparing rooms and lecture auditoriums.

Formulas for Testing Gears

By J. A. Potter*

The following formulas for the plug measurements for testing spur gears may be helpful to some of the readers of the *American Machinist.* They are presented as worked out for a definite problem for a gear having 20 teeth, 8 diametral pitch, 2.500-in. pitch diameter and 14½-deg. involute teeth.

The number of teeth is 20, and the number of spaces is also 20. So the angle subtended by the chord of the arc of the pitch circle that traverses a tooth space is equal to

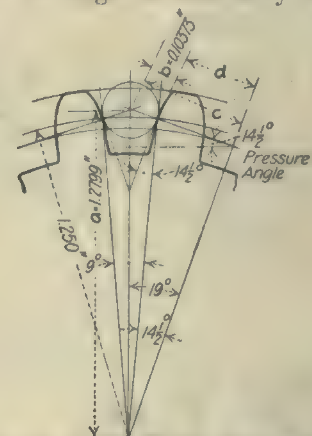


DIAGRAM OF PLUG TEST FOR SPUR GEARS

$$\frac{360}{2(number\ of\ teeth)} = \frac{360}{40} = 9\ deg. \qquad (1)$$

The dimensions that we need to find are the diameter of the plug and the distance between the centers of two plugs inserted in diametrically opposite tooth spaces. From these measurements we can find the distance over two opposite plugs.

The distance A between the plug center and the gear center is found from the following equation:

$$A = \frac{cos\ 14\tfrac{1}{2}\ deg.\left(\frac{PD}{2}\right)}{cos(14\tfrac{1}{2}\ deg. + \tfrac{1}{2}\ angle\ subtended\ by\ tooth\ space)}$$

$$= \frac{cos\ 14\tfrac{1}{2}\ deg.(1.250)}{cos\ 19\ deg.} = 1.2799\ in. \qquad (2)$$

The radius of the plug b is equal to $c - d$ (see diagram)

$$c = sin\ 19\ deg.\ (1.2799\ in.) = 0.4167\ in. \qquad (3)$$

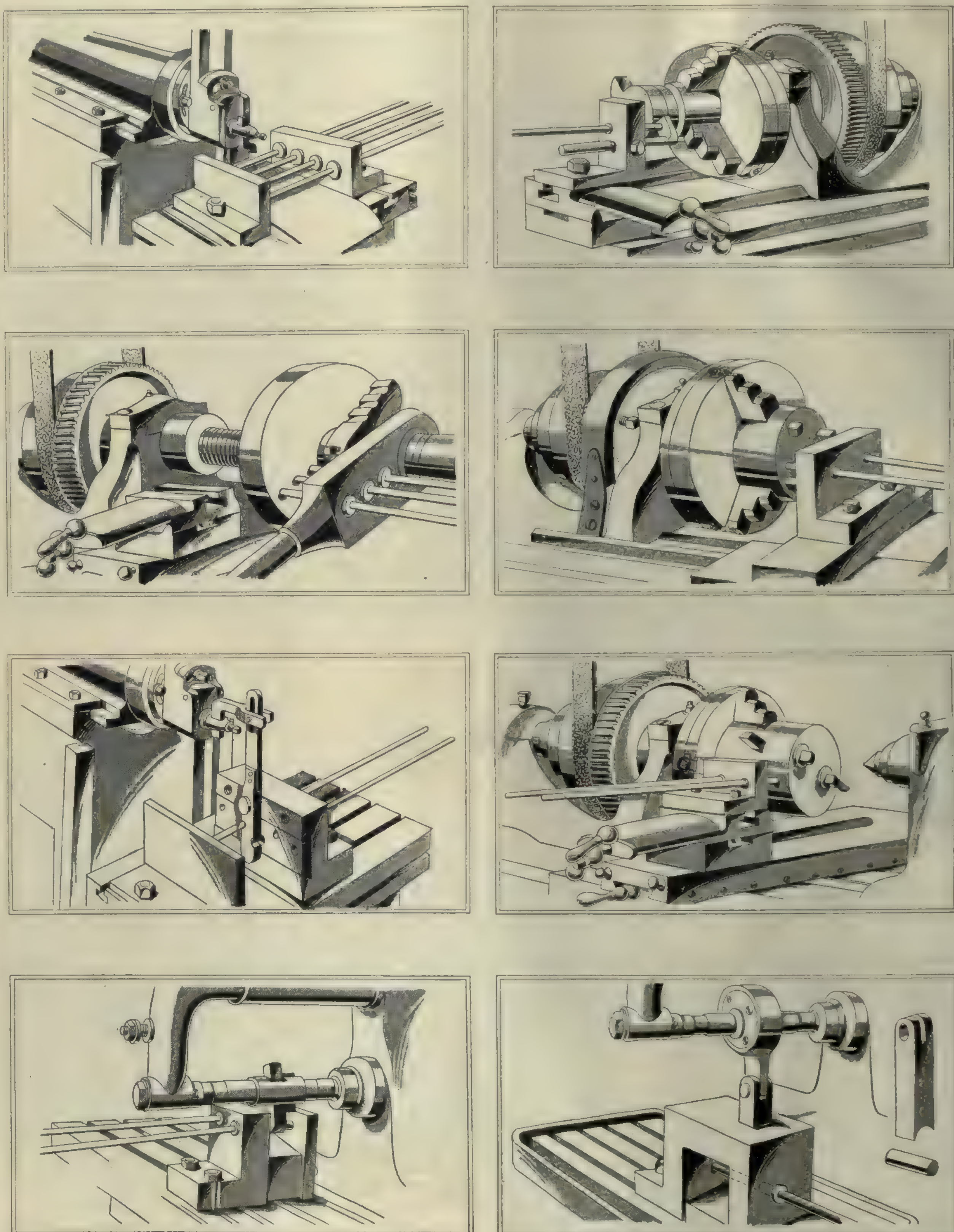
$$d = sin\ 14\tfrac{1}{2}\ deg.\ (1.250) = 0.31297\ in. \qquad (4)$$

$$Radius\ of\ plug\ b = c - d = 0.4167 - 0.31297 = 0.10373\ in. \qquad (5)$$

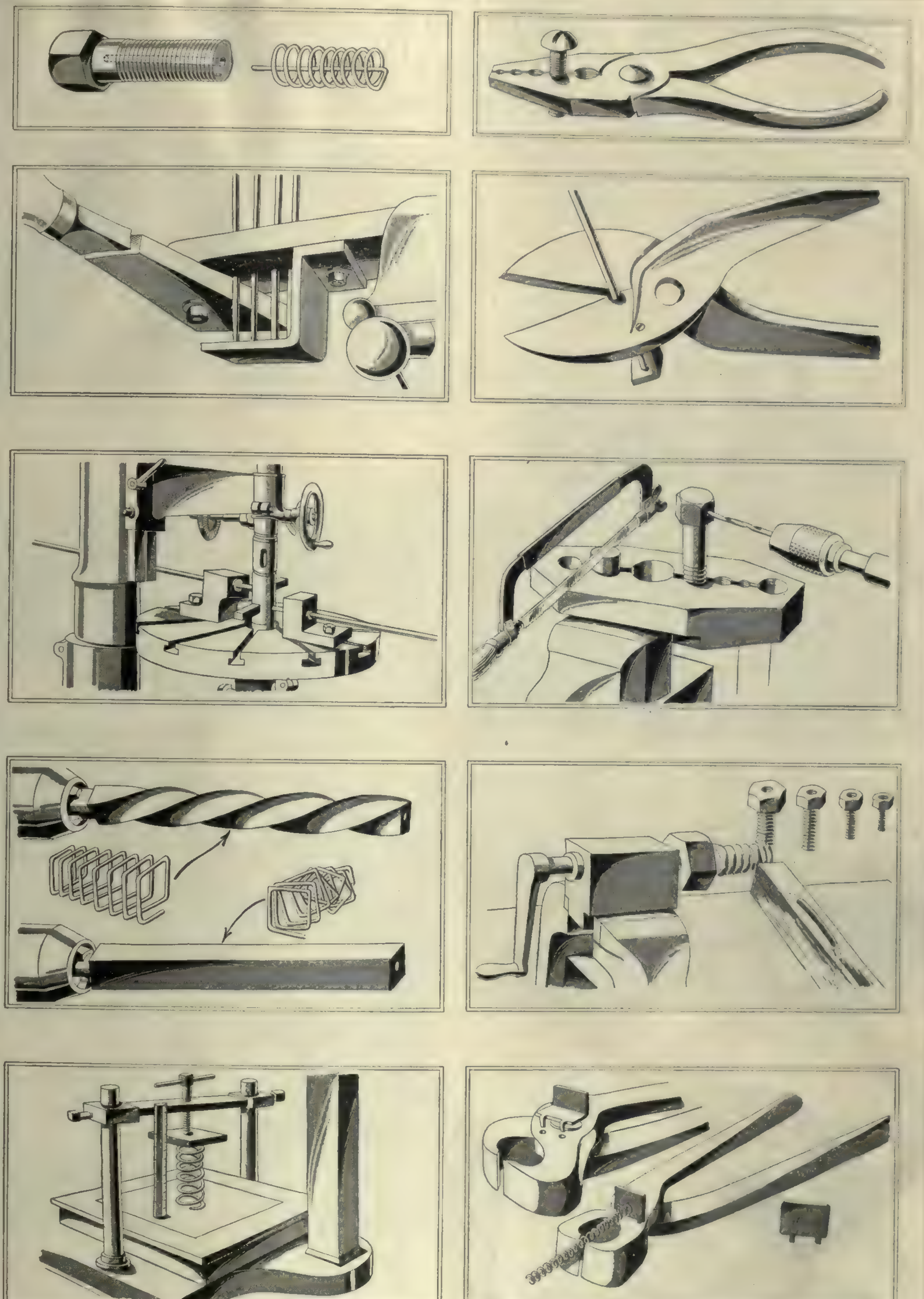
The distance over two plugs fitted into diametrically opposite tooth spaces is equal to twice the radius of the plugs plus the center distance apart of the plugs, or

$$2\ (0.10373) + 2\ (1.2799) = 2.7672\ in. \qquad (6)$$

*Chief Tool Designer, Becker Milling Machine Co.



A Number of Ways To Cut Pins in Quantities



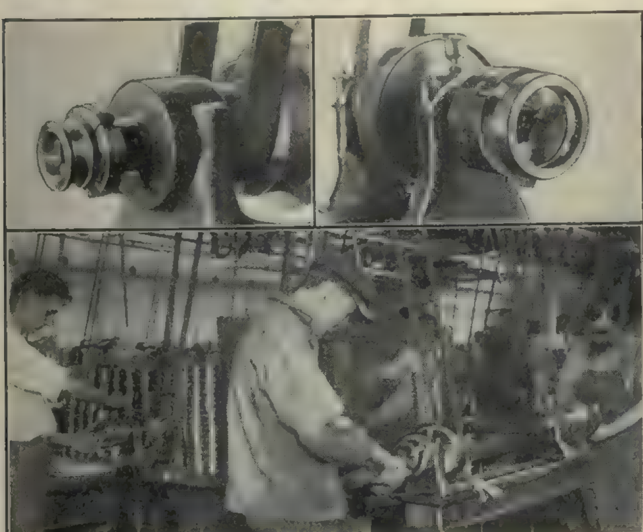
Spring Winding, Tooling, and Cutting and Other Kinks

Ball Bearing Assembling and Inspection Methods

Editorial Correspondence

SYNOPSIS—The methods and gages described here give a good idea of the care used in the making of these bearings. Few machine parts are as accurately made, and all the finishing steps are precision processes.

In a previous article some of the principal machining methods on Hess-Bright ball bearings were described. In this one a brief outline will be given of some of the as-



FIGS. 1 TO 3. METHODS USED IN POLISHING RINGS
Fig. 1—Polishing inner ring. Fig. 2—Method of holding outer ring. Fig. 3—Polishing lathe

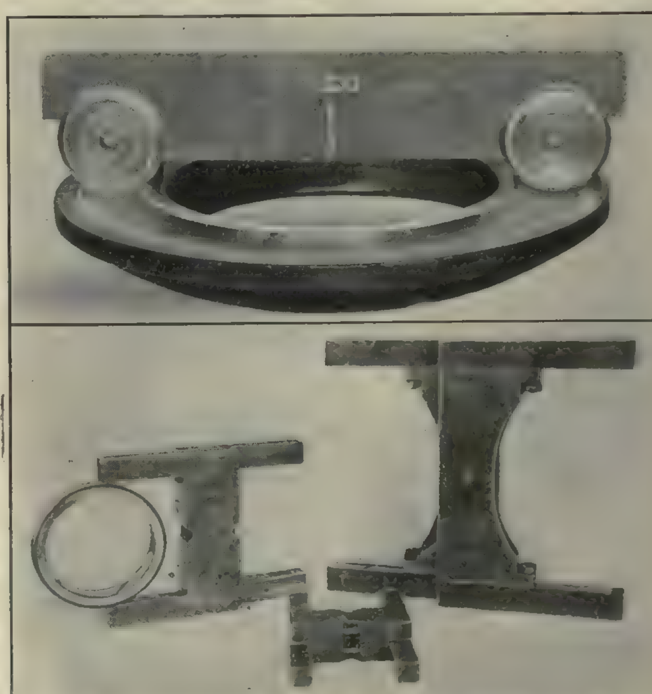
FIG. 4. CAGE-ASSEMBLING JIG

FIG. 5. RIVETING A CAGE

sembling and gaging operations. The greatest care is taken throughout the various steps to insure accuracy and durability. After being ground, the ball grooves are polished to a mirror-like surface that will not show scratches under an ordinary pocket microscope. The assembling of the balls and outer and inner race of each bearing is divided into two separate operations. In the first, balls of a uniform size within a tenth of a thousandth are assembled into the rings, the fit being so close that the rings are turned with some difficulty; or at least the rings will not spin when revolved by hand. Following this, the bearings go to another set of operators who disassemble them and polish down the grooves until the balls are a nice easy fit and the bearings spin easily.

It is not necessary to describe each step, but during the process both the inner and outer ring grooves are polished with fine emery cloth, the inner ring being held as shown in Fig. 1 and rotated while the workman presses the cloth

FIGS. 6 AND 7. GAGES FOR INSPECTING THE RINGS
Fig. 6—Gage used on inner rings. Fig. 7—Outer ring inspector's gage



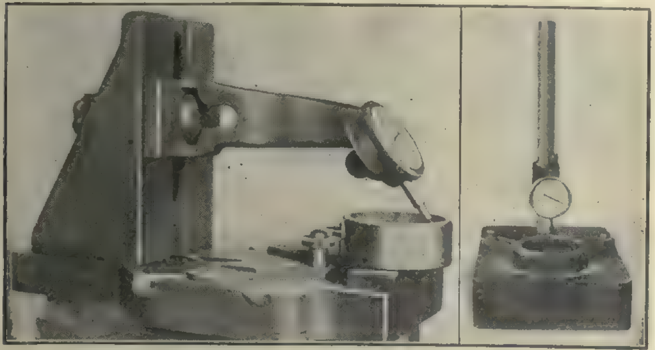
FIGS. 8 AND 9. FORMS OF INSPECTION GAGES
Fig. 8—Gage for thrust bearing grooves. Fig. 9—Types of go and not-go gages

into the groove with a rounded stick or with his fingers. Outer rings are held as shown in Fig. 2. For some of the work, special double-end lathes, like the one shown in Fig. 3, are used.

After the bearings have been properly fitted, the cages are put in and riveted. The first operation on this work is to put in the two parts of the cage and "tack" the rivets with a hammer and hollow punch, while the rivet heads rest on the supports of the jig shown in Fig. 4. The rivets are then properly headed in a Townsend riveter, as shown in Fig. 5.

Numerous gages are used at every step through the shop process of manufacture. Every part of a bearing is inspected after each operation, the inspectors having

one set of gages and the machine operators another. One of the shop gages used in centering the groove in inner rings is shown in Fig. 6. Others used by inspectors on outer rings are shown in Fig. 7. A gage used while grinding the groove in a thrust bearing is shown in Fig. 8.



FIGS. 10 AND 11. INDICATOR STANDS
Fig. 10—Stand for an indicator. Fig. 11—Indicator stand for double bearing rings

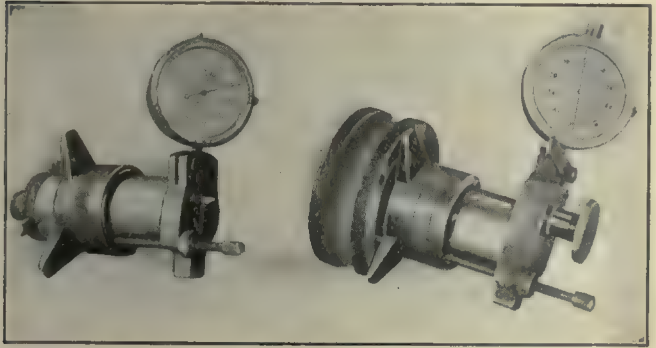


FIG. 12. GAGES FOR BORE OF INNER RINGS

FIG. 13. TESTING BALLS FOR SIZE AND TRUTH

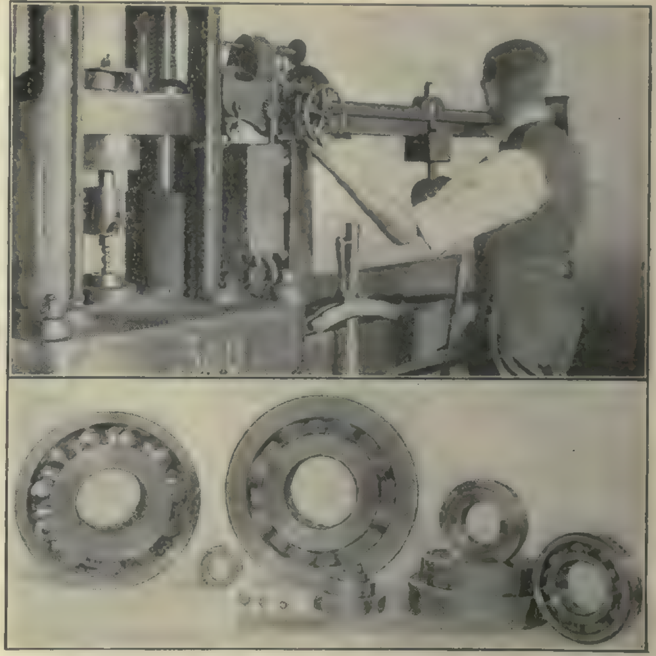
All these make use of a hardened steel disk with a knife-edge.

In Fig. 9 are shown the types of go and not-go gages used for ring diameters in the inspection room.

A large number of dial indicators are used both for shop and for inspectors' gages. These are mounted on special stands. One so mounted for use in testing the thickness of outer rings is shown in Fig. 10. The ring is simply placed against the stops and rotated under the indicator, which instantly shows whether the ring is ground the same thickness all around or not. Another indicator mounted for gaging the grooves in double bearing rings is shown in Fig. 11. In this case the stops are fitted with knife-edge disks against which the ground outer diameter of the ring contacts.

The gages shown in Fig. 12 are to test the truth of the bore ground in inner rings. The one at the left shows a gage empty and that at the right one with work in place. The point of the indicator rests on a contact lever, so that as the ring is turned the variation is read from the dial. Numerous other examples might be shown of the gages used, but these represent the principal types and are sufficient to give a good idea of the care and accuracy used in the work.

All the care in the world applied to the bearings would amount to very little if the balls were of various



FIGS. 14 AND 15. TESTING AND THE FINISHED BEARINGS
Fig. 14—Crushing test on balls. Fig. 15—Some of the finished bearings

sizes in the same bearing. To obviate this, each ball used is tested as shown in Fig. 13, and sorted into lots, each lot being of uniform size within a tenth of a thousandth. Each ball is also tested for spherical accuracy by revolving it between the points, as shown. A light oil is used in the pan at the right of the operator, into which the balls are first dumped. This oil prevents rust and also helps in the testing process.

In order to be as sure as possible of the quality of the balls used, a certain number are taken from each lot received and crushed in a Riehle testing machine, as shown in Fig. 14. Others are carefully examined under a powerful microscope for surface finish. Assembled bearings from each lot are also taken at random and run to destruction, or for a certain predetermined time, in special testing machines.

A few finished bearings of different types and sizes are shown in Fig. 15.

The Kind of Work for a Trade-School Shop

By Entropy

There appear to be two widely varying ideas as to what should be attempted in the machine shops of trade schools. One camp would treat every job from the rather elementary standpoint of the backwoods jobbing shop with only the most limited complement of machinery and tools; the other would make it a highly organized manufacturing plant with every facility for making the work of the apprentices productive of the greatest marketable value.

To my mind both are partly right and neither wholly so. If the aim of the school is to turn out a few highly skilled men to fill a local want, then of course it is necessary to study the local shops that may require the services of the graduates; and the school shop will reflect the organization of the shops that it supplies. It does not seem as if this could be entirely justified in a state-aided school. Any one state will have manufacturing establishments ranging from the crudest development, as typified by the wayside blacksmith shop, to the most modern factory with fine subdivision of operations and jigs that cannot be used except in the way for which they were intended. The school that accepts state money, it would seem, should train boys so that, according to their temperaments, they may fit into either kind of shop or any of the intermediate stages of development. It is this very universality of the demand that makes it desirable for a school to have a large range of work from which to select and a wide range of methods for doing it. The fact that a school is situated in a machine-tool district does not justify it in limiting its work to the building of speed lathes, nor does the fact that it is in a textile center justify its limitation to looms or other textile machinery.

What the Public Pays For

The public pays for two things that should be harmonized: First, the training of its boys in the arts for which they are fitted, regardless of the demand or lack of demand for the practice of those arts in the town in which the school happens to be situated; second, the training of such of these boys as may be fitted, for the industries that are included in the community taxed for the support of the school. These two functions are somewhat antagonistic and can only be harmonized by a compromise in which the boy's interests and those of his future employer must be given equal weight.

The Ideal School

The ideal school, where every boy would have an opportunity to learn whatever would fit him for what he ought to do for a life work and where every employer would be supplied with the kind of help that he required, cannot of course ever be realized. At the age when boys ought to be attending a trade school they are not mobile, as college boys are. They must be kept near home and mother. Consequently, there are many limitations that may not be for their best interests, taken one by one. Then, too, the employer may not be broad-minded and far-seeing enough to be willing to wait for the graduate to secure an all-around training. He may want him half trained, but kick because he finds him only half trained.

It is very easy for an employer to define in terms of his present and apparent necessities the requirements for a trade-school graduate, without realizing that what he wants is a man trained to think for himself and yet willing to play the game in good teamwork with the rest of the shop. That can only come slowly but it is entirely independent of the trade that the boy is learning and of the way in which his shopwork is being presented.

Presenting Work in Two Ways

If a reasonable amount of time, say four years, can be had, then there is time, at least in the machinists' trade, to present the work in both of the ways suggested above. Then it is easiest to reverse the pedagogue's way of approaching the job and give the boy the best of tools, jigs and other facilities for turning out work at the start and save the more purely machine-shop methods and principles for the last.

The first interest that the average boy has in mechanical things is to see something go around. Set him to work chipping and filing for more than a short period and he tires of the trade, because that represents to him a form of inactivity that does not appeal. He works, but he does not see results fast enough. That is where the woodworking trades and electrical work have their drawing power. The woodworker makes a great showing; he cuts a board off long before the machinist gets a bar of steel clamped in the saw. The electrician fastens up a switch and runs a line of wire almost as quickly, while the machinist may fuss around all day scraping a surface plate and have little to show at night.

Very few have mechanical patience when they are 14 or 15 years old. The easiest and most logical way to secure work for this phase of training is to manufacture parts of machinery for manufacturers. In this way there can be secured the kind of work for which the pupil is ready at that time. No machine that can be manufactured as a whole in a trade school will give the balanced training that is needed. There will be too much lathe work and too little grinding, or too much planer work and not enough drilling. If parts of machines of standard manufacture are made, they can be obtained from many different concerns and may represent many different kinds of finished product. They can be readily obtained, and good prices will be paid by any large shop that is up to date enough to manufacture small parts and store them against the time of assembling. A small shop cannot always furnish such work, because it must be able to depend on a time of delivery, which is something that a trade school should not attempt.

Treatment of the Manufacturer

In justice to the manufacturer he should not be asked to furnish anything except blueprints. If he furnishes materials, there will be the difficulty about replacing spoiled parts; and if he furnishes tools and jigs, he will be without them longer than seems reasonable. A trade school that does its whole duty by its pupils must do many things that no manufacturer would tolerate in his shop, for the reason that the trade school is making an entirely different product. The manufacturer

is making machinery or some other material product at so much a ton, which depreciates from the moment it is sold, while the trade school is making men with no limit on their ultimate value provided of course they have ability and receive the proper training.

Teaching vs. Exploiting the Boy

If the trade school keeps a boy on a job after it is sure that he can do it "habitually well," it is exploiting him. A manufacturer cannot possibly make a profit on a man or a boy except by keeping him beyond that point. Again, a trade school must look out that each pupil is given a job that will require all the mental ability that he has and that will lead him along beyond where the last job left him. A manufacturer can always afford to give a man a job well within his proved ability. That is also the way the manufacturer makes money. It may therefore be accepted that it is unlikely that a trade school that shows a profit is doing its best to train the boys intrusted to it.

But to return to the manufacture of small parts: If the school ought not to borrow the manufacturer's equipment and yet must have the proper facilities for rapid production, it must necessarily make them itself, which brings us to the article on page 842, Vol. 45, of the *American Machinist*, describing certain fixtures designed at the state trade-education shops at Bridgeport, Conn. These fixtures evidently are made by advanced pupils who have made the drawings and possibly think they have also done the designing. The fixtures are built on the conventional lines, which are the only safe ones for a trade school to follow. At the risk of being criticized I venture the suggestion that machine design, or jig and fixture design, has no place in a trade school, if the word design is to be given its strict meaning. No one should attempt machine design without a broader acquaintance with the principles and art of machine manufacture than can possibly be acquired or understood by any boy of trade-school age. It is all-sufficient glory if such a school can command the services of instructors who are able intelligently to interpret the designs in common use, so that the advanced students can do the construction work.

One Purpose Is To Form Habits

By the aid of these fixtures and strict discipline in following instructions, preferably written, almost any group of boys can be made sufficiently productive so that they will find some interest in the work. At this stage, however, it is much easier for them to carry through quite good-sized lots. Our friends from the technical schools will abhor the idea of having lots of over half a dozen pieces, but it should be borne in mind that the purpose of the trade school must be to form habits as well as to develop reasoning power and initiative. At the age when boys can attend these schools they can be molded, but their initiative is likely to run in wrong directions unless kept pretty well in check.

Varying Ability of the Boys

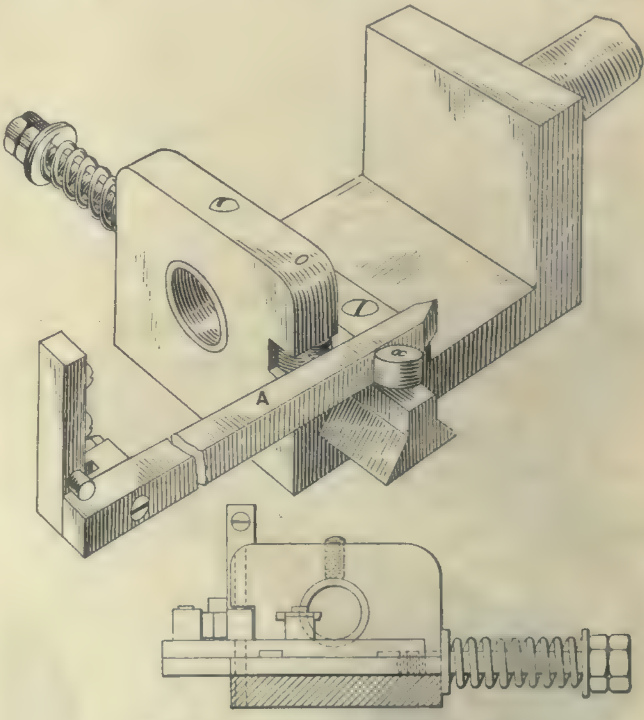
This strictly manufacturing method of instruction may of course be all that some of the pupils can rise to, but out of every class there will be found some who can learn to work in the simon-pure machine-shop fashion, having little to do with except their native mechanical ability. Such boys should be given the best of opportunity to build machines of simple design, all the way through from the castings to the running machine—and that without jigs or fixtures of any kind. For their benefit some general jobbing work that can be allowed to take its time in the shop should be provided. Boys who can do this kind of work will not, however, be allowed to remain long as machinists. If they develop executive ability, they will become foremen; if they have a knack of originating new combinations of standard designs, they may become draftsmen and be called designers; and if they have a faculty of planning work for others, they may find places in so-called efficiency departments.

These are the few boys who in the old days served apprenticeships and became machinists. The others make up the higher grade of machine operators, only it seems impossible that they will not have a better realization of the relation of their product to the finished machine, and a clearer idea of their relations to society, than the men who merely go into a shop and pick up a portion of a trade.

Taper Turning Attachment for Screw Machines

By Mark Gluckman

The illustration shows an efficient device for cutting tapers in the screw machine. It has been in use for a long time in our shop, successfully. We use it mainly for tapering long rods, but pieces of irregular outline can



TAPER TURNING ATTACHMENT

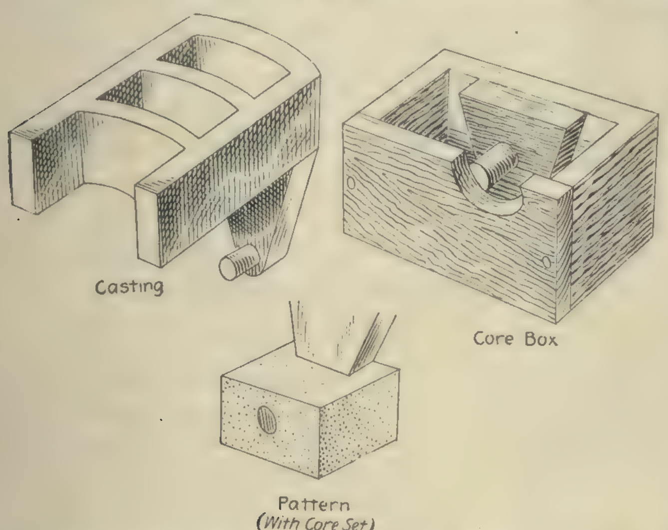
be turned by substituting a curved guide *A* in place of a tapered one. The bracket holding the guide is bolted to the headstock in a manner depending upon the design of the latter. The guide is hinged so that it can be lifted out of the way to make room for the cross-slide when needed. The cross-slide is held in contact with the shaped guide by means of the heavy spring, which bears against the side of the bracket, as shown.

Setting a Core Without a Print

By Donald A. Hampson

Hearty coöperation among the members of that great mechanical quartet—designer, pattern maker, foundryman and machinist—can only result in a better product at a lower cost and in harmony all along the line. But as frequently happens, the foundryman is an outsider—that is, the plant contracts for its castings—and there arises at once a loss from not having the foundry viewpoint exert its own particular influence and its own short-cuts on design and machine work.

The grate casting illustrated will serve as a typical example of a kink well known to foundrymen, but little



THE PATTERN, CORE BOX, CORE AND CASTING

known to designers and machinists unless they have had foundry experience or are in a position to discuss such a problem with a man of that trade. On each end of this casting is an arm with a hub near the end for the shaker bar. If it were not for this hub, the pattern would draw very nicely; but with it many designers and pattern makers would make a rather elaborate core extending the full height of the grate.

The foundryman's short-cut is to make a small outside core that fits over the end of the arm and has a hole in it the size of the required hub. This core is set in place around the arm when the pattern is put in the flask, and the sand is rammed up around them both. When the pattern is drawn, the core stays in the sand, where it remains to form both the hub and the end of the arm. It will be noticed that there is no core print on the pattern.

The core box and the core in place are shown in the drawings. The same kink can be used on any number of similar constructions. As illustrating the advantage of coöperation with the foundry, the matter of casting these grates presented itself when the pattern was nearly finished. Instead of going ahead and putting in core prints that would necessitate an extensive core-making job (there were 120 pieces in the lot), the pattern maker stepped into the foundry and asked the foreman if he knew of a simpler way. The answer saved several dollars both in the foundry and the pattern shop. This same kink would have saved a job shop five dollars when two rocker arms of peculiar shape were wanted; however, a simple pattern and an elaborate core box were made up.

The Use of Snap and Ring Gages

By F. H. Bogart

Judging from existing practice, there is a wide divergence of opinion on the relative merits of snap and ring gages for measuring diameters. Many shops use ring gages wherever they can be got on the work, while others have discontinued their use entirely, claiming they have no place in modern manufacturing. The advantages of the ring gages are that they are cheap to make, easy to use, and are generally preferred by every class of help required to use them. The disadvantages are that they cannot be used exclusively, as the diameters of grooves or turned surfaces between shoulders of longer diameter—such as the band groove on a shell, for example—cannot be measured with them; moreover, they are inconvenient on parts turned or ground between centers. Other disadvantages are that two are required for each tolerance, and they do not detect eccentricity, allowing the operator to turn a part undersize at one or more points, thinking he is still oversize because his ring will not go on.

Much of the prejudice against snap gages is owing to the fact that when they first came into use they were made altogether too frail, and the average operator would bend them out of shape and size after a few hours' use. This disadvantage has been overcome by the substitution of very substantial forgings for the yoke pieces, strong enough to insure them against springing to any appreciable degree, even with rough usage. With this objection overcome, very little remains in favor of the ring gage except that the operators like to use them.

The writer recently visited a shop where it seemed to be the practice to use ring gages for all roughing dimensions, and maximum and minimum limit snap gages for finishing. The roughing gages were all made of gray iron cast with a projecting rim around the outer edge, making them easy to handle and protecting the finished portion from damage in everyday use. These cast-iron gages did not cost much to make and maintain.

Crane Operation Facilitated by Reflecting Mirror

By William Lailer

In connection with the operation of several large traveling cranes in our shops, it was noticed that whenever any lifting was to be done near the end of the crane where the driver's cage was located, it was necessary for the operator to lean far out over the window opening in the crane box in order to obtain a view of what was going on below. This was unsafe, owing to the possibility of the driver losing his balance and falling out; and while in this position the driver was at a disadvantage in operating the control levers.

To overcome this situation we procured several large reflecting mirrors, somewhat on the order of the mirrors used on automobiles for viewing the road behind, and attached them by means of substantial brackets to the outside of the crane cars so that the image on the floor directly below the crane car would be projected to the driver while in his normal position. The cost of installing this simple device was exceedingly small, but its advantages are obviously worth while.

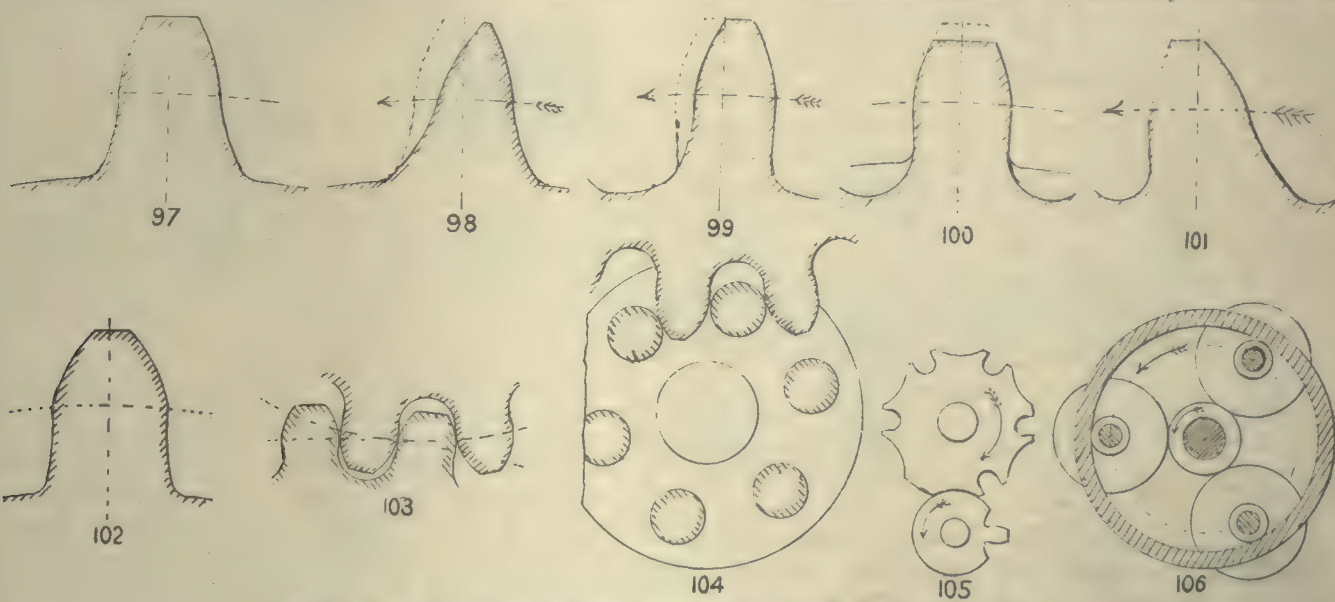
A Book on the Looks and Details of Machines—V

BY JOHN E. SWEET

SYNOPSIS—This fifth installment takes up gearing, belting and pulleys with the sureness of analysis and clearness of explanation that were so characteristic of Professor Sweet. After discussing wear in gear teeth this bit of wisdom is written, "The machine that has to be corrected for wear is always too much out before correction is made."

In the case of tooth gearing, the tooth that is theoretically correct, or at least supposed to be—the double-arc epicycloidal form, Fig. 97—is not the best in practice except for gears that have nothing to do but run nicely. The reason is that a gear should not only be good when new, but the best compromise between a new one and one reasonably worn out. A tooth cannot wear any at the root and can wear to a knife-edge at the point, Fig. 98. All the time, from the beginning to the end, an assumed correctly formed tooth grows worse and worse. No engine builder would think of turning out an engine in which the cylinder was not counterbored to prevent the piston from leaving a shoulder at the end as it wears. While it is not practicable to undercut a gear tooth, the single-arc odontograph does this to a certain extent. The gear not only runs well when new, but for a long time; and the gear of this kind, when half worn out, will show that it has worn into an assumed correct form, Fig. 99. From this fact the false conclusion is often reached that it should be so made originally.

Another objection to the epicycloidal form is that it is necessary to maintain a fixed distance between the shaft centers. This is not only difficult to do but much more difficult with that form of tooth than with the single arc. The objection to the undercut tooth is that it is weaker; but many engineers are advocating and others have adopted a shorter tooth, Fig. 100, than that which has been in use for years, which is stronger. Other ways to get strength are to use a coarser pitch where the driving is always in one direction, or light in running backward, to give the back of the tooth a different form by cutting away the point and filling in at the root, Fig. 101—a practice followed by some crane builders. Any number of forms of teeth will run well when new, provided there are not too few teeth in the pinion, if the teeth are *accurately spaced* and the *gears round;* yet none will run well if either of these two conditions is not complied with.



FIGS. 97 TO 106. VARIOUS GEAR FORMS AND THE GENEVA STOP

Figs. 97 to 101—Forms and wear of gear teeth. Fig. 102—Tooth of Willis system. Fig. 103—Tooth profile formed by circular arc. Fig. 104—A lantern pinion. Fig. 105—The Geneva stop. Fig. 106—Internal gear and pinions

Theoretically the face of the tooth at the pitch line should be radial, to prevent all tendency to thrust the gears apart; but to be able to make gears interchangeable and with pinions as small as twelve teeth and not too weak, an angle of 14½ deg. to the radial line was adopted by Professor Willis, a Manchester professor, many years ago, and later by makers of machine-cut gears in this country.

The Willis odontograph system was one in which the curves on the teeth were all arcs of circles, and all gears of one pitch would mesh with any other gears of the same pitch, Fig. 102.

This is true with gears generated on the epicycloidal or involute systems, but these systems have the defect pointed out above—that they are good new gears and poor old ones. It is possible that the generating cutter can be so made as to undercut the finished tooth. In cases where the work is not so excessive but that the contact between any single pair of teeth is ample, the actual arc of contact necessary for one tooth to bite before the previous pair let go is very short. So if the

circular arcs are struck from what we may say is a too short radius, Fig. 103, the gear will work all right, run smoothly and get no worse by wear for a long time; but there will be but a single pair of teeth in contact, until they wear to it, and the curves they wear to will be correct, provided the root is undercut enough. This is not to advocate any new form of tooth or of tooth curve, but simply one view of the subject and an extreme case to show that out of the many forms advocated those which will do best through a long life are better than those that are correct when new and grow poorer from then on.

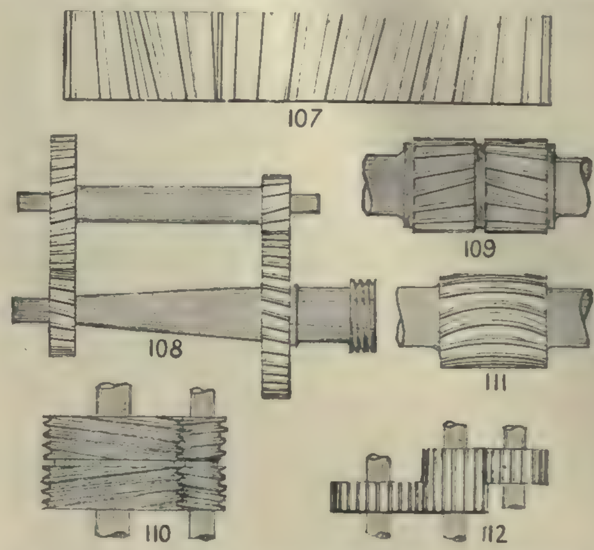
The use of the diametral pitch and the standard milling cutters of the Brown & Sharpe system is so well established for all machine-cut gearing that it would need to be something infinitely superior to justify any change; but there are cases where a stronger gear is necessary, and the shorter tooth with a better root is a simple way to get it. Turning the blank smaller, say once and a half the pitch instead of twice the pitch larger than the pitch circle, shortens the tooth at the outer end, and grinding off the corners of the cutter till the end is a true half-circle will fix the root right. The faces would remain the same as before, and the result would be a tooth stronger than those shortened in the usual way.

Where two gears are of a size or where the larger wheel drives a pinion, the pinion should not have fewer teeth than twelve, unless the work is very light. When the work is light, a lantern pinion, Fig. 104, with as few as six teeth will run very well. When the pinion drives the wheel, as few teeth as one will work, which is what the Geneva stop motion is, Fig. 105; but in this case the wheel remains at rest a goodly portion of the time, and the wheel cannot be made to drive the pinion.

With a two-tooth pinion the wheel comes to rest at each half-revolution, and it cannot be made to drive the pinion except with some sort of flywheel on the pinion shaft, and not then until the shaft is started off the dead center.

There are advantages sometimes in using internal planetary gearing rather than plain spur gears. As an example, assume the ordinary back gear of a lathe to have a spur on the spindle 24 in. in diameter on the pitch line. Then the spindle will be turned with a lever arm of 1-ft. radius. Take an internal gear, Fig. 106, of 18-in. diameter, with pinions and gears as planets, pinions 3 in., gears 9 in. and a central pinion of 6 in., which would give a reduction of something over 9 to 1 and a lever arm from the two pinion journals of 15 in. instead of 12 in., as in the case of the spur gear. The driving, being from both sides, would wear the main bearings much less. Besides, with two or three planets the strain on the teeth would be much less. There would also be another point: The liability of the tools chattering would be practically eliminated, though the true way to prevent chattering is to put more iron in the bed and headstock of the machine. The back gear of a machine so designed would, so far as the driving is concerned, be better, but to change from fast to slow involves mechanical difficulties. Besides, the construction of the whole system requires very accurate work to make it successful.

The whole aim of the builder and the desire of the purchaser have for the last few years been to get machines to do a vast quantity of work in the shortest time. But there is likely to be as there always have been before, periods of progress in one direction, then—what appeared to be the limit in that direction having been reached—progress in another direction taken up. So it may not be idle to imagine that rivalry will spring up to see who can build the best, and the gage will become not quantity but quality of product. That can only be accomplished by machines that do not wear out of truth. The machine



FIGS. 107 TO 112. VARIOUS FORMS OF GEARING

Fig. 107—Spiral gear teeth. Fig. 108—Lathe back gear. Fig. 109—Rolling-mill gear. Fig. 110—Herringbone gear with extreme degree of spirality. Fig. 111—Rolling-mill gear. Fig. 112—A Marlborough gear.

that has to be corrected for wear is always too much out before the correction is made.

Gear making is one of the puzzles in the business. However much care is taken, occasionally some will be noisy, either from imperfection in design or workmanship, or owing to the peculiar character of the work. This is particularly observable in power cranes and explainable in lowering, as it may be that the weight and the power work alternately in driving the intervening mechanism. One remedy for this is to use rawhide pinions, but while fairly effective they are just a little too short-lived. Rawhide gears and steel pinions would do finely, but that bugbear cost prevents their use. Just why the purchaser will pay $5,000 for a crane and rebel on $25 for a gear wheel to insure quietness and a long life is simply because the builder does not put it in and say nothing about it, instead of selling the crane for $4,975 and charging $25 extra for the rawhide.

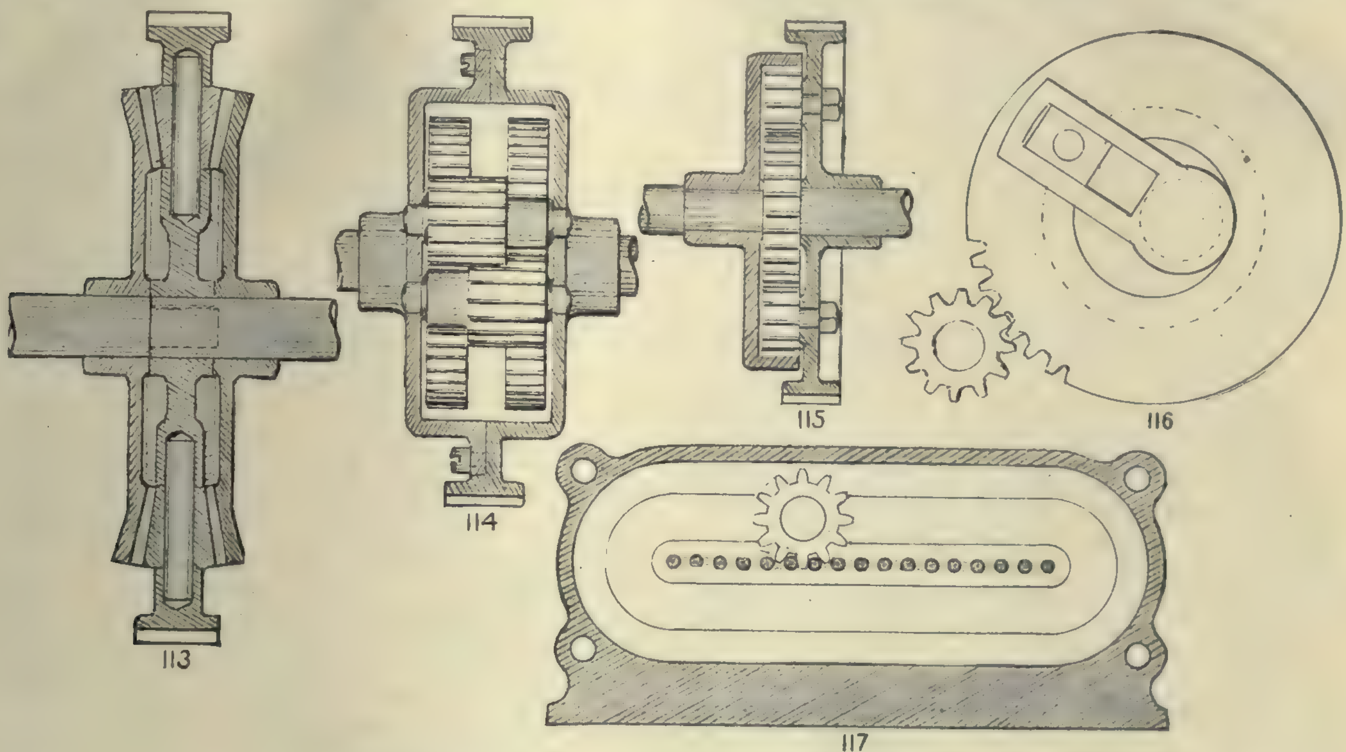
Another way and a mechanical one to avoid noise is to cut the teeth on a spiral, Fig. 107. The objection at once raised against this is the end thrust against the shoulders; but this is more imaginary than real, for if the angle is as great as 3 in. to the foot (an unnecessary one) the end thrust cannot be over one-fourth that against the bearings and is probably very much less. Where there are two gears like the back gear of a lathe, Fig. 108, on the same shaft—one the driven and the other driving and both of the same hand spiral—one will neutralize the other. One's first impression would be that one gear should be right-hand and the other left-hand spirals, but further consideration will show that both should be the same.

Theoretically, to make the balance perfect, the teeth in the pair at the faceplate end should be of greater spiral than the other, as the strain is greater.

If both were drivers, then they would need to be right and left. In very heavy work, such as rolling mills, they are so made, Fig. 109, the two being in one casting. They are known in the trade as herringbone gears. Such gears are difficult to cut by machinery except in large sizes, but with machine-cut patterns and suitable draw plates and guides they can be cast so perfectly that than the herringbone if equally well made, as the shafts may be out of parallel without harm.

A pinion or gear that has a face wide enough to engage with a gear or two pinions of half the face, Fig. 112, is called a Marlborough gear.

What is sometimes called differential gear, but more correctly compensating gear, was originally called a "Jack in the box." As a man who invents a thing has a right, or ought to have, to call it what he likes, perhaps this name ought to have been let alone. For many years,



FIGS. 113 TO 117. VARIOUS COMBINATIONS OF GEARS

Fig. 113—A "jack-in-the-box." Fig. 114—Equivalent of device shown in Fig. 113, using spur gears. Fig. 115—The Hubbard gear. Fig. 116—Whitworth quick-return motion. Fig. 117—The mangle gear

nothing further in the way of quiet running can be desired. The degree of spirality in the case of the herringbone-gear type can be of any amount. In fact, the pinion can be a single-screw thread, half right-hand and half left, Fig. 110, and the wheel any full number of sizes larger; that is to say, the pinion may be one inch in diameter at the pitch line of the thread and the wheel two, three or any number of inches in diameter.

If the pinion is cut with, say, six pitch and the wheel 6 in. in diameter, it would need to be cut six threads 1-in. pitch, half right-hand and half left. The wheel and pinion would run together properly at speeds 6 to 1, perfectly quietly and without slip. This gear would not do, however, for back and forth motion as the least lost motion would prove excessive, nor would it do except for light work.

When driving is in alternate directions, as is the case in crane or electric street-car work—spiral gear with end play in the shafts—the pressure will be first against one shoulder and then the other, and the journals will keep in perfect order.

Another form of gear used in rolling mills is the crescent tooth where a curved face is used instead of the herringbone, Fig. 111. Though very difficult to machine and more difficult to cast, it would be better fifty or more, it was never made in any way except by the use of two bevel wheels and two or more bevel pinions, Fig. 113. It is doubtful if hundreds of good mechanics did not believe it practically impossible to do the same thing with spur gears. Yet it is very simple, as two gears and two or more Marlborough pinions, Fig. 114, do the same thing in a much better way. By this device two shafts in line, but extending in opposite directions, may be driven with equal force and at different speeds. On the other hand, a wheel may be driven from each side by forces coming from each side at unequal velocities; or with a Hubbard gear a shaft extending one way with a spur gear on its end and another shaft in line with it and extending in the other direction, with an internal gear on it and one or more spur pinions secured to a spider and engaging the two, Fig. 115, turning the spider will drive the two shafts at any varying speed.

Elliptical gears have been used from time to time for producing a quick return for shapers and slotters, but the Whitworth quick return, Fig. 116, produced by two revolving elements with their centers eccentric with each other, has proved so much more satisfactory that the best use, though not the only one, there seems to be for the eccentric gear is to furnish mental discipline in a college drafting room.

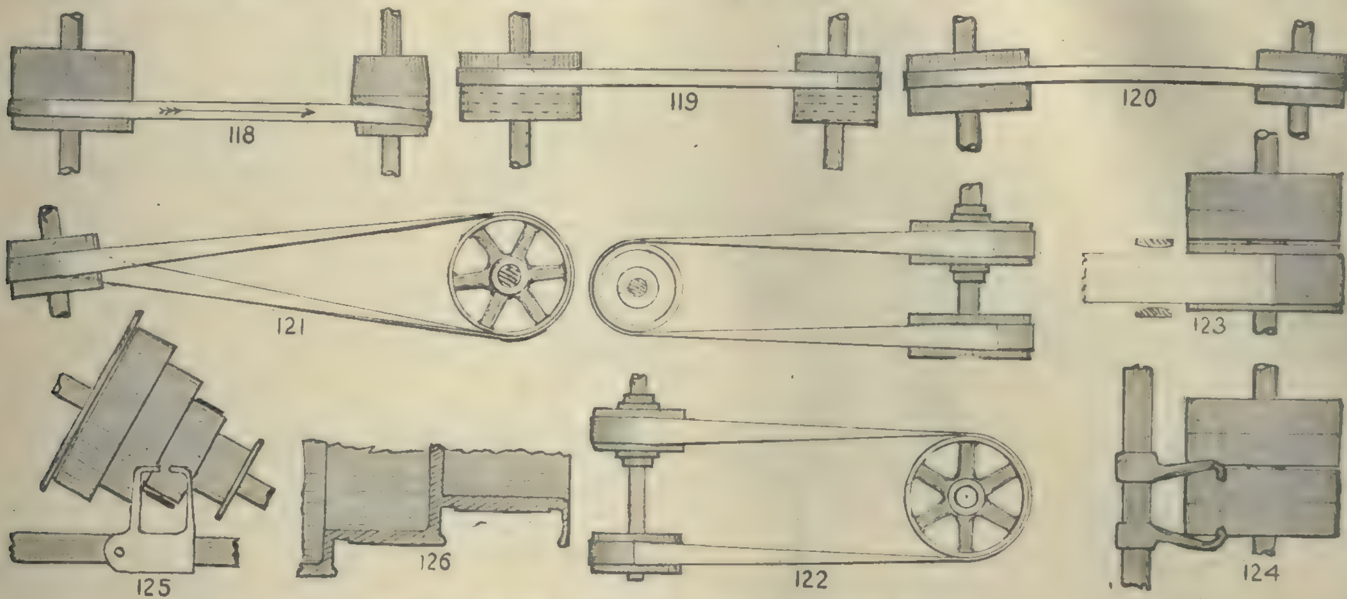
In the Whitworth variable-speed or quick-return gear the pinion is assumed to turn the ring with uniform velocity. When the slotted arm, which is rotated by the pin and sliding block, is up, the shaft will rotate slower than the ring; but when the arm is down, it will rotate faster than the ring.

A form of rack and pinion arrangement known as a mangle gear, Fig. 117, used for moving a platen back and forth as in either a mangle or a printing press, is one of the devices for giving a practically uniform motion with quick and fairly quiet reversal. If the pinion is free to move up and down, but held by the shaft in guides so as not to move side wise and if the rack and slide, which must be secured to each other, are free to move back and forth, it will so move when the pinion is turned. To make the reversal more gradual it is only necessary to make two racks, place them a distance apart and use a larger-radius circle at the ends.

If the weight of the bed is moderately great, buffer springs are necessary to arrest the momentum and overcome the inertia in starting back. If the speed is variable, the springs should be adjustable, and air dash pots with adjustable cylinder heads would be a simple way. However, the springs will not avoid jar, as the springs simply thrust the blow onto the framing. A practically perfect remedy for this would be to have an equal weight traveling in the same plane and in the opposite direction at the same time the bed travles forward—by no means an easy or inexpensive thing to do.

Link-chain transmission, while very old, was not extensively used until the advent of the safety bicycle. Though extensively used in that vehicle, it did not meet with such favor as to introduce its use in other work to any extent.

The fundamental defect in both the ordinary link chain and those of the bicycle sort is that the wear makes the pitch of the chain longer and the pitch of the sprocket shorter. A certain amount of this is admissible, but after a little the chain begins to climb and fails to work properly. The invention by Hans Renold of the silent chain opens up a new agent for the machine builder, as it gives the most of the advantages of the belt, the positive drive of tooth gearing and a variable distance between shafts. The silent feature of the chain is only an incidental feature, as the real object was to overcome the trouble from the chain growing longer in pitch by wear and out of pitch with the sprocket, which grows shorter as the sprocket grows smaller. In this invention, as the chain grows longer it takes a larger path on the sprocket. This not only takes up for the extra length on the sprockets, but unless too long between the sprockets it compensates for the extra length there. The chain has a positive drive and requires very much less width than a leather belt for the same work. It is not to be preferred to a tooth gear when that is available, but is better than a leather belt in many places.



FIGS. 118 TO 126. VARIOUS DETAILS OF BELT DRIVES
Figs. 118 to 122—Pulley and belt arrangement. Figs. 123 to 125—Belt shifters. Fig. 126—Belt faces for pulleys

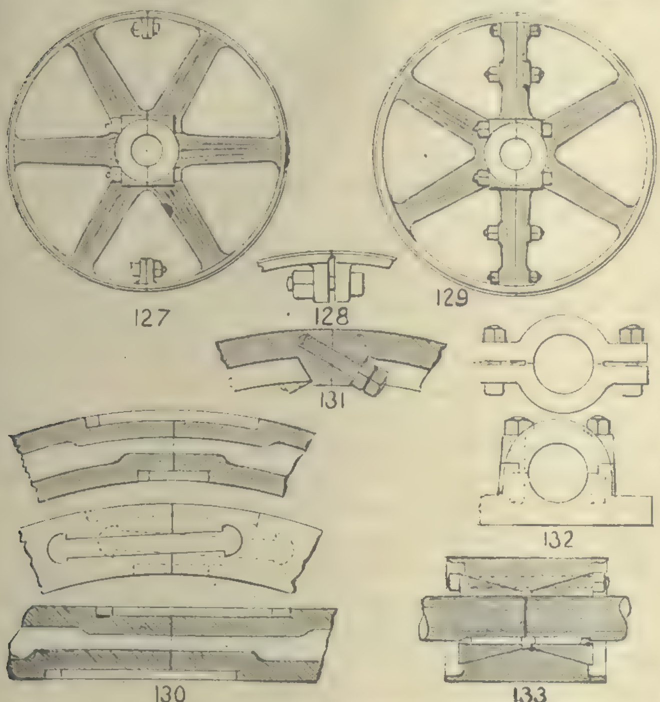
The simple transmission of power and the change of speed by the use of belts, though simple in the extreme at first sight, lead to many points of complication when followed through the various forms and places where used.

The notion has been preached from father to son and from master to man for years that the belt will run toward the high side of a pulley onto a straight-face pulley. It never did so, except when running down the shafts out of parallel or when the belt was crooked, but it does persistently strive for the larger diameter, Fig. 118; hence the use of crowning pulleys.

If the shafts are out of parallel the belt, if on straight-face pulleys, will at once travel toward the ends of the shafts that are the nearest together, Fig. 119. This is on the assumption that the belt is straight and may be neutralized by a crooked belt, Fig. 120, if the short side of the belt is on the side where the shafts are nearest together.

Cross-belts, where the shafts are reasonably far apart and the pulleys not too large, run about as well as straight belts, except for the slight friction between the parts at the crossing; but cross-belts where the shafts are close together or the pulleys large are to be avoided, as are twisted belts—that is, where one shaft is above the other, Fig. 121, and at right angles to it. The twisting of the belt puts a destructive strain on one edge of

the belt; and if the machinery is turned backward, the belt runs off. It is only where the shafts are quite a distance apart and the belt narrow that it does at all well. A much better plan is to have a tight and loose pulley on each shaft, Fig. 122, and the belt taking four paths instead of two. Though in this case each part of the belt takes a quarter twist, it is quite different from the twist in the other form; and running the shafts backward does not throw the belt off. Rope transmission can be used in the place of twisted belts without



FIGS. 127 TO 133. PULLEY, FLYWHEEL AND COUPLING DETAILS

Figs. 127 to 129—Joints for split pulleys. Fig. 130—Fritz flywheel-rim joint. Fig. 131—Armstrong flywheel-rim joint. Fig. 132—Arrangement of bolts in parted boss. Fig. 133—Compression coupling

objection. Of the two systems of rope transmission—the European and the American—each has its advantages. The European is a succession of endless ropes each running in its own pair of grooves. It is practically impossible so to splice the ropes as to have them of exactly the same length; hence they do not look well running, some sagging more than others. The natural inference is that they are not all driving. It is more than probable, however, that the objection is more imaginary than real, unless there are several more ropes than needed for the work. Though they may appear uneven, each may be doing its share of the work, though some do show more slack on the slack side than the other. With this system one or more ropes may be broken without crippling the plant.

The American plan of using a single rope wrapping around in successive grooves over each sheave and then switched over on the tightening pulley has the advantage that all the laps appear to be doing their proper work. The tightening pulley keeps them uniformly tight whenever the rope changes length, as it tends to do in wet and dry weather. There is but one splice to make; but when the rope gives out, the plant is stopped.

Rope transmission is only used in the main driving, except occasionally small round leather belts are used for the feed works of machines, small lathes, etc. Rope pulleys may be narrower than flat belt pulleys to do the same work, but cost more.

Of the many substitutes for leather belts each may be successful in certain places, while for general use the leather belt holds its place. Rubber belts in damp places and leather-lined cotton belts have proved excellent for long driving belts, as they possess the same driving power as leather, stretch less and keep straight.

Leather link belts are too heavy and stretch too much. A thick belt with leather blocks riveted to it, used in the Reeves changeable-speed gear, is adopted from necessity and not from choice. Link chains have the advantage of a positive drive, the same as a gear, but are not applicable where the driving power starts and stops with the driven, whereas leather belts can be thrown on and off, making the most perfect friction clutch where time can be allowed to make the change.

All belts should be sufficiently wide or run at a sufficiently high speed to do the work, when in fairly good condition, on smooth cast-iron pulleys. When different coverings or dressings are applied to prevent slipping, it means a more rapid destruction of the belt or its lacing, except where a belt is ample for the work and a dressing or covering is applied that will permit running the belt looser. That is an advantage, for when a belt has to be strained tight to do the work, an unnecessary strain is put upon it.

For forty-five years at least, to the writer's knowledge, inventors have been endeavoring to devise some better way to join belts than a leather lacing, but it seems to be as difficult to replace the leather lacing as the leather belt. The first attempt, belt hooks, appears to have been about as successful as anything else. There is one, however, that possesses a life-saving feature, and for that reason alone it deserves consideration. A coil of wire is threaded through each end of the belt to be joined, then flatted down to the thickness of the belt and the two ends slipped together on a string drawn through, forming a regular hinge in which the string is the pivot. The advantages of this form are that none of the leather is cut away and the work can be done on the floor; hence the danger is reduced to simply putting up the belt and running through the string. The actual cost is light, but the objection is that it requires a somewhat expensive machine as a primary investment.

In addition to the regular wear and extra strain that lead to the destruction of belts, shifting belts are subject to the punishment of shipper irons, which are usually about as illy devised for the work as they well can be—simply pegs at right angles to the belt, as if designed to push the belt straight over edgewise—and cut out the edge; or if the belt twists, as it should, it is as likely to twist the wrong way as the right. If the edge of the belt that is to be pushed is twisted in toward the pulley, it will move over easily and quickly; if it twists the other way, it will only go over by brute force. The fork should have wide rounded surfaces, Fig. 123, where it strikes the belt and be set at an angle, Fig. 124.

The practice of shifting cone belts by the skill of the operator—very few of whom ever acquire the act—by a pole or by a man on a ladder, which are almost the universal ways, shows a lack of completing the job on the part of the machine-tool maker.

Perhaps, however, by the time a proper shipper device becomes a part of the standard countershaft outfit the

electric motor will have superseded the cone-pulley system altogether.

A belt can be thrown from one step of a cone to another, either up or down, with a proper-shaped fork, Fig. 125, set so as to lift one edge of the belt at the time the larger step of the cone raises the other; the side of the fork that throws it down is like the plain shipper.

If belts were always straight and ran true, the cone as usually made would meet all requirements; but they are not, and crooked belts running from side to side strike the lift of the next larger size and tend to crawl up. This has a tendency to bend the edge of the belt at that point, and the trouble grows worse and worse.

A partial remedy is to make the faces of the pulleys ⅜ to ½ in. wider than the belt to be used, sink this allowance below the face, so that the center of the crown comes farther away, and then undercut the lift so as to leave a narrow rounded band as far away as possible, Fig. 126.

Of the various kinds of pulleys—cast iron, wrought iron, wrought rim, wood rim, all wood, pressed steel, etc.—cast iron makes the smoothest and most easily cleaned of all, and the pressed steel the lightest, both desirable features, but not combined in one.

In all shops of moderate size it is highly desirable to have all pulleys—or at least all but the main driving pulleys—split or parting pulleys and, so far as practical, have all the shafting, irrespective of what it has to do, of the same size, for the convenience of interchange of pulleys.

With the exception of the wrought-iron pulley it is the uniform practice to part pulleys in the wrong place. When the joint is halfway between the arms, Fig. 127, and the lugs for bolts inside, as they must be, not only the centrifugal force, which is augmented by the bosses and bolts, but the grip of the bolts, Fig. 128, helps rather than resists the tendency of centrifugal force to bend the rim out; with the joint between the two halves in the center of an arm, Fig. 129, the resistance against centrifugal force at the joint is equal to that of any other part of the rim, and the bolts through the lugs on the inside of the rim are in the correct position. Of course, centrifugal force tends to separate the two halves of the pulley in either case; hence, if the joint bolts are equal to the strength of other parts of the pulley, then the pulley equals a solid one.

There are various plans adopted to join the rim of flywheels. It is desirable to make the joint as strong as the other part of the rim and yet have the rim free from projections. This has only been done on the plan devised by John Fritz, Fig. 130, that of casting the rim hollow throughout the body except at the ends, and at the ends casting on all four sides recesses for links, removing the same amount of metal for the links as is cored out of the center and using wrought-iron links in the recesses that are as strong as the cast iron in the rim.

Being conscious that the lugs and bolts, as usually used, halfway between the arms, were wrong, Mr. Armstrong devised the plan of putting the bolts on an angle, Fig. 131, so as to obtain a tie as near as possible at the outside.

There are two methods of locating the bolts in the bosses of parted pulleys, parted boxes, etc., Fig. 132: One, and the wrong one, is to project out thin ledges and use short bolts; the right way is to put the bolts as near the shaft as practical and use long bolts. If the fit is correct—that is, the allowance nearly the same as it would be for a forced fit—then the grip alone would drive a pulley for ordinary work.

Shaft couplings, like parted pulleys, should be bored a forced fit on the shaft. Then any of the various kinds do well; and if a loose fit, none of them will. The compression kind, Fig. 133, can be compressed to a certain extent, but do not compress to a round hole. Split cones or the split sort of any kind can be spread open so as to be a loose fit for putting on or removal. It makes no difference whether the hole is round or not; but when brought to place, they should fit, and none should be tolerated unless the bolt heads and nuts are so protected as not to endanger workmen.

Red Tape in Navy Yards

By B. Davis

I have read the articles that have appeared in the *American Machinist* on why the navy yards are slow in shipbuilding and I would like to add a little from actual experience in the hope that something may be done to obviate the unnecessary delays.

Having four or five ⅞-in. studs to drill out of a valve bonnet, you decide an air drill would be both labor- and time-saving. First it is necessary to get the permission of the warrant officer, and you have to tell him that you want an air drill and explain what you want it for. Then you go to the logroom and again explain what you want. There a typewritten form is filled out on 8x10-in. paper, stating the articles wanted. Each article is also enumerated on a similar form, which is to be signed by the chief engineer. If he is busy, or is out, it is a case of wait until he gets back to sign it. Then you are directed to a certain building, which may be in the yard, and told to ask for so and so.

So and so reads what you want, signs his name to the sheet, and tells you to go to building No. 21 for the air drill and to building No. 6 for the air hose. If you don't know where the buildings are, you can look for them, sometimes for a half a day. When you find building 21, you ask for the foreman, and he takes the sheet for the air drill. He gives you the drill, you sign for it, and it is charged against you. You leave the sheet of paper there and start for building No. 6, which is possibly at the other end of the yard. Having found it, you go over the same rigmarole as in building 21. After this you have all the necessary articles for your work.

When the articles are returned, you take them to the toolroom, get your sheet of paper, and everything is over. You can then destroy the paper and no questions are asked. The time wasted in getting the air drill and the hose was just one working day.

Butt-Welding Tubes

By W. Thompson

In electric butt-welding $\frac{3}{4}$x$\frac{3}{16}$-in. wall tubing in a plain machine such as is used for welding solid bars, we experienced difficulty due to uneven heating of the parts.

To overcome this trouble we inserted a piece of ⅜-in. cold-rolled 1½ in. long in the tube. We have welded 10,000 front-axle tie-rod tubes in this manner.

United States Munitions*

The Springfield Model 1903 Service Rifle

Operations on the Sleeve—II

SYNOPSIS—This article completes the operations on the sleeve and also includes the sleeve lock and firing pin rod, all essential parts of the firing mechanism.

While this article shows minor operations on the sleeve, they are by no means unimportant. The holes for holding the safety lock in any of its three positions and the holes for the sleeve lock are both given. These and other operations give a good idea of the various forms of fixtures and gages employed in this work. Rotating or oscillating fixtures for a kind of form or profile milling are also used, as shown in Fig. 818, for the safety-lock groove. The work is rotated around the milling cutter, the movement being controlled by stops.

Gaging is very important in this work, as the parts are small and location is important. An instance of this is shown in Fig. 816, while Fig. 816-A shows how to gage the location of each of the three locking holes.

OPERATION 21. DRILLING THREE HOLES FOR SAFETY-LOCK PLUNGER

Transformation—Fig. 813. Machine Used—Sigourney Tool Co. 12-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 814; details in Fig. 815. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 816; sleeve is placed on plug A and pin gages used in bushings B, C and D. Production—40 per hr.

OPERATION 22. HAND-MILLING GROOVE FOR SAFETY-LOCK PLUNGER

Transformation—Fig. 817. Machine Used—Garvin No. 3. Number of Operators per Machine—One. Work-Holding Devices—Clamped on stud, Fig. 818; details in Fig. 819; sleeve is located and held on studs A and B, supported by C and clamped by finger D; fixture is rotated by lever E. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 820. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 821; plug A fits firing-pin hole; pin B goes through arm C and gages depth of groove. Production—175 per hr. Note—Work-holding points, hole and bottom.

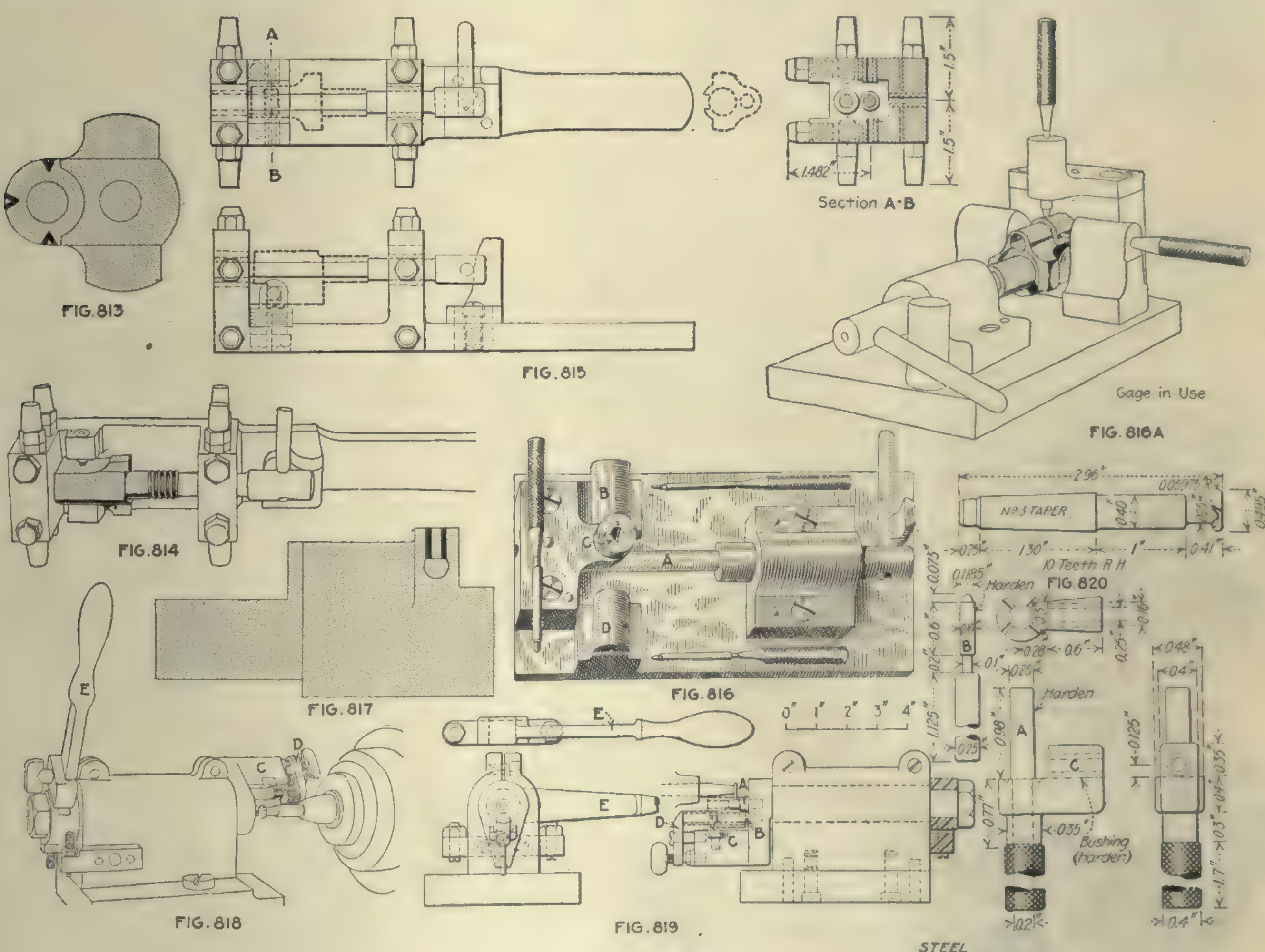


FIG. 813 FIG. 814 FIG. 815 FIG. 816 FIG. 816A FIG. 817 FIG. 818 FIG. 819 FIG. 820 FIG. 821

OPERATION 21 & 22

*Copyright, 1916, Hill Publishing Co.

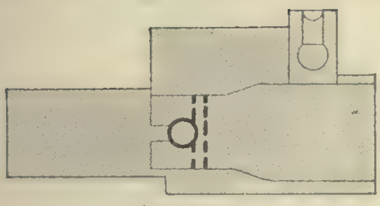


FIG. 822

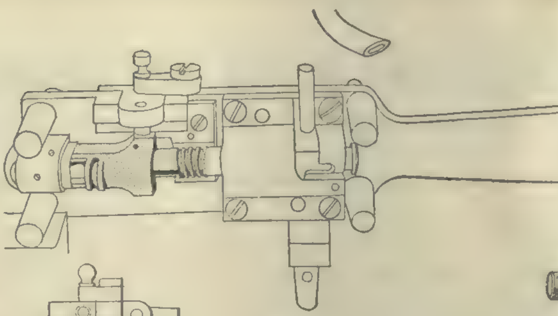


FIG. 823

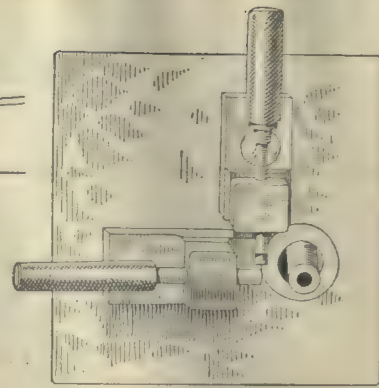


FIG. 826 D

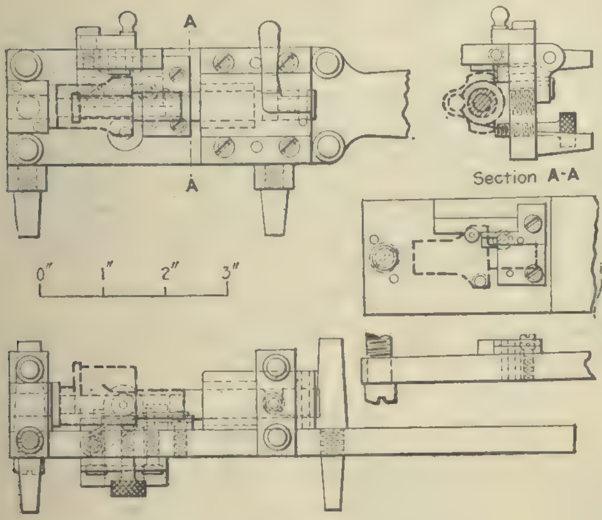


FIG. 824

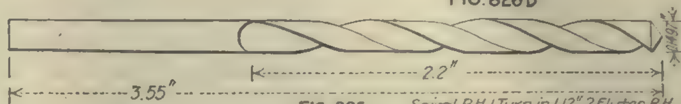


FIG. 825

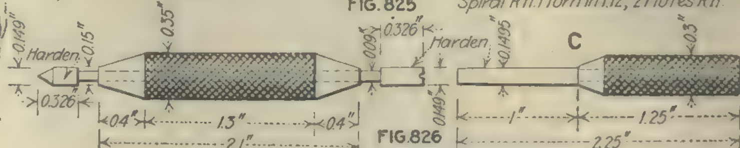


FIG. 826

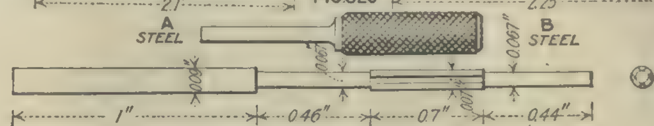
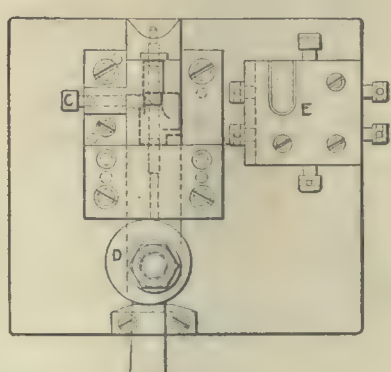


FIG. 827

OPERATION 15

FIG. 828



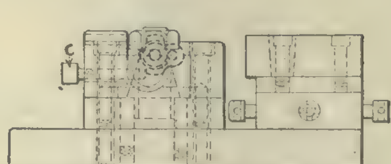


FIG. 830

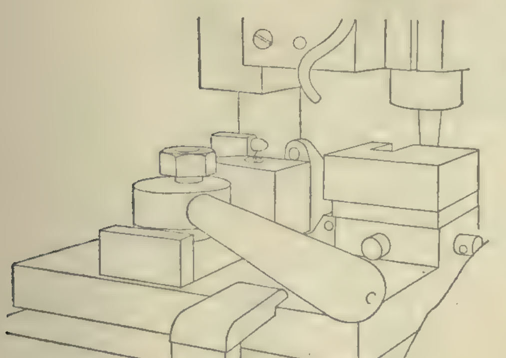
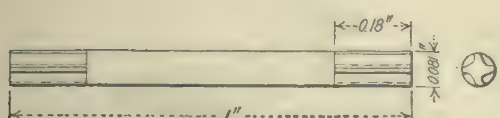
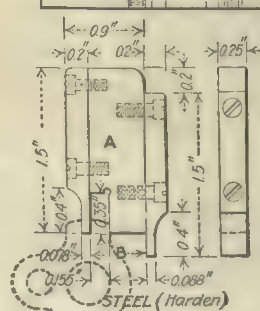


FIG. 829



4 Teeth, R.H.
FIG. 831



OPERATION 17

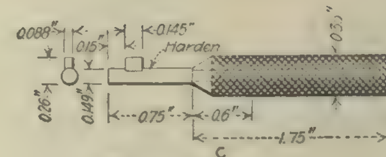
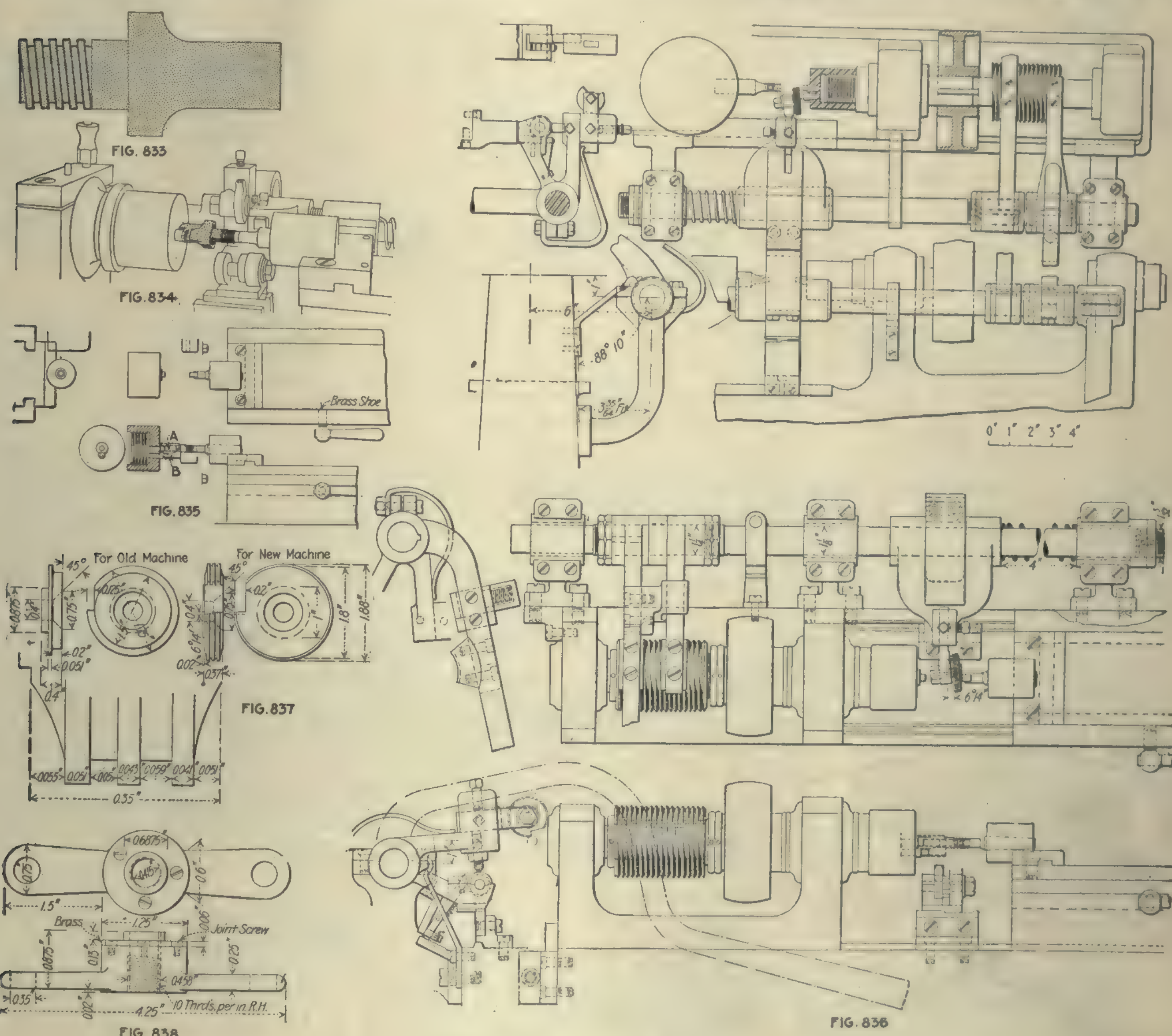


FIG. 832

Threading the sleeve is somewhat similar to the same operation on the barrel except that the lead of the screw must start from a given point so as to tally with the thread in the lock end of the bolt, while the barrel, being round and threaded first, is the basis to which the receiver must be threaded. The sleeve is held on centers but located from the back end so as to start the thread correctly. A special machine is used for threading, this being a sort of Fox lathe with the hob and leader conveniently arranged as can be seen from the different views in Fig. 836. Two circular cutting tools are used, one for use on the old and the other on the later machine, one of which went to the Rock Island arsenal. A segmental leader is used; the hob is on the lathe spindle, while the tool cuts from above. The gage, Fig. 838, is almost identical with that for the thread on the rifle barrel.

Several operations prepare the sleeve for the cocking piece, this sliding in the sleeve and being guided by it.



OPERATION 18

OPERATION 15. DRILLING SLEEVE-LOCK AND PIN HOLES

Transformation—Fig. 822. Machine Used—Pratt & Whitney 14-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 823; details in Fig. 824; held on studs, and fixture has two positions, 90 deg. apart. Tool-Holding Devices—Drill chuck. Cutting Tools—Two drills and a bottoming tool, Fig. 825. Number of Cuts—Three. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 826; A, diameter and depth of sleeve-lock hole; B, not-go gage; C, pin hole; D, location of holes. Production—40 per hr.

OPERATION GG. BURRING SLEEVE-LOCK PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs from pin hole. Apparatus and Equipment Used—File and small reamer, Fig. 827. Production—300 per hr.

OPERATION 17. PROFILING FOR SLEEVE-LOCK LATCH

Transformation—Fig. 828. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—On studs, clamped at ends, Fig. 829; details in Fig. 830; held on studs A and B, located against stops C, clamped by cam D; profiling form at E. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 831. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 832; A, location of slot from sides; B, width of slot; C, relation of slot to hole. Production—40 per hr.

OPERATION HH. REMOVING BURRS LEFT BY OPERATION 17

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 17. Apparatus and Equipment Used—File. Production—250 per hr.

OPERATION 18. THREADING BARREL OF SLEEVE

Transformation—Fig. 833. Machine Used—Special Fox lathe made at Hill shops. Number of Operators per Machine—One. Work-Holding Devices—Held on center, Fig. 834; details in Fig. 835; sleeve fits on stud A and is driven by stud B in safety-lock hole; this also locates sleeve so as to start thread in correct position for bolt; details of machine in Fig. 836. Tool-Holding Devices—In holder. Cutting Tools—Fig. 837, circular thread tool, ratchet feed, see Fig. 836. Number of Cuts—Five. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—150 pieces. Gages—Fig. 838, size and location of threads. Production—40 per hr.

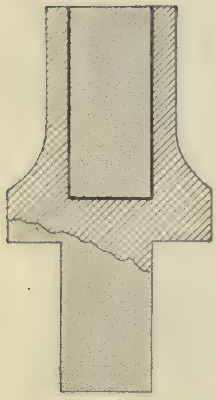


FIG. 839

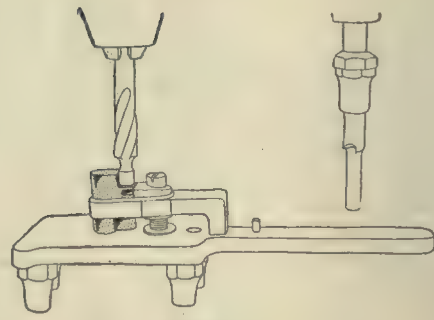


FIG. 840

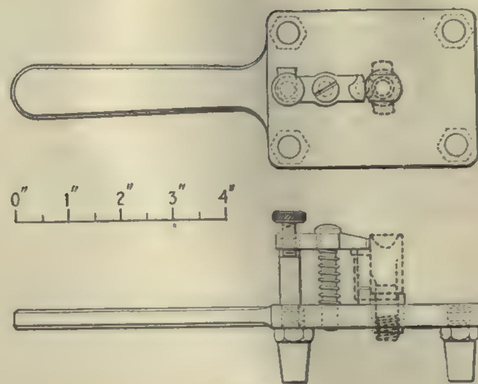


FIG. 841

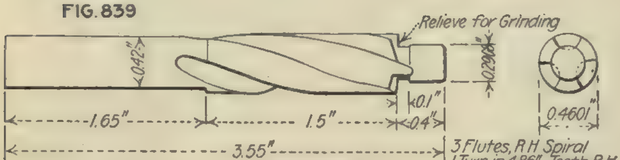


FIG. 842

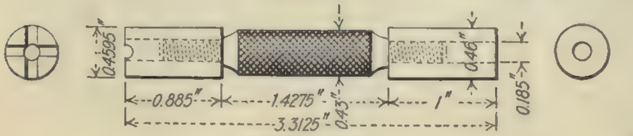


FIG. 843A

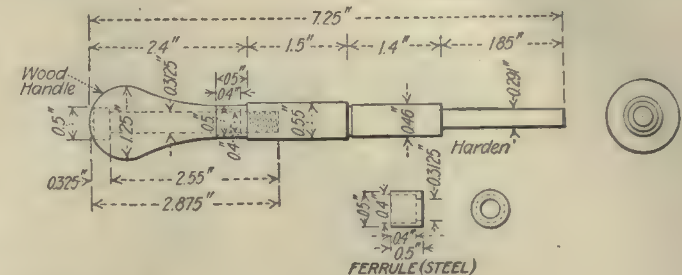


FIG. 843 B

OPERATION 19

OPERATION 19. COUNTERBORING COCKING-PIECE SEAT

Transformation—Fig. 839. Machine Used—Ames 16-in. vertical drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 840; details of another type in Fig. 841. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore, Fig. 842. Cut Data—150 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 843; A, diameter and depth gage; B, concentricity of holes and counterbore. Production—40 per hr.

OPERATION 20. MILLING COCKING-PIECE SLOT

Transformation—Fig. 844. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—On studs clamped at ends, Fig. 845; details in Fig. 846, which shows two cams instead of one as now used. Tool-Holding Devices—Standard arbor. Cutting Tools—Two radius cutters, Fig. 847. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, two ⅛-in. streams. Average Life of Tool Between Grindings—2,000 pieces. Gages—Fig. 848. Production—50 per hr. Note—Work-holding points, hole and side.

OPERATION II. REMOVING BURRS LEFT BY OPERATION 20

Number of Operators—One. Description of Operation—Removing burrs from cocking-piece slot. Apparatus and Equipment Used—File and reamer, Fig. 849. Production—Grouped with operation 20.

OPERATION JJ. REMOVING BURRS FROM FIRING-PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 20. Apparatus and Equipment Used—File and reamer. Production—Grouped with operation 20.

OPERATION 23. MILLING MATCHING GROOVE RECESSES FOR SAFETY-LOCK PLUNGER

Transformation—Fig. 850. Machine Used—Sigourney Tool Co. four-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Figs. 851 and 852. Tool-Holding Devices—Drill chuck. Cutting Tools—Fig. 853. Number of Cuts—Two. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—600 pieces. Production—80 per hr.

OPERATION 24. FILING EDGES OF COCKING-PIECE SLOT AND SAFETY-LOCK THUMB-PIECE BEARING

Number of Operators—One. Description of Operation—General filing, cornering and brushing up. Apparatus and Equipment Used—File. Production—100 per hr.

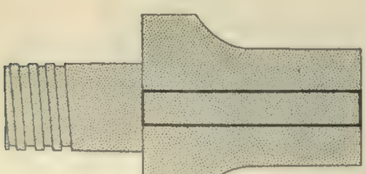


FIG. 844

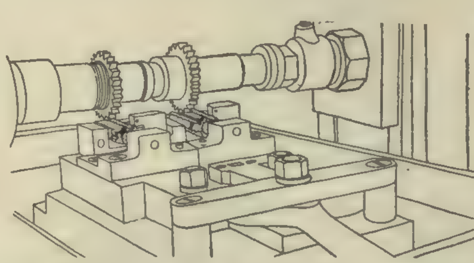


FIG. 845

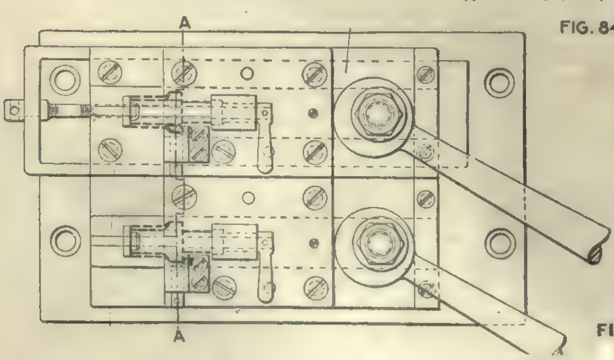
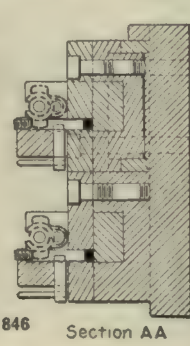


FIG. 846



Section AA

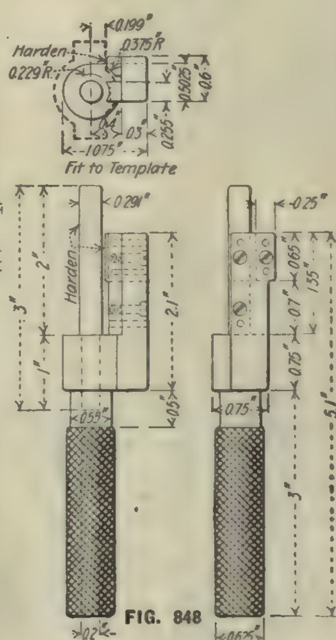


FIG. 848

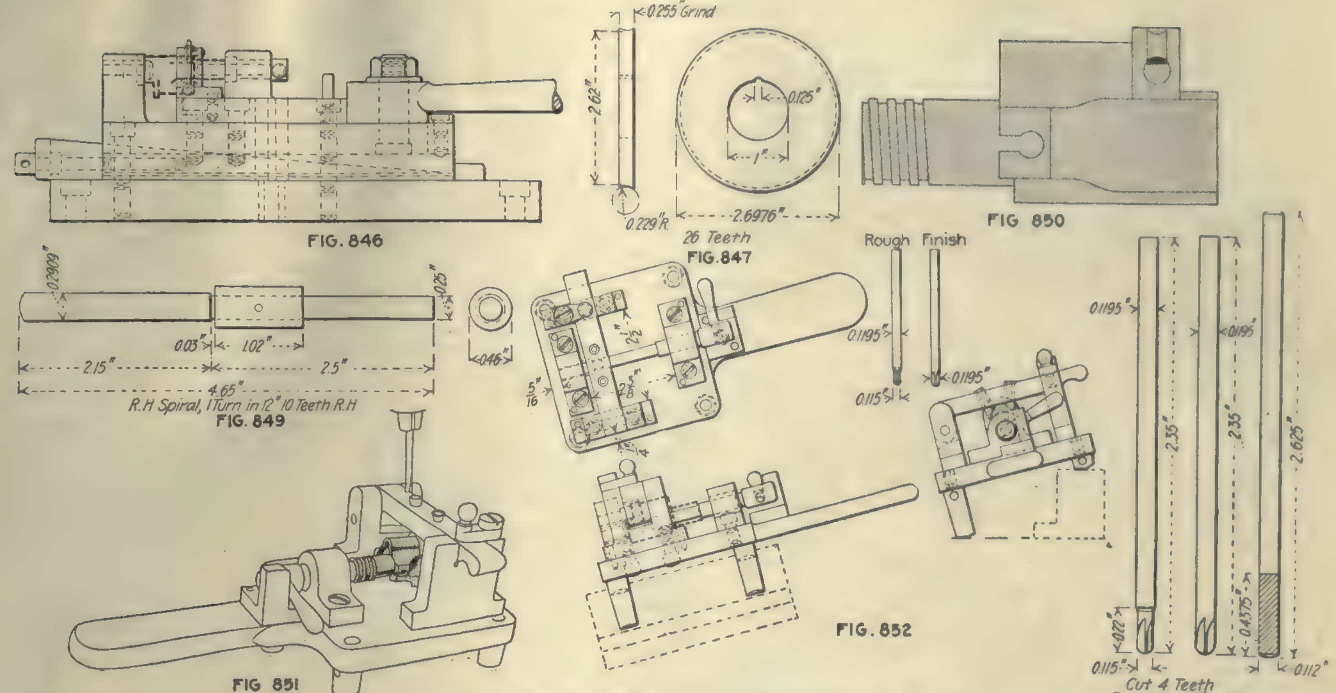


FIG. 846 FIG. 847 FIG. 849 FIG 850 FIG 851 FIG. 852 FIG. 853 FIG. 854

FIG. 844, 845, 846, 847, 848, 849 OP. 20-FIG. 850, 851, 852, 853 OP. 23
FIG. 854, OP. 26

OPERATION 25. REAMING HOLE FOR SLEEVE LOCK, BURRING SAFETY-LOCK SPINDLE HOLE AND COUNTERSINKING SLEEVE-LOCK PIN HOLE, ETC.

Machine Used—Prentice 14-in. speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Work held in hand. Tool-Holding Devices—Drill chuck. Cutting Tools—Burring reamer. Number of Cuts—One. Cut Data—About 250 r.p.m. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,500 pieces. Production—400 per hr.

OPERATION 27. POLISHING EXTERIOR SURFACES

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Polishing jack and wheel. Production—25 per hr.

OPERATION 26. ROTARY FILING MATCHING SAFETY-LOCK PLUNGER RECESSES WITH PLUNGER GROOVE

Number of Operators—One. Description of Operation—Rotary filing lock-spindle recess to match with spindle groove. Apparatus and Equipment Used—Rotary file, Fig. 854. Production—120 per hr.

OPERATION 28. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Cornering and general brushing up. Apparatus and Equipment Used—File. Production—25 per hr.

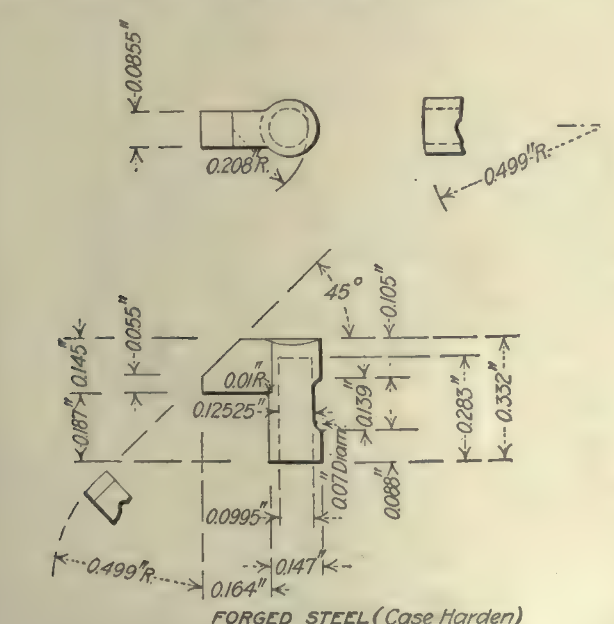


FIG. 855

DETAILS OF SLEEVE LOCK

OPERATION 29. CASEHARDENING

Number of Operators—One. Description of Operation—Packed in whole, new bone; heated to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quenched in oil. Apparatus and Equipment Used—Same apparatus as for the receiver and bolt.

OPERATION 30. ASSEMBLING WITH SLEEVE, LOCK PIN AND SPRING, AND SAFETY LOCK

Number of Operators—One. Description of Operation—Assembling safety lock and spring with sleeve. Production—50 per hr.

The Sleeve Lock

The sleeve lock is a small piece in the form of a hook that fits in the left side of the sleeve and locks it to the bolt in the proper position. It is a drop forging of Class D steel, which comes in bars 0.26 in. square. It is annealed and otherwise heat-treated in the same manner as the sleeve itself, so far as the heat-treatment is concerned. It is designed to prevent the accidental turning of the sleeve when the bolt is pulled back.

As will be seen from the detail drawings, Fig. 855, it is a small piece and is on this account handled in multiple fixtures wherever possible. There are but few operations that require detailed illustrations.

OPERATIONS ON THE SLEEVE LOCK

Operation	
A	Cutting off
A-1	Forging from bar
C	Annealing
D	Pickling
B	Trimming
2	Milling top of lug, roughing
1	Drilling, reaming and hollow-milling body, facing right side of lug
3-4	Milling sides of lug and over body
5	Hand-milling, rounding top to match sleeve
7	Hand-milling, rounding bevel front end
AA	Reaming pin hole
8	Hand-milling clearance for pin
9	Filing general cornering and matching
10	Casehardening

OPERATION A. CUTTING OFF

Number of Operators—One. Description of Operation—The bars come too long to work easily, so are cut in two. Apparatus and Equipment Used—A pair of alligator shears.

OPERATION A-1. FORGING FROM BAR

Transformation—Fig. 856. Number of Operators—One. Description of Operation—Blocking from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—400 per hr.

OPERATION C. ANNEALING

Number of Operators—One. Description of Operation—Pieces are packed in powdered charcoal placed in iron pots; left in furnace over night to cool. Apparatus and Equipment Used—Powdered charcoal, iron pots, Brown & Sharpe annealing furnaces.

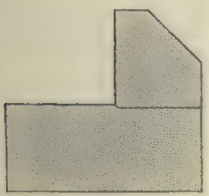


FIG.856
OPERATION 1-A

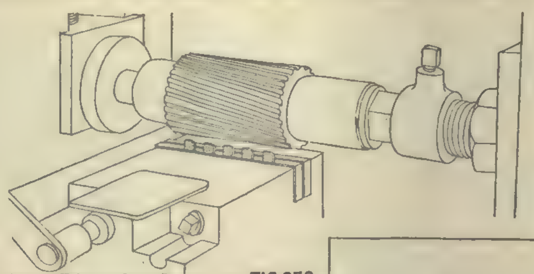


FIG.858

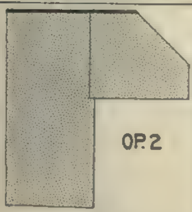


FIG.857

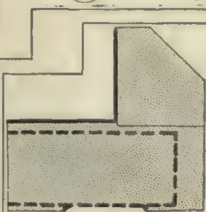


FIG.859

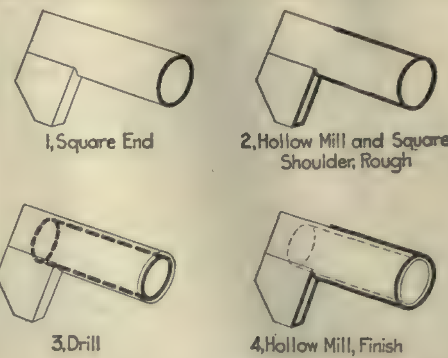


FIG.860

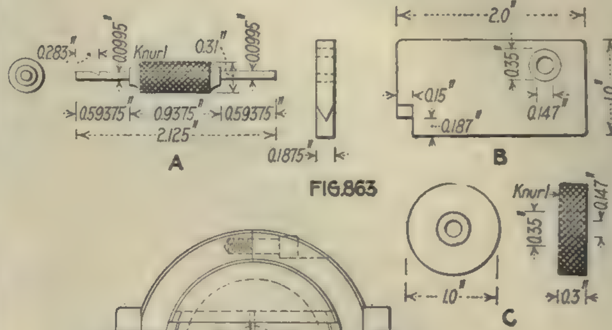
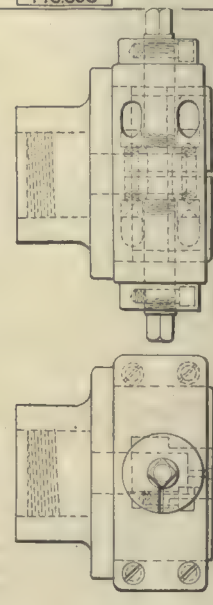


FIG.863



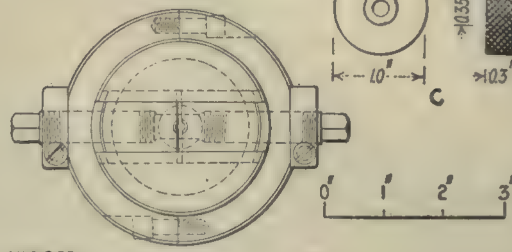


FIG.862

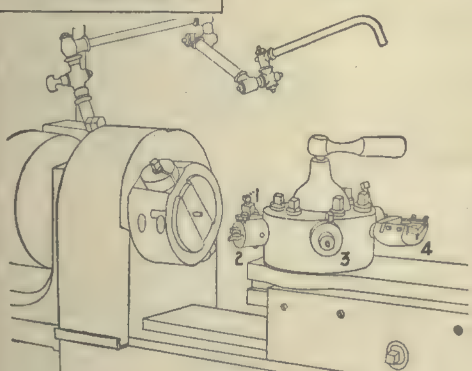


FIG.861

OPERATION 1

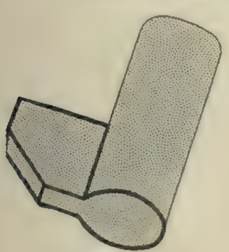
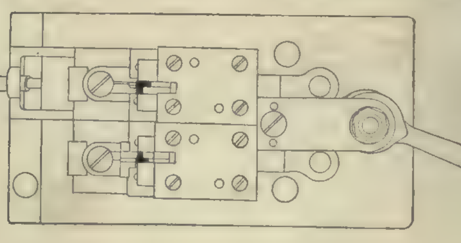


FIG.864



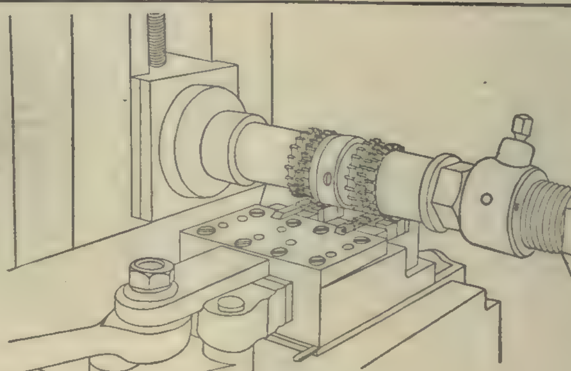


FIG.865

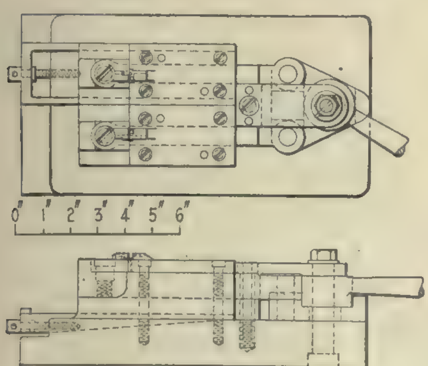


FIG.866

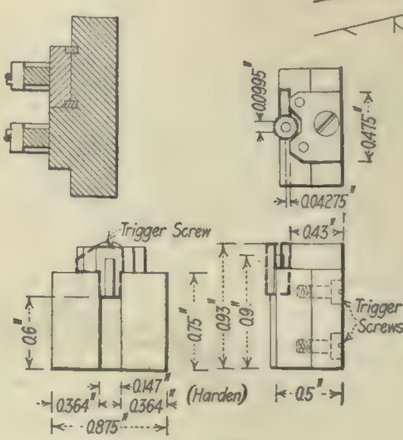


FIG.867

OPERATION 3 & 4

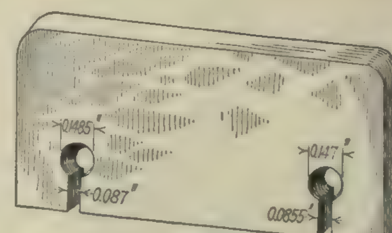


FIG.868

OPERATION D. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets, put into the pickling solution previously described, and left there for about 12 min. Apparatus and Equipment Used—Wire basket, wooden tanks, hoist.

OPERATION B. TRIMMING

Machine Used—Perkins & Snow power press No. 2. 3-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch holder. Dies and Die Holders—In shoe by setscrews. Production—600 per hr.

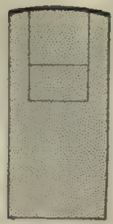


FIG. 869

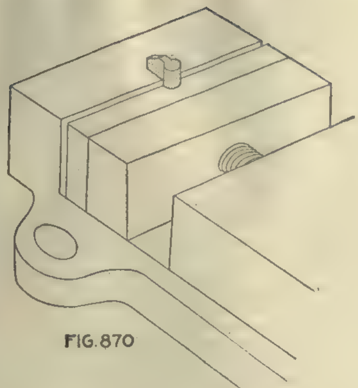


FIG. 870

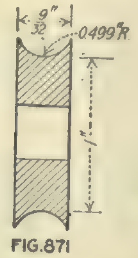


FIG. 871

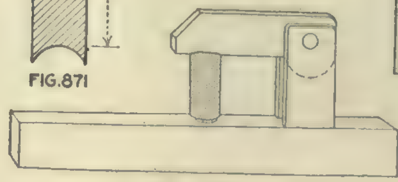


FIG. 872

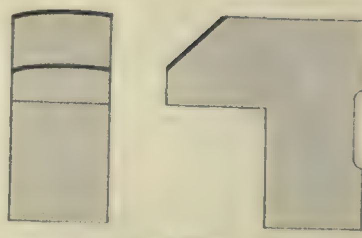


FIG. 873

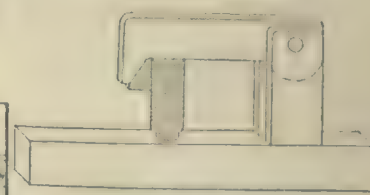


FIG. 876

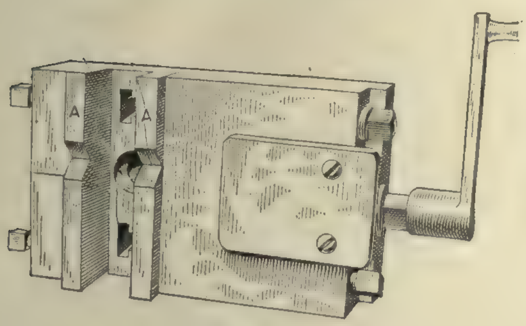


FIG. 874

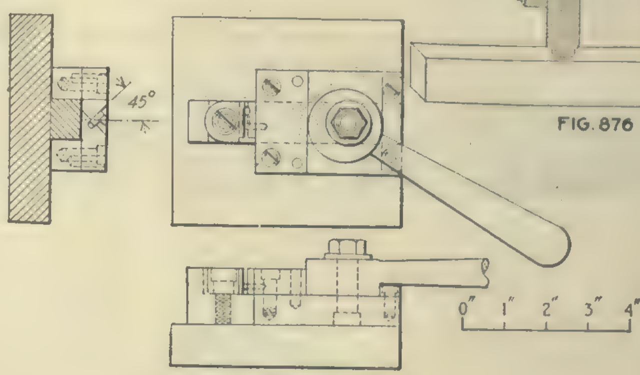


FIG. 875

OPERATION 5 & 7

OPERATION 2. MILLING TOP, ROUGHING

Transformation—Fig. 857. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Multiple vise; five are clamped by stem at each setting, Fig. 858. Tool-Holding Devices—Standard arbor. Cutting Tools—Wide-face milling cutter. Number of Cuts—One. Cut Data—Speed, 70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—8,000 pieces. Production—45 per hr.

OPERATION 1. DRILLING, REAMING AND HOLLOW-MILLING BODY, FACING RIGHT SIDE OF LUG

Transformation—Fig. 859. Machine Used—Pratt & Whitney No. 1 hand screw machine; machining diagram, Fig. 860. Number of Operators per Machine—One. Work-Holding Devices—Two formed chuck jaws, Fig. 861; details in Fig. 862. Tool-Holding Devices—Turret of machine. Cutting Tools—Spotting drill, hollow mill, box tool and reamer. Number of Cuts—Five. Cut Data—Speed, 900 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 863; A, diameter and depth of hole; B, thickness of head; C, outside diameter of stem. Production—60 per hr.

OPERATIONS 3 AND 4. MILLING SIDES OF LUG

Transformation—Fig. 864. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Formed vise jaws, Fig. 865; details in Fig. 866. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutters. Number of Cuts—One. Cut Data—700 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—15,000 pieces. Gages—Fig. 867, sides of lug with hole in body; Fig. 868, limit gage for body and lug.

OPERATION 5. HAND-MILLING, ROUNDING TOP TO MATCHING SLEEVE

Transformation—Fig. 869. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Standard Vise with jaws formed to hold shank, Fig. 870. Tool-Holding Devices—Taper shank. Cutting Tools—Formed milling cutter, Fig. 871. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—See Fig. 872. Production—175 per hr.

OPERATION 7. HAND-MILLING, ROUNDING BEVEL FRONT END

Transformation—Fig. 873. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise with formed jaws, Fig. 874, or with cam, as in Fig. 875; work held in grooves AA, to get bevel at proper angle. Tool-Holding Devices—Taper shank. Cutting Tools—Fig. 871. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 876, form and height gages for operations 2, 5 and 7. Production—350 per hr.

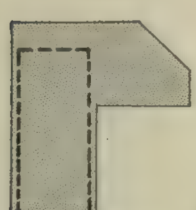


FIG. 877, OP. AA


FIG. 878

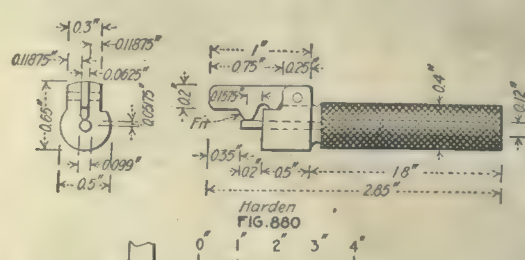


FIG. 880

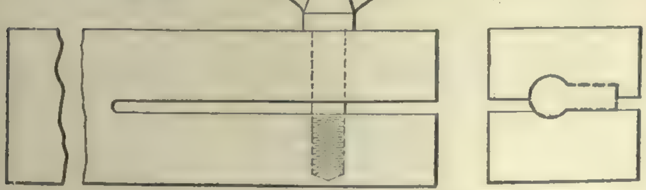
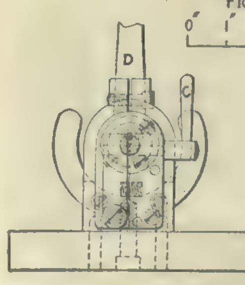


FIG. 877A



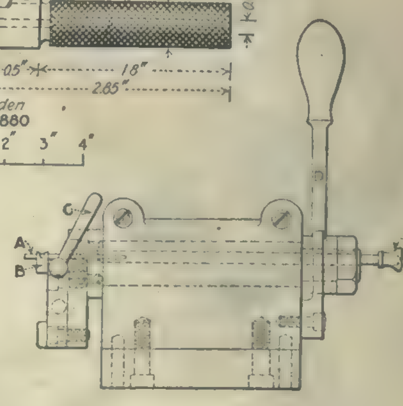


FIG. 879

OPERATION 8

OPERATION AA. REAMING PIN HOLE

Transformation—Fig. 877. Machine Used—Speed lathe. Number of Operators per Machine—One. Work-Holding Devices—In holder, Fig. 877-A. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamers. Average Life of Tool Between Grindings—3,000 pieces. Production—350 per hr.

OPERATION 8. HAND-MILLING CLEARANCE FOR PIN

Transformation—Fig. 878. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin A in rotating fixture, Fig. 879; clamped between jaws B by lever C; rocked by handle D and removed by ejecting rod E. Tool-Holding Devices—Taper shank. Cutting Tools—Formed cutter. Number of Cuts—One. Cut Data—Speed, 900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 880, lock is slipped on pin and finger drops on the milled spot. Production—350 per hr.

OPERATION 9. FILING, GENERAL CORNERING AND MATCHING

Number of Operators—One. Description of Operation—General filing, cornering and brushing up. Apparatus and Equipment Used—File. Production—50 per hr.

OPERATION 10. CASEHARDENING

Number of Operators—One. Description of Operation—Heated in cyanide to 1,500 deg. F., quenched in oil. Apparatus and Equipment Used—Crucible in oil furnace.

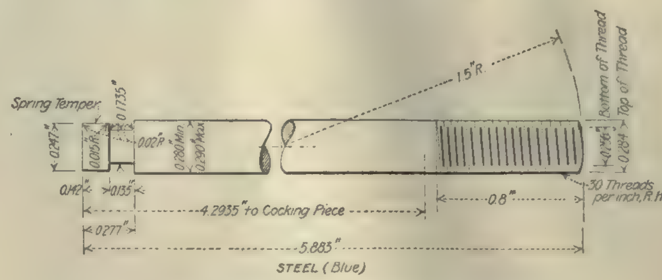


FIG. 881. DETAILS OF FIRING-PIN ROD

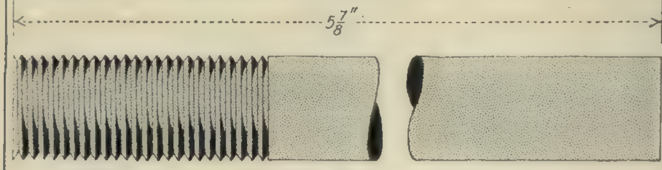


FIG. 882

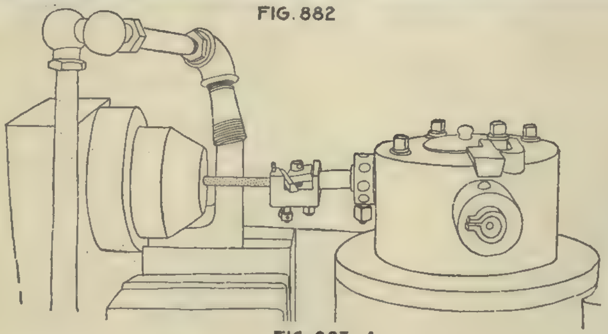


FIG. 883 A

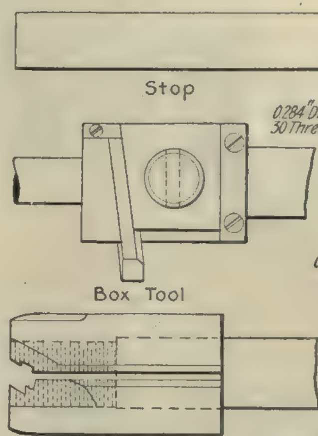


FIG. 883

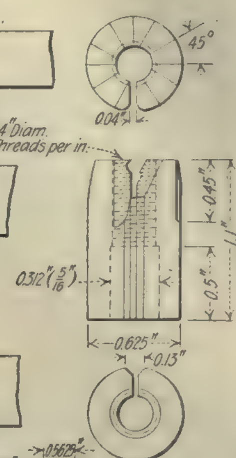
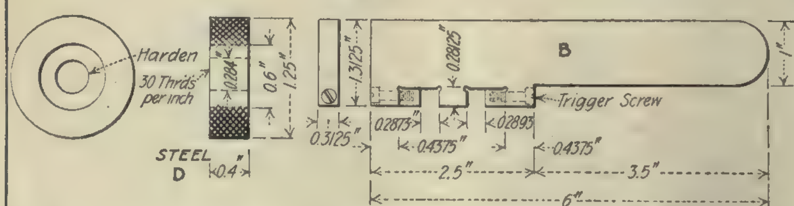


FIG. 884



OPERATION 1

FIG. 885

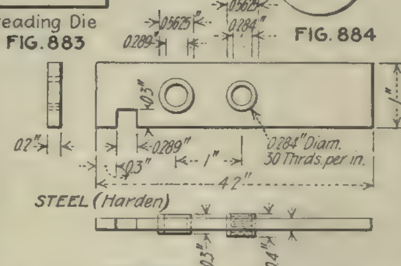


FIG. 885C

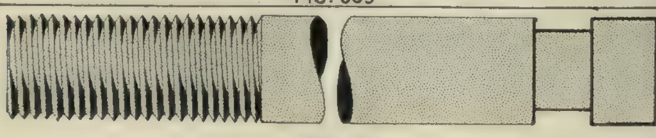


FIG. 886

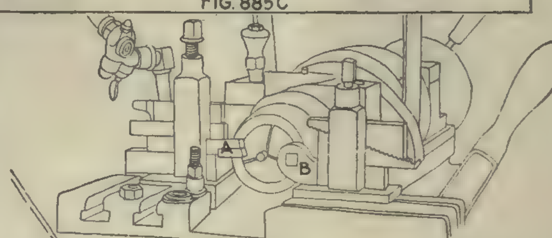


FIG. 887

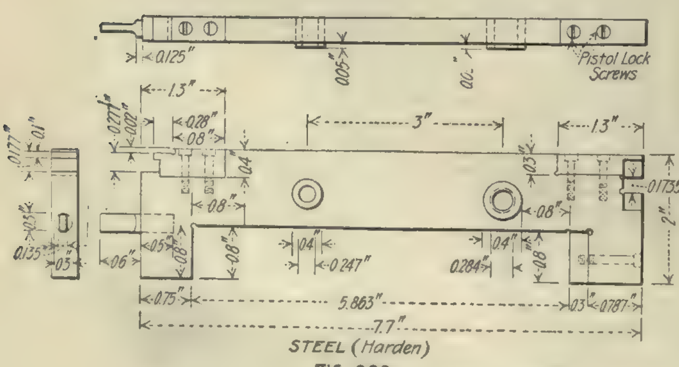


FIG. 889

OPERATION 3

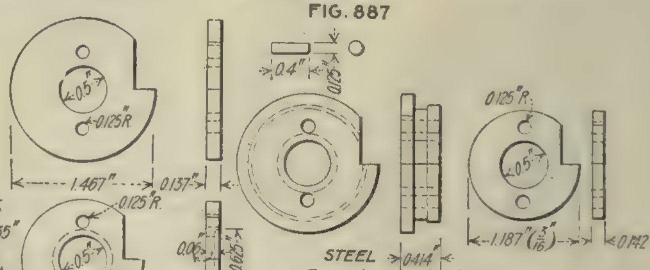


FIG. 888

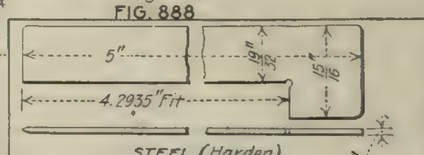


FIG. 890, OP. 1A

The firing-pin rod, Fig. 881, is made of Class B material, 0.290 in. in diameter, with an allowance of minus 0.002 in. This is made from wire that must be annealed, bright, straight, free from kinks and capable of being easily worked in automatic machines. It must be suitable for being handled in an open fire and is drawn to a low temper in a lead bath. The pin is screwed into the cocking piece and is riveted over the end, the length of the rod being so adjusted that when the end of the cocking piece bears against the interior shoulder of the sleeve the striker point will project the proper distance beyond the face of the bolt. The firing-pin rod and the cocking piece when assembled make up the unit known as the "firing pin." The firing-pin rod itself is only an automatic screw-machine job, except for the heating and tempering and the necessary burring operations.

OPERATIONS ON FIRING-PIN ROD

Operations
- 1 Cutting off and threading
- 3 Forming joint (3 and AA grouped)
- AA Removing burrs left by operation 3
- 4 Tempering (two operations hardening)
- 5 Straightening
- 6 Polishing circle, except 1½ in. of rear end.
- 7 Bluing
- 1-A Assembling with cocking piece
- 8 Polishing rear end
- 9 Etching rear end

OPERATION 1. CUTTING OFF AND THREADING

Transformation—Fig. 882; machine diagram, Fig. 883-A. Machine Used—Hartford Machine Screw Co. 1-in. automatic, Fig. 883-A. Number of Operators per Machine—One. Work-Holding Devices—Spring chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—See Fig. 884. Number of Cuts—Two. Cut Data—250 r.p.m.; ⅝-in. feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 885; A, length; B, diameter of wire; C, diameter of pin and thread; D, thread gage. Production—35 per hr. Note—These are cut off and threaded by the same machine.

OPERATION 3. FORMING JOINT

Transformation—Fig. 886. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Tool post A and back rest B on crossfeed carriage, Fig. 887. Cutting Tools—Circular cross-slide tool, Fig. 888. Number of Cuts—Two. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 889, width of groove, diameter of head. Production—70 per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 3

Number of Operators—One. Description of Operation—Filing burrs thrown up by operation 3. Apparatus and Equipment Used—File. Production—Grouped with operation 3.

OPERATION 4. TEMPERING (TWO OPERATIONS HARDENING)

Number of Operators—One. Description of Operation—Harden in open fire at 1,450 deg. F. and temper end of rod that fits in striker; tempered in oil at 900 deg. F. Apparatus and Equipment Used—Rockwell high-pressure oil furnace, firebox about 12x24 in.; lead pot for drawing temper. Production—200 per hr.

OPERATION 5. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening after hardening; detect crooks by rolling on a bench plate. Apparatus and Equipment Used—Cast-iron bench plate, hammer and lead block. Production—175 per hr.

OPERATION 6. POLISHING CIRCLE, EXCEPT 1½ IN. OF REAR END

Number of Operators—One. Description of Operation—Polishing end for bluing. Apparatus and Equipment Used—Polishing jack and wheel. Production—200 per hr.

OPERATION 7. BLUING

Number of Operators—One. Description of Operation—Bluing rod after polishing; blued at 800 deg. F.; kept in solution from 2 to 4 min., then dipped in hot water and afterward in cold water with a layer of oil on top to coat with oil and prevent rusting. Apparatus and Equipment Used—Crucible containing mixture of 10 parts refined niter (saltpeter) to 1 part black oxide of manganese; heated to melting point. Production—About 800 per hr.

OPERATION 1-A. ASSEMBLING WITH COCKING PIECE

Number of Operators—One. Description of Operation—Heading over firing-pin rod after assembling with cocking piece. Apparatus and Equipment Used—Vise and hammer. Gages—Fig. 890, length of assembled pieces. Production—100 per hr.

OPERATION 8. POLISHING REAR END

Number of Operators—One. Description of Operation—Polishing rear end after heading. Apparatus and Equipment Used—Polishing jack and wheel. Production—350 per hr.

OPERATION 9. ETCHING REAR END

Number of Operators—One. Description of Operation—Etching end of cocking piece; there are a few pieces, such as the cocking piece, firing-pin rod and the safety lock, which are riveted in place after being browned; as the riveting must be smoothed down, thereby removing the browning, a special etching acid is used for coloring the polished portions to match the browning previously put on; this is done by putting some of the etching acid in a shallow glass dish and dipping into it the parts to be colored; in order to check the working of this acid the piece is immediately dipped in hot water, then in a dish of ammonia at full strength and then thoroughly covered with oil; the etching acid is composed of 1 qt. "tincture of steel," previously mentioned in connection with browning the barrel, on page 727, 2 oz. corrosive sublimate and 1 oz. nitric acid. Apparatus and Equipment Used—Etching acid, earthenware plate. Production—1,000 per hr.

New Process of Hydraulic Shell Drawing

By G. R. Smith

In the working of sheet metal, an industry that is increasing rapidly of late years, there lies a gigantic field for experiment. A sheet of metal is now forced, cajoled and tricked into all conceivable forms and shapes, by various interesting methods.

The drawing press and the spinning lathe have long been recognized as important factors in the working of

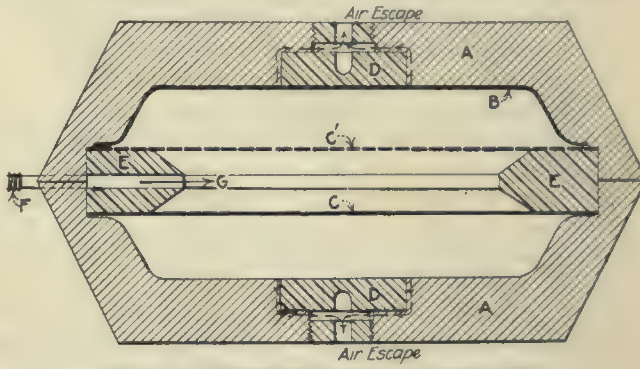


FIG. 1. CROSS-SECTION OF THE DIES

sheet metal, but there are forms of shells and metal formations that cannot be made on either of these machines. It is with these that I am going to deal in this article.

Some of the shell drawing that I shall describe can be done on a toggle drawing press, in four or five draws and annealings, but it is an utter impossibility to do any of them two at a time in one draw, as we are doing by this new process. The other shells and sheet-metal formations here described cannot be drawn at all on a power press. As for the spinning process, the formation itself precludes this method of manufacture, so up to the present other designs had to take the place of what it is now possible to manufacture from sheet metal, in one operation, at greatly reduced cost.

I believe I am safe in stating that this is the first time this process has been described, it being in practical use but a short time. I might also add that few companies in this country at present know of its existence and value. The process has passed the theoretical and experimental stage and is now applicable to a large range of work.

In this process water under pressure is utilized to force a sheet of metal into shapes that could not be obtained by the use of metal punches and dies. Much less equipment is required, and the cost of the tools and dies is greatly lessened. The dies are made of blocks of cast iron, machined to the required shape and set up and held in a hydraulic press or by some kind of clamping arrangement capable of resisting the hydraulic pressure exerted inside the dies. The hydraulic press is much the better arrangement, provided the correct style is used, as the water pressure can be utilized for the dies.

In Fig. 1 is shown a cross-section of the dies *A* as they would appear, together with a drawn shell *B* in the top die and two blanks *C, C′* in position ready for drawing. Little difficulty has been experienced in removing the drawn shells, but should there be a tendency for the shells to hold in the dies, it would be a simple matter to make the vent plugs *D* at the top and bottom act also as knockouts.

The dies are made of good iron, free from blowholes and sand pits, and in the finishing they are stoned up smooth and even so they will draw properly. Should a small leak exist, it is easily remedied by placing a ring of thin felt or cheese cloth between the blank and the steel ring *E* on the inside. This works as a sort of packing, and when the dies are brought together and held under pressure in the press no water can possibly escape.

When the dies are set up in hydraulic presses, holes can be tapped in the top and bottom dies to screw them to the upper and lower plates of the press.

No oils or lubricants whatever are used in this process, as the water itself supplies all the lubrication necessary; and unless the shell is very deep and drawn from a low grade of material, no annealing is required.

From a careful study of this process, and of what the metal is going to do when the water pressure is turned on, it will be seen that the stretch of the metal takes place over a much larger area than under any other drawing process, or by any other method of manufacture, with the exception of hand hammering in which, however, the stretch is not so uniform.

In shell drawing with a press, the only part where the metal is stretched is the small portion that is drawn over the rounded drawing edge of the drawing dies. In the case of a shallow shell of large diameter, the stretch of the metal is in small proportion to the size of the blank. The metal is drawn over the rounded edge of the die by the action of the punch, while the rim of the blank is held by the pressure ring, to prevent wrinkles in the work. There is practically no stretch whatever in the area of the bottom of the shell, all the stretch taking place along the sides of the shell, resulting in work of uneven thickness. Therefore high grade, expensive metal of great tensile strength is required, and large, powerful and heavy presses are necessary for the work. Few mechanics have any idea of the great power needed to do this kind of drawing.

The machine designer is required to figure this all out, or give it a close estimate, and build his machine so as to exert a little more pressure than is required in order to have a good working margin for metals of different tensile strengths. Pressures of 50 to 150 tons are quite common in shell-drawing operations. Presses to deliver these pressures are heavy, bulky and expensive.

In this new process of hydraulic drawing the conditions are of an entirely different nature. The chief factor in its success is the area of stretch. This area is the entire area of the blank. The blank is rigidly clamped near its perimeter, and thus held this area cannot stretch. On application of the water, the pressure is uniform at all points; therefore the metal stretches equally over the whole area of the blank exposed to the pressure. For this reason it is possible to draw shells from metal of low tensile strength.

Such metal as common sheet steel or iron can be drawn into shells which it would be impossible to make by any other process even though the best deep drawing steel obtainable were used. The common sheet steel has a stretch of from $\frac{1}{16}$ to $\frac{1}{8}$ in. per inch, but this stretch taken at all points in the effective area of the blank is sufficient where the blanks are of large area to form the shell.

With the dies set up in a hydraulic press such as shown in Fig. 2, with the ram of the press down leaving

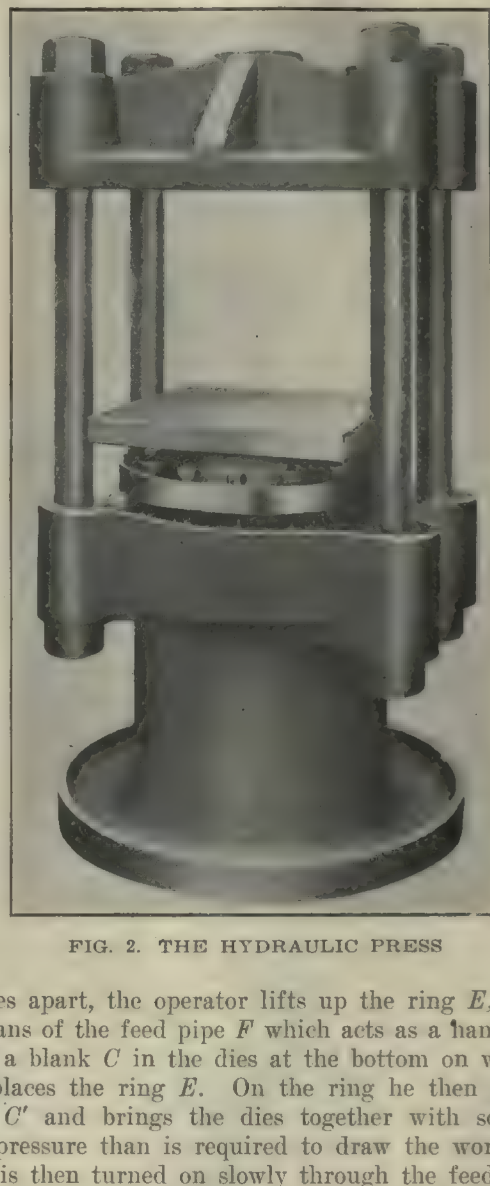


FIG. 2. THE HYDRAULIC PRESS

the dies apart, the operator lifts up the ring *E*, Fig. 1, by means of the feed pipe *F* which acts as a handle, and places a blank *C* in the dies at the bottom on which he then places the ring *E*. On the ring he then places a blank *C′* and brings the dies together with somewhat more pressure than is required to draw the work. The water is then turned on slowly through the feed pipe *F* to allow the space *G* between the blanks *C, C′* to fill before the pressure is applied. This is done because a rush of water under great pressure entering the dies might be apt to burst or tear the metal.

The inlet valve is slowly opened until the maximum flow is reached, and left thus for a few seconds to allow the shell to conform completely to the die and the water punch. After shutting off the water the dies are opened by lowering the ram of the press, when it will be found that the metal has shaped itself to the dies, is perfectly smooth and can be quickly removed. The bottom shell of course will be found full of water, but is easily removed with the aid of a knife blade or like tool.

Enough pressure can be given by this process to emboss the surface of the shell with the grain of the iron dies. Eight to ten tons hydraulic pressure is all that

is required to do large work in 0.060 copper, brass or steel.

Of course this process is more applicable to steel drawing, which, on account of the low tensile strength of the steel or the peculiar shape of the shell, cannot be done by any other method.

A hydraulic press of from eight to ten tons capacity suitable to do this work is not expensive and the cast-iron dies are cheap as compared with the hardened tool-steel dies necessary for use in a drawing press. Good deep-drawing steel costs more than common steel. There are the further losses incurred through the waste in broken shells, the increased operations and the many annealings. Even with all these disadvantages only a limited variety of work can be produced with a draw press.

It requires from two to three minutes by this new process to complete a cycle of the operations of the dies which produce two completely drawn shells. The dies will last forever, as there is little if any wear on them. The shell breakage is small indeed, even with the poorest of common sheet steel. One operator, working 10 hr. a day, will do from two to three thousand shells of any kind, and many more of some kinds.

Samples of Hydraulic Drawing

In Fig. 3 are shown samples of work done by this process. At *A* is shown a steel oil tray 38 in. long, 22 in. wide and 2½ in. deep drawn from 0.045 common sheet steel. This tray on a drawing press would require at least five draws and four or five annealings.

At *B* is shown a tray of like design, 20 in. long, 12 in. wide and 2 in. deep, drawn from 0.060 common steel.

At *C* is a circular shell, 16 in. in diameter by 4 in. deep, made from 0.060 common steel, with flaring sides like a wash basin. At *D* is a feeding pan 40 in. in diameter, 4 in. deep at the sides and 6 in. deep in the center. This is drawn from 0.060 bessemer steel and is a good example of the difficult work that it is possible to do in one draw by this method. This shell would require at least six drawing operations and six annealings, even when made from the best deep drawing steel, if done on a toggle-action draw press; and it is doubtful if it would ever be a success. The first time this design was tried with the hydraulic press it proved successful.

At *E* is shown a cover for the pan shown at *D*, and drawn from the same metal. At *F* is an indented cover with flaring side drawn from 0.040 steel. At *G* is shown an almost complete steel ball for decorative work, drawn from 0.040 cold-rolled steel. It is 4½ in. in diameter. This piece of work was drawn by this new hydraulic process in a sectional die and is a good specimen of the kind of shell work that cannot be drawn or spun in one piece by any other known process. It is an impossibility on a draw press of any kind, as the beading at the base of the ball defies any expanding punch or other steel form that could possibly be made.

The metal formation shown at *H* is the half of a radiator for an artificial ice plant in a family refrigerator. When two of these formations are placed together and spotwelded with a continuous, or what is known as a "hammer" weld, a good sheet metal radiator is formed.

It is a sample of work that cannot be done by any other method. Formerly it was cast in malleable iron. Examples such as this, the nature of which has heretofore defied their manufacture in sheet metal, show the large range of work to which this process alone can be applied.

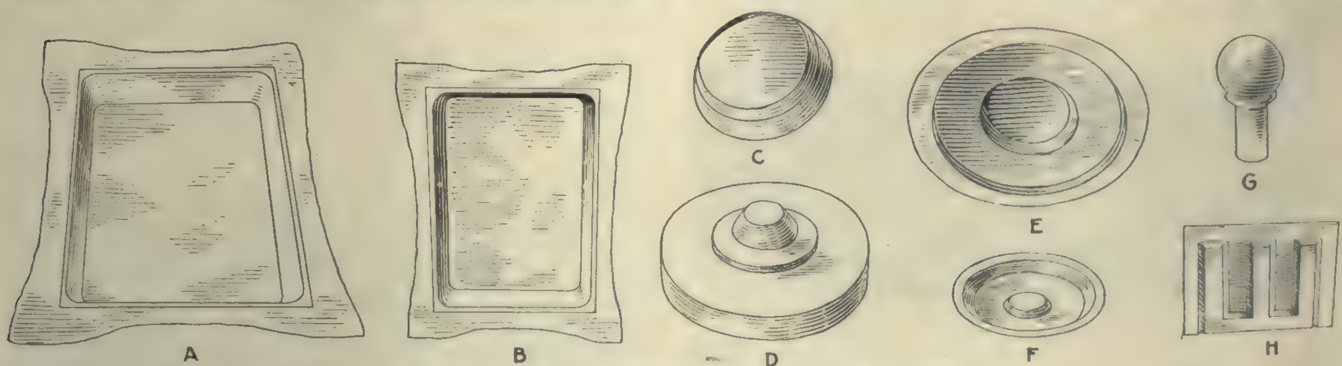


FIG. 3. VARIOUS FORMS MADE BY THE PROCESS

To make this radiator the metal is required to draw in four distinct directions—with and across the grain of the metal, at an angle of 45 deg. to the grain at the ends of the channels, and in an arc when forming the channel itself. These are conditions that few if any drawn-metal shells or forms would require.

I believe this piece can be made from common sheet steel, but cold-rolled steel was selected on account of the buffing, final finish and inside coating of the finished radiator. This part being specified by the inventor was out of my province, so I never undertook its manufacture in other than the metal called for in the specifications.

Should a piece of like nature be undertaken in common steel, I would advise annealing before starting, and perhaps a greater radius at the edges of the forms, thus assuring complete success at the start without costly experimenting. As the entire process is so cheap where the hydraulic presses or water pressure is already in use on other work, it is easy to undertake the making of almost any sheet metal form with it.

Successful Where Power Press Failed

I know of a company that worked fifteen high-grade tool makers three months on dies for an end piece with several brackets for holding shelves. In trying out the dies every kind of rolled metal was tried, but the job had to be given up as a failure, for it would not draw with any style of power press.

By this process of hydraulic drawing we made a perfect success of that job at the first trial without encountering difficulties.

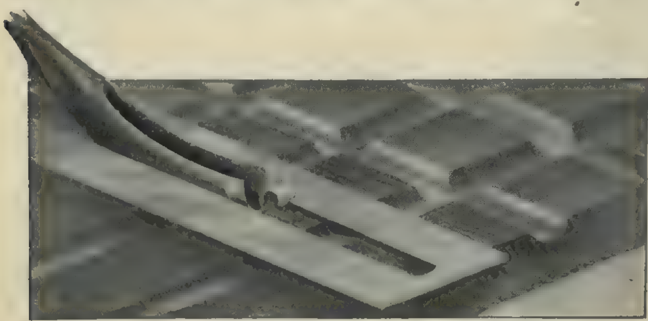
There is no doubt but that there is an endless amount of expensive work now being made the cost of which could be cut in half by this new process.

Tool Guide for Checkered Plate Patterns

By W. H. Sargent

In making wood patterns for checkered plates, it is first necessary to cut grooves in the lumber to divide the surface into strips and then cut other grooves diagonally across the first to form the diamonds.

No special difficulty will be found in performing the first operation, but in the second the corners of the diamonds are liable to chip off across the grain. After trying all sorts of experiments with plane, chisel and saw, one man hit upon the plan shown in the accompanying illustration. He took some thin sheet brass about 2 in. wide and 15 in. long, and cut a groove lengthwise through the middle, just the width of the groove between the diamonds. Having laid out the checks in pencil on the wood, he fastened this templet down to the pattern with a few brads. Then selecting a gouge, or carving tool, outside ground, and of suitable size, he scooped out the wood through this slot. The brass strip served a double purpose; it acted as a depth gage for the tool, and it effectually held down the fibers of the wood and prevented splintering when working across the grain, particularly when forming the diamonds.



THE WORK, TOOL AND GUIDE

Patterns made in this way with a round-bottomed groove mold better, and the castings clean easier than when the pattern is made on a saw with a V-shaped channel between the checks.

Making Practical Use of the Background Pages

By A. Towler

The illustration depicts the method used by the State Trade Education Shop, Bridgeport, Conn., in dealing with the background pages that have been one of the features in the *American Machinist* during the past two years.

It will be seen that the two pages, which form an article, are cut from the paper and pasted in a folder. These folders are suitably indexed, the information being transferred to a file.

When it is desired to design any tools, jigs or fixtures the pupil, by referring to the index, can get out the correct folder, on which is pasted the drawing of a guiding tool, to assist the designer.

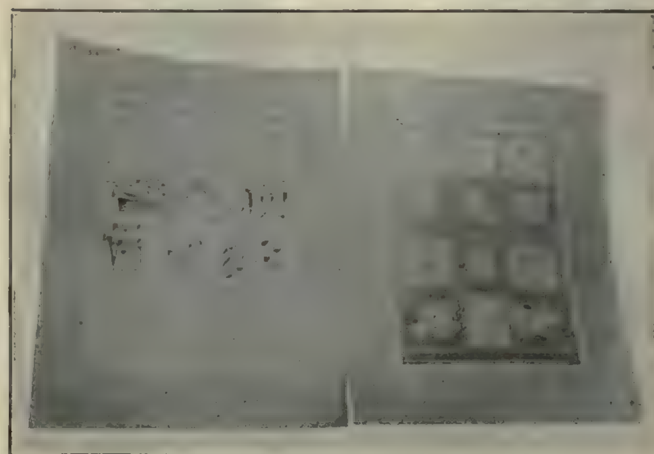
The average age of the boys in this school is 16 years, and it has been found that these jig and fixture pages have proved of great assistance to them.

During the winter months the school conducts evening classes, among which is one class organized for the purpose of teaching its members how to read blueprints and drawings. This course is chiefly for machinists who work during the day and who have little or no knowledge of reading mechanical drawings.

One of the features adopted in this class is the giving to each student of one of the jig and fixture pages showing a part of a tool to be machined. The student is then asked to make a free-hand sketch of the work separate from the tool, jig or fixture.

If this is successfully performed, the instructor knows that the student understands the use of the tool (being able to separate it from the part to be operated upon). It also shows the ability of the student to read a mechanical drawing.

Aside from the use of these jig and fixture sheets in this class, another evening class, made up of draftsmen and machinists who are studying tool design, employ them in the design of jigs or fixtures for special jobs. It has been found that the ideas displayed on these sheets are of great help to the pupils, as the diagrams offer many valuable suggestions of methods to be used on the special jobs in question. As the sheets are classified and indexed the information is readily obtainable.



FOLDER FOR PRESERVING THE BACKGROUND PAGES

Drilling Cotter-Pin Holes in Clevis Pin

By W. Thompson

Considerable difficulty is usually attached to drilling cotter-pin holes in clevis pins, owing to breaking of drills, which is caused from the absence of lubrication at the cutting point.

In order to overcome this trouble, also increase production, we arranged our drill jigs so that they were immersed in drilling compound to the depth of the jig. This was accomplished by placing the jig in a pan of sufficient depth and clamping the jig and pan to the drill table. Holes for $\frac{3}{8}$-in. pins are drilled at the rate of 150 to 175 per hour, and the average production per drill is 1,200 holes; the size of the drill is $\frac{5}{64}$ in.

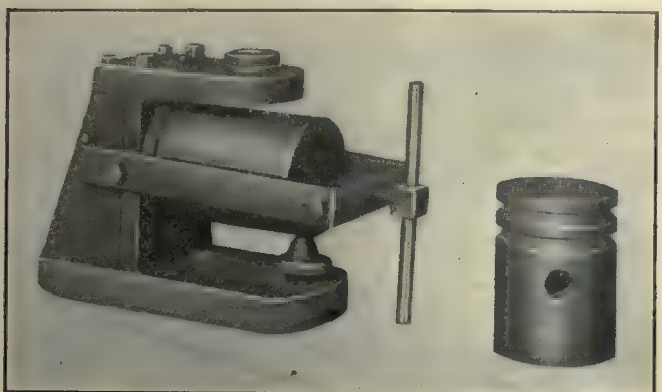
There may be more or less objection from the men to this method of handling the work immersed in the lubricant. It has its disadvantages especially in cold weather, but on the other hand there is no annoyance from red hot chips.

Letters from Practical Men

Wrist-Pin Hole Drill Jig

In the illustration is shown a simple form of jig for drilling and reaming the small wrist-pin holes in the smaller sizes of pistons. One of the finished pistons is shown to the right of the jig. These pistons are 3 in. in diameter and 4 in. long, with a ¾-in. reamed hole.

The pistons are held in a universal chuck in the screw machine, and faced to length, and the open end bored to size, so that they may be slipped over a plug in the jig.



JIG FOR MACHINING PISTON

In order that they may be properly placed with respect to the internal bosses, a chalk line is drawn outside corresponding to the boss on the inside, and this mark is placed central with the drill bushing. The writer at one time used a self-centering V-block for this purpose, but the extra complication did not prove to be of any great value.

The pistons are held in place by the swinging clamp, this being held in a horizontal position by the pin at the left. After the screw in the clamp is tightened, the knurled nut at the bottom underneath the head of the piston is run up with the finger until it just touches the casting. The holes are first drilled, after which the loose bushing is removed and the holes reamed.

This arrangement works out very nicely and is one of the quickest and simplest which the writer has seen used. D. D. Barrett.

Lima, Ohio.

Shrinking Steel Pinions Too Large in the Hole

A number of small pinions that were to be shrunk on shafts were found to have been reamed oversize, so that they slipped freely on the shaft where they were supposed to be shrunk. This difficulty was overcome by heating the pinion to a red heat and dipping it for half its length into water. This cooled and contracted the lower half, which caused the upper half while still hot to contract. Upon finally cooling, the upper half was found to be much smaller in diameter, while the lower half remained unchanged.

This operation was then repeated, the ends being reversed, thus bringing the entire pinion to a sufficiently small diameter to allow it to be heated a third time and shrunk on the shaft in the usual way.

This method is of course restricted to short pieces. It has, however, enabled us many times in various ways at a very small cost to reclaim rejected and expensive material that would otherwise have been scrapped.

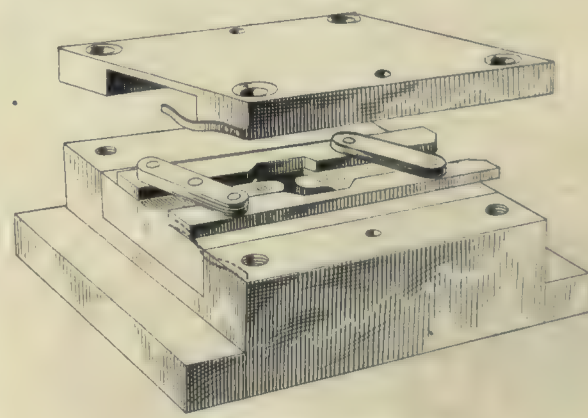
Fond du Lac, Wis. H. J. Rueping.

Centering Strip Stock in Dies

It is sometimes desirable to blank pieces from commercial strip stock—that is, form a blank which is the same in width as the stock, a small piece of scrap being cut from between the ends of the blanks.

When the blanks are to have a formed end, like the one shown, is is necessary to provide for the variation in width of the stock, so that the form will come central with the stock.

The illustration shows a die that was designed for this work, and which proved satisfactory. As will be seen, an arrangement of two guide bars connected by pivoted links, similar to a parallel rule, is the method employed to take care of the variation of the stock. The strip of stock is pushed in between the guides, the spring tending to keep them closed, thus holding the stock central. Charles W. Leck.



THE CENTERING DEVICE

Newark, N. J.

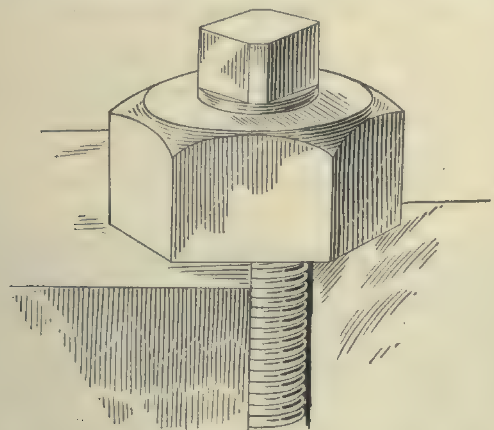
Foundation Bolts

A small but far from unimportant detail worth extended application wherever important foundation bolts are in question came under my notice recently.

Where a plain anchor plate and square or hexagonal-headed bolt is used, or even where a cotter is employed without special means to render the bolt nonrotating, there is difficulty in tightening the foundation nuts when they slacken back, as the bolt and nut are likely to turn together.

As it is impossible to get to the bottom end of the bolt for obvious reasons, the job of effectually tightening it is very difficult and may often involve expensive dismantling to retighten a few nuts.

The illustration shows a foundation bolt with a squared upper end which can be held while the nut is being



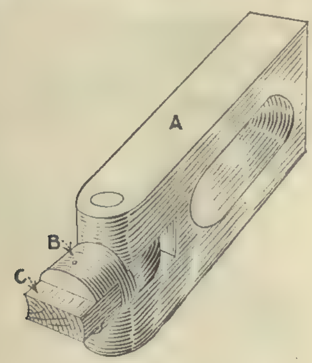
HOLDING DOWN BOLT WITH SQUARED END

tightened. It is not claimed as original or even new, but is so rarely applied to holding down bolts that it is worth remembering in this connection.

London, England. A. L. HAAS.

Universal Steadyrest Jaws

The three jaws are made as illustrated at *A*, with the part *B* pivoted as shown. The part *A* is of steel, while *B* is cast iron and has a slot milled in the end to hold



THE UNIVERSAL JAW

the wood shoes *C*. These are made of hard wood, such as maple. The advantage of this set of jaws is that they are universal for straight, taper or ball form spots on bar work in the lathe. A. H. LENZ.

Fond du Lac, Wis.

Let the Other Fellow Know

For a number of years, I have been a contributor to the *American Machinist*. At first I was rather timid about sending in an article. I would write one and then lay it aside.

Several years ago I came across a number of these articles that I had written, and having a little more nerve than usual at the time, I said to myself, "Well, here goes," and I sent in my first article.

I must say that I was sorry after I had done so; however, it had gone, and I awaited results, expecting to get it back most any time. Judge of my surprise when in a few days I received a check in return!

I was more than pleased when a number of the articles that appeared in answer to mine gave several good ways of doing a certain piece of work that I had never thought of. One of them was far better than the one I had sent in and I at once adopted it.

I received a great many answers to my articles through the mail, and I feel that the writers are just as timid as I was before I sent in my first article.

Now put aside your timid feelings and send your answers to any article appearing in the *American Machinist* direct, so that everyone interested can read them. This will create interest for all.

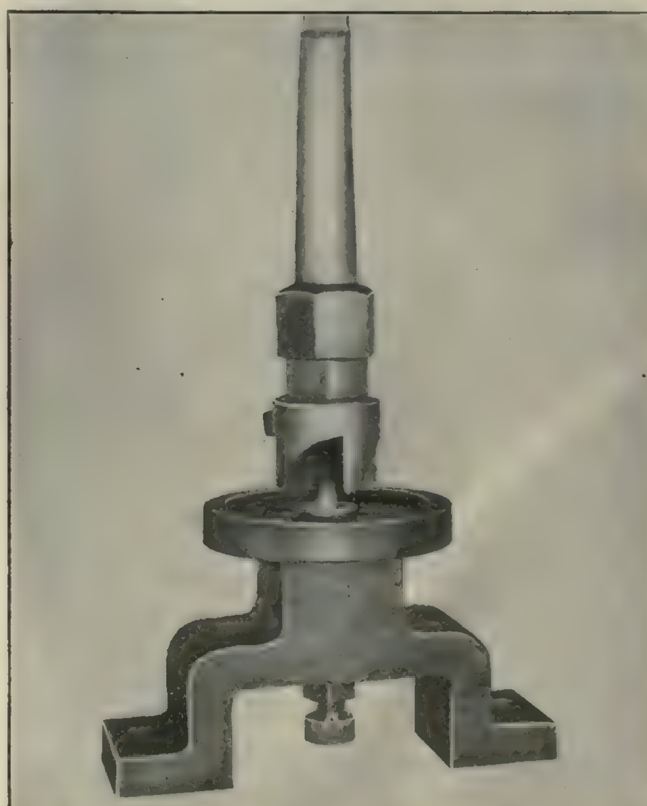
Naugatuck, Conn. A. E. HOLADAY.

[The motion is seconded.—Editor.]

An Interesting Special Small Tool

The students at the State Trade Education Shop, Bridgeport, Conn., have designed and built some interesting small tools that are used in the machine shop at the schools.

A fixture and cutter for facing the hubs of pulleys is shown in the illustration. The cutter is made with a



A HUB FACING FIXTURE

pilot that fits into a previously machined hole in the pulley. The fixture is provided with an adjustable knurled-head screw. To use the fixture and cutter the setscrew is set and locked with the check nut shown, so that when the end of the pilot comes against the screw the desired amount of metal has been removed from the pulley hub. A. TOWLER.

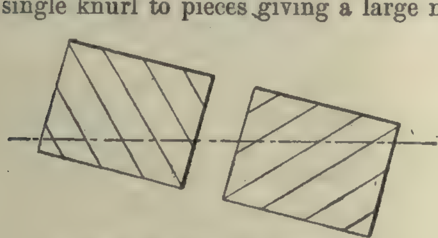
New York City.

Discussion of Previous Question

Cross-Knurling

Mr. Gribben, in replying (page 693, Vol. 45) to Mr. Ware's query (page 388), refers to a difference in the number of nicks on the two sides of a cross-knurling showing a thread effect, but "gives up" on the reason for the difference.

In trying to find out the cause of the split nick sometimes seen in cross-knurling, I found that in applying a single knurl to pieces giving a large number of nicks the number can be changed by changing the depth of nick on the first revolution. This varying depth of start is responsible for the split nick. After reading Mr. Ware's query I kept it in mind, and on the first opportunity I tried out my idea as to the cause of the appearance of this thread. By tipping the knurl holder at an angle, the thread appeared at the right or the left hand, according to whether I tipped the holder to the right or to the left.



KNURLS SET AT AN ANGLE

I had tried this out before I read Mr. Gribben's reply and after reading it I counted the nicks on the piece I had left and found there were 33 on one side and 34 on the other. This was to be expected, as the change of angle already mentioned has the effect of changing the tooth space, as can be seen by referring to the accompanying sketch of knurl faces set at an exaggerated angle.

The lines in the upper wheel cross a vertical line much closer together than those in the lower.

Cincinnati, Ohio. WALTER H. WEBSTER.

Training Young Mechanics

The article by J. S. Williams on page 935, Vol. 45, is interesting. It is almost impossible for a young man to thoroughly learn the machinist's trade in any of our large present day shops. Modern efficient methods that have been forced upon us by keen competition make it unprofitable to spend valuable time in training a green hand in all the finer points of the art of working metals, as practiced by the all-around machinist a quarter-century ago.

How, then, are we to train our young men to replace those who are constantly dropping out? As I view the matter, it is up to the individual himself to keep his eyes and ears open, carefully observing how good mechanics handle intricate operations. To be sure, one has to have practice to become proficient in any line; but observation must come before practical work. The young man must learn by experience what to do and what to avoid, and above all things he must learn to profit by his mistakes.

A practical illustration of this is shown in an incident observed a few months ago in a small shop. A young mechanic was reaming out a tapered hole in a piece of tool steel gripped in the lathe chuck. The reamer was none too sharp, and to pull the cut he was running his lathe with the back gears in. As may be imagined, he twisted the shank off the reamer. "You should know better than to attempt to force a tapered reamer," I informed him. "No wonder you broke it." "Well," he replied, "I do know better now."

Here we have the whole situation in a nutshell. The young man was discharged, but I venture to say he will not repeat that mistake, because he has learned from experience that he made a costly blunder.

The best way to gain practical experience is by drifting from one shop to another, working on repair and experimental work when possible. This calls for skill, to be sure, but the young man who is observant soon learns how to make good if it is in him to do so. Many will claim that the roving machinist is a careless, no-account sort of chap. While this is true in some cases, the majority of our good mechanics, including a goodly number of foremen and superintendents, have been tramp machinists in their time; and it was through the varied experience thus gained that they became skilled craftsmen.

Few firms take apprentices in their toolrooms, and the question naturally presents itself, Where do the tool makers come from? The majority are all-around machinists who have worked on close work and afterward ventured out as tool makers. As a matter of fact, there is but little difference between tool making and accurate work as done by the all-around machinist, especially one who has worked on experimental work to any extent.

I claim that it is up to the young mechanic to train himself, and if he will read papers like the *American Machinist* and put in at least as much time studying the fine points of the trade as he often does in making rings on a bar-room table with the bottom of a beer glass, he will eventually succeed if he is mechanically inclined.

Indianapolis, Ind. F. B. JACOBS.

Blueprints Without Tracings

I have noticed a number of articles on the subject of blueprints without tracings. The latest of these is on page 738, Vol. 45. The correspondent suggests the use of carbon paper to reproduce the lines on the back of the drawing to be blueprinted, and so give body to the lines. I do not regard this as a practical method, as there is quite a lot to be said against it.

The first point is erasure. If a line is wrong, it must come out. In using the carbon this means unpinning the drawing to get at the back of it. Again, a carbon line is, as a rule, none too easy to erase. Unpinning the drawing also means that time has to be lost in getting it back into position again, and this has to be carefully done in the case of a large assembly drawing.

The second point that I wish to bring forward is the tendency of a carbon line to smear. I think that your correspondent will admit that such lines will smear very easily; and not only will the back of the drawing become "smudged," but when the drawings are filed, the lines on the back of a drawing of this type will affect the face of the drawing immediately underneath and also smear that.

I do not consider this method practical at all and personally prefer drawings on bond paper finished in H-grade lead. WILLIAM HALL.

Heywood, Lancs, England.

Does Technical Writing Pay?

As he is "an old hand at the game," Mr. Jacobs' contribution on page 544, Vol. 45, on writing for technical papers, was to me of more than ordinary interest. To criticize his remarks is not my intention, but rather to add one or two points he appears to have missed.

To the young mechanic with a notion of appearing in print, Mr. Jacobs' strong point on "rapidity of writing" being a necessary qualification might tend to warn the novice off the grass altogether, and my advice in this direction is take your time. If you wish to score a "bull," you must begin with a cool deliberate aim.

My first attempt earned one dollar. It was the combined effort of myself and a young wife for three whole evenings and was rewritten at least a dozen times, checked and counterchecked. Since that time I have earned sixty dollars in less time, and I honestly believe with less real enjoyment than I got from that single dollar.

Of course, my methods nowadays have reached Mr. Jacobs' standard—about an inch of pencil and any old bit of paper. The environment does not matter in the least, a seat in a tramcar or train being quite as satisfactory as a seat at my desk. I first decide my "plot," as I suppose is done by the blood-curdling novelist, then the editor who is to be my victim; after that the inch of pencil takes on the real high-speed notion of things, and I fill up sheet upon sheet until the subject is dried up and my thumb and finger feel like a boy's stomach that is carrying an overdose of green apples. The results of this effort are then handed over to my daughter and a typewriter purchased with a check from *American Machinist* for "one single night's work." I may read through the copy before signing, but no other time is wasted.

Just what constitutes a successful technical writer may be open to argument. In my own case, when my contributions began to appear something as they were when leaving me, I considered I had attained that position; but a better argument may be found in a pigeon-hole in my desk. It contains letters from editors asking for contributions on various subjects. These, I think, coming as they do to one who prefers the inside of a machine shop to the finest office chair, settle the argument. To attain this position a prime essential, quite overlooked (perhaps accidentally) by Mr. Jacobs, stands alone—read, read, read.

If you wish to become a contributor to this journal, read it from cover to cover, not once now and then, but every issue. There are many reasons for this. If you are not in the machine-tool field, there is very little hope for you. If you are, you will be welcomed with open arms. Its whole organization from top to bottom is made up of machine-tool men first, professional journalism coming after; and no matter how correct your grammar, your King's, Queen's or United States English, your brilliant brain streaks, your great penmanship, your college degree, they will never materialize unless you read continually.

The men of my acquaintance who have attempted this fascinating hobby and failed have done so from one cause alone—failure to read. This class of writer sends along his effort to the editor, confident in his own mind that his particular method of turning out six corkscrews a day cannot be beaten. Had he read the issue of a fortnight ago, he would have seen that just an ordinary individual on two legs had a method of turning out six thousand a day and thought it nothing out of the ordinary.

I believe with Mr. Jacobs that a broad shop experience is also necessary for the purpose of writing. I also believe that a broad shop experience is only a sham, without reading. How can a man claim anything for his methods unless he knows what others are doing?

A few days ago I was called upon by a firm to describe the manufacture of a particular article from A to Z, to use the chairman's phrase. This I did in the same method as I write this article. I called for over $100,000 worth of American machine tools, some of which I had never seen, in addition to machines made in Britain. I named every maker without reference to catalog or book of any sort. I estimated operation times in several cases solely from information received in the manner I recommend—reading.

In reading operation times in advertisements, I convince myself that this or that can be done or it would not appear in black and white in these columns, and I compare these records continually with what I am doing in my own work.

On the financial question, all readers (particularly those who deal with other journals) will indorse Mr. Jacobs' remarks on the liberality of the *American Machinist*. Without the monetary element no doubt I would have been out of the business years ago, if only on account of my nationality, which necessitates considering the "bawbees" [Scotch for halfpence] all the time; but looking back now over a number of years, I can truthfully say, had I never received a cent for my efforts in this line, I would still have been recompensed beyond all comparison to the effort and time given for this purpose. The broadening of my mind, the addition to my pay envelope, the position I now command, *not occupy*—all of these can be tumbled into the scale and send the balance up with a bang.

A few days ago I was reading of the late Major Pond, who made lecturing and lectures a great success in America. He handled most of the great men, both American and British, of his time. His most successful feature was "his great ability to keep the money element always in the background." No doubt many of his clients were very touchy on this point, but they wanted the money.

After many years' experience with the *American Machinist,* I think this feeling permeates its management. I have found the money element always in the background; but it is there, and many delightful surprises have been my lot. If you have never experienced this, you have missed the most fascinating hobby a machine man can have. It beats fishing, and you do not have to put wriggling, creepy things on a hook.

Belfast, Ireland. F. P. TERRY.

In Regard to the Standard Sizes of Drills and Reamers

Just what does A. J. Shirley mean in his query on page 777, Vol 45, when he asks what size should a standard-size drill be? I find that drills of different makers vary in size, some as much as 0.0015 in. under or over size. I also find that drills from 3/8 in. and larger seem to be under size, while from 1/4 in. to 3/8 in. they seem to be pretty near to size, and from $\frac{1}{16}$ to 1/4 in. a little oversize.

How much to allow for reaming depends upon how the piece is to be reamed, if in a jig or a fixture. Allow $^1/_{64}$ in. for jig reaming for holes $\frac{3}{16}$ to $\frac{7}{8}$ in., and $\frac{1}{32}$ in. for larger sizes. If the piece is to be line reamed after jig reaming, allow about 0.003 in.

West Orange, N. J. F. W. MUNSON.

Cutting U.S.S. Threads Accurately to Standard Size

On page 962, Vol. 45, of the *Machinist* is an article by J. B. Murphy on cutting U.S.S. threads. I think that if this method were followed out, it would make an undersized thread. My reason is as follows:

In the U.S.S. thread, owing to its having an angle of 60 deg., the amount of increase from the flat up, if brought to a sharp point would not be one-half, but 0.866 times the flat (by trigonometry the altitude of an equilateral triangle is equal to the base or one side, times the sin of 60 deg. or 0.866), and if taken on both sides would be 1.732. Hence, 1.732 times one-eighth the pitch, added to the outside diameter, would give the size for this method. JOHN C. DINWOODIE.

South Manchester, Conn.

A Plea for Signed Help Wanted Advertisements

The plea for signed help wanted advertisements on page 999, Vol. 45, is easily answered by those who have had experience in employing men for positions of various kinds.

The most common reason is that the employer is sure to be deluged with telephone calls or personal visits even though the advertisement states that applications should be made by letter only. The writer has found this to be the case so many times that he is sure that a test of this kind will prove that one or two applicants will not obey the instructions. Another common reason for not signing the name is that employees of the company are sure to notice the advertisement, and if, for example, a foreman is wanted, it is certain that rumors will be started that some foremen is to lose his position in the near future.

Employees of the company who may read the signed advertisement are very likely to apply for the position advertised. And while such an application might bring to the attention of the employer an opportunity to promote a man in his own shop, it is probable that he has already looked over the field and decided that he must obtain other help. If an application is made by an employee and is not accepted, it may create some feeling against the successful applicant and hinder him somewhat in his work.

The unsigned advertisement has several advantages. Occasionally a man already in the employ of the company will apply for the position advertised not knowing that his application will be forwarded to his present employer. The writer knows of several cases where this has occurred. Sometimes it has happened that the employee has brought favorable attention to himself. The employer may thus receive a warning of the employee's intention to seek other employment in time to enable him to take steps to make the applicant's position more satisfactory so that he will stay. In other cases the applications have resulted in opening the employer's eyes to possibilities for improving his organization.

The applicant who does not know to whom he is applying is naturally more conservative in describing his record and his accomplishments, for the very simple reason that he does not know how well the advertiser may be able to check up his statements. This, of course, does not apply to all applicants.

Any one who has run long and continuous advertisements in several publications knows that there are men who have apparently formed the habit of answering any and all "Help Wanted" advertisements which seemed to offer a better position than that which they hold. Naturally they do not continue to send any applications to those advertisers who sign their names. These chronic applicants are sometimes guilty of changing their self-acknowledged accomplishments to meet the requirements of the advertiser.

I believe the keyed advertisement is very much to be preferred by the employer, particularly when seeking applicants for the higher positions.

W. F. ROCKWELL,
Assistant General Manager, The Torbensen Axle Co.
Cleveland, Ohio.

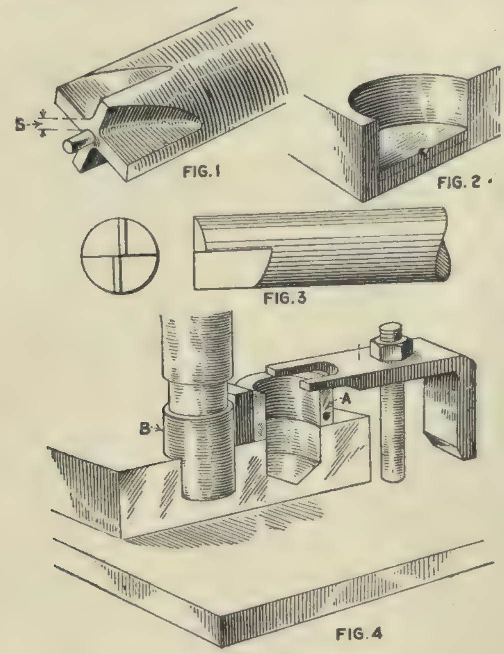
Counterbore with Disappearing Pilot for Flat-Bottomed Holes

The counterbore shown on page 628, Vol. 45, by Jan Spaander, is not the type of tool a mechanic would use to produce a flat-bottomed hole. The end view of this tool is shown in Fig. 1. He first drilled holes 1/8 in. in diameter to suit the disappearing pilot, but he cannot follow up with a tool made as shown in Fig. 1 because the cutting edges do not run right up to the pilot. Therefore, there is metal left by the spaces *S*, and the tool will rub on this. Even if forced down the tool will not go to the required depth, for it will refuse to cut when at the bottom of the 1/8-in. hole and leave the work as in Fig. 2.

The pilot is much too small and will never control the tool and give accurate results, but will only cause trouble through bending and seizing.

A more practical method of producing the holes accurately is to first use an ordinary drill and drill to the correct depth to a stop on the machine, using a bushing as at *A*, Fig. 4. Then follow up with a two-fluted counterbore, as shown in Fig. 3, again working to the stop. Next insert a plug *B* in this hole, and working off this and using the bushing, drill and counterbore

the second hole. This is shown in Fig. 4. The use of the bushing in the first operation is to control both tools, so as to insure the counterboring tool starting concentric to the drilled hole. The point of a correctly ground drill of this size will leave about 1/8 in. in diameter flat at the point, so that should the teeth of the counter-



THE WORK AND THE TOOLS

bore not quite cut to the center, it will make no difference. Jan Spaander does not state how he produced the 1/8-in. holes to the correct centers, although he stipulates that they must be correctly spaced.

Surrey, England. P. J. TOMPKINS.

A Question of Lathe Design

A little investigation in several of the older catalogs and in works on machine-shop practice reveals the following conditions from which the conclusions drawn will, I hope, clear up the situation.

The tendency of British machine-tool builders in the past has run very largely toward the building of gap-bed lathes. It has been but recently that this has not been the case. To obtain a "short hold" upon the tools and at the same time to permit a big job to swing in the gap, no wings are permissible upon that side of the carriage toward the headstock; in other words, the bridge or cross-slide has to be moved from an approximately central location to the extreme left of the carriage. Furthermore, there are occasions when the cross-slide partly overhangs the gap.

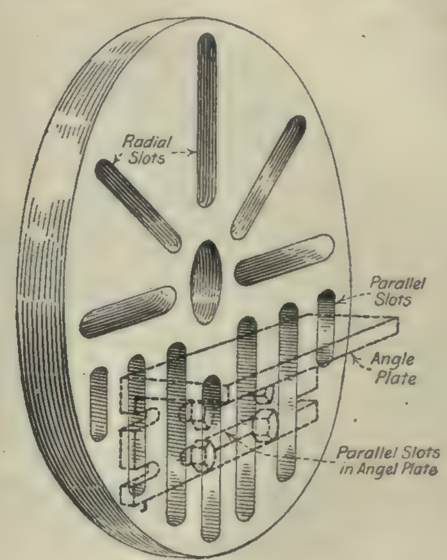
Under these circumstances, were the traversing handle placed at the left-hand side of the carriage, it would interfere with the crossfeed handle. Also, if the two did clear, a rather long train of gears would be needed to transmit the motion to the rack pinion, which has to be toward the right side of the carriage in order that the cross-slide may hang over the gap. The "surfacing" or crossfeed would have to be gotten around, as would the clamp-nut mechanism.

In those days gearing was an expensive proposition and was avoided whenever possible. We find therefore in the designs of those times rude simplicity, an arriving at the desired result with the fewest number of parts.

With the carriage-feed handle at the right, it is out of danger from being struck by some large job swinging in the gap, and the workman is less exposed to accident from the same cause. When turning work at high speeds and making hand adjustments, the hands are more often out of the way of uncomfortably hot turnings.

Against the foregoing the chief argument is lack of convenience in operation, which is largely a matter of what one is accustomed to. British conservatism—unwillingness to change what has for the past fifty years given satisfactory service—is about the only reason for continuing the practice. As the number of gap lathes is proportionately decreasing, we find more of a tendency to bring the handwheel over to the left side, as in the average American lathe.

The left-hand lead screws that Mr. Davis mentioned indicate to me that the lathes he has in mind are "middle-aged." It has been the practice of some tool builders to make their screws left hand, thereby avoiding an extra gear and idler stud in the change-gear mechanism.



IMPROVED DESIGN OF FACEPLATE

These lathes are quite old, the last one I ran being a "Niles," 42 in., built in 1874. I also have seen quite a number of American built lathes in and around Manchester, England, with the left-hand lead screws, but the practice is now abandoned.

Another point of convenience that has been overlooked in faceplate design is that in ninety-nine cases out of a hundred the bolt slots in faceplates are radial. For angle-plate work especially it is much more convenient to have half the working surface of the faceplate with slots parallel instead of radial, as shown in the illustration. Now if the slots in the angle plate are so located as to be at right angles to those of the faceplate, there will be a much more convenient adjustment possible than when the faceplate slots are radial, the number of cases of bolts jamming just before the desired location of the work is reached being reduced to a minimum. This principle is extensively used in structural ironwork and even in building up foundry flasks. It seems worth while—why not apply it in this instance also?

Dayton, Ohio. ROLAND V. HUTCHINSON.

Editorials

The Unending Struggle

The food supplies that Nature and man's toil may produce during this year will be consumed or destroyed by the natural processes of decay twelve months from today. The fabrics that form our clothing may last a year or two or three, and then they become useless and disappear. Our dwellings may have a life of ten or twenty years, or even a little more, but the most permanent of our structures require an annual outlay for upkeep, which means that each generation pays for all the great works and buildings that it uses. Man's labor is continually spent in replacing that which Nature is destroying.

We have been told that the great businesses of the world have been at various times war, religion and industry. It is a common thing to have someone say that for the last one hundred years the great business of the world has been that of carrying on its manufacturing and its industrial pursuits.

But from the time when man first began to exist, his great business has been getting a living. He has always been compelled to fight hostile Nature. Hunger and cold have ever camped across his trail. His life has been a continual battle to obtain food, clothing and shelter. Truly, the business of the world is and always has been to wring from a resisting Nature enough to support life.

Statistics show that the purchasing power of a day's work has steadily increased since the time when records are available, and that during the period from 1840 to the present there has been a decided jump. The reason for this unquestionably lies in the development and application of labor-saving machinery. Such machinery is one of the weapons that man uses to fight back the hostile forces by which he is surrounded. Such machinery helps him to exist on this planet.

Once we recognize the elemental business of human life, the place of labor-saving machinery becomes plain. Over and over again the popular fallacy that the introduction of labor-saving machinery injures labor comes forward in some form or another. Whenever a new machine goes into operation, men are relieved from some handicraft; they are thrown out of work. It seems hard for those who take only a superficial view of such an occurrence to realize that these men have not been seriously injured. On the surface, it looks as if their means of gaining a living had been ruthlessly taken away.

But when we think that the human race as a whole is dependent for its living upon production, that everyone, if he is doing a man's work in the world, is fighting Nature, we realize that whatever increases the output of the soil or improves the products taken from the soil is a direct benefit to mankind.

Labor-saving machinery is one of our greatest weapons for making Nature produce what we need. With a flail a man can thresh some five bushels of wheat or rye in a long working day. Seven men running a modern threshing machine can turn out 1,800 bushels per day, or say 250 bushels per man; that is, the labor-saving machine thresher multiplies the effectiveness of a man's labor by fifty.

When we appreciate the real place that labor-saving machinery occupies in our fight for existence on this planet, we can never think again that the introduction of a producing machine is a detriment. On the reverse, it is a boon to humanity.

Applying the "Plattsburg Plan" in the Shop

Dr. Ira N. Hollis, the newly elected president of the American Society of Mechanical Engineers, at one of the sessions of the recent convention of that society suggested applying the "Plattsburg plan" to engineers and Government shops. For two summers several thousand civilians have left their regular duties and gone to the Plattsburg camp for a month's military training. Dr. Hollis' plan is that in a similar way civilian engineers should leave their regular duties for a month each year and work in some one of the arsenals or navy yards.

The thought is that the engineer who has had a brief experience in the manufacture of articles in Government shops will be as valuable to his country in the time of emergency as the man who has had a brief training in military affairs at Plattsburg.

The suggestion was favorably received by those who heard it. There should be no serious difficulties in working out the details and putting the plan into effect.

It has often been said that in case of the emergency of war, the trained engineers of the country should not enlist for any kind of active service. Their technical knowledge and skill would be of too much value in producing manufactured articles to permit them to serve in any military capacity. But if men from other walks of life are willing to take a limited amount of military training as a patriotic service, should not a similar opportunity be presented to the trained engineer?

Dr. Hollis evidently believes that there should, and his suggestion opens the way. The manufacture of materials for the army and navy has been closely held hitherto in the Government arsenals and navy yards. If civilian engineers are to take the responsibility of producing in large quantities at some future time, it is obviously wise that they should have some experience in their production in time of peace. What more reasonable, then, than to suggest that they volunteer for a month's service a year in some of the Government plants and specialize upon the work that may some day come to them.

It is more than likely that many men would welcome such an opportunity. There are many engineers in executive and managerial work who would be glad of a brief close contact once more with the routine of

shop life. When this opportunity comes accompanied by the chance of performing a patriotic service, the plan holds a twofold attraction.

The method to be followed in selecting these men after they have volunteered for service, in distributing them through the various navy yards and arsenals, and in setting their work to obtain the maximum of results in a month's time, all involve a considerable amount of careful study and planning. At the same time none of these difficulties is insurmountable. Let us hope that Dr. Hollis' suggestion will be adopted, and that, during the coming summer, a large number of civilian engineers will volunteer for training in our Government shops.

Co-operation in Social Work

During the past few weeks, comments in these columns have pointed out the social responsibility of employers and indicated some of the lines along which employees' service is now being developed. Thus far, this work has been done in large plants. If industry is to gain the maximum of benefit from this movement, the small shop must not be overlooked.

A physician who has had several years of industrial practice, and is at the head of the employees' service department of a machine shop employing some 1,500 men, gives as his mature opinion that any shop employing from 350 to 400 men can install such work with mutual advantages to employer and employee. But there are many shops employing less than 350 men.

As a rule, the working conditions in the small shop of necessity do not equal those of the large. There is less opportunity to provide the newest facilities for ventilation, heating, sanitation, lighting and the like. The small shop is often located where good lunchrooms are not plentiful, and where there are many corner saloons. The small shop cannot afford a mutual benefit association—there is no one to look after a banking and loan service. The small shop cannot do anything by way of noonday recreation, it cannot support a dispensary, or give dental advice.

On the whole, the small shops are behind their larger brothers in those things that are usually classed under the head of "employees' service."

Where a need exists a remedy must be found. The employees of small shops need service work. How can they obtain its benefits? The only suggestion that has been offered is that of combining for such work.

Is it not possible for several shops in one locality, whose aggregate number of employees is, say, 350 or more, to combine as regards their social work. Is there any reason why a mutual benefit association cannot include men from several shops, instead of being restricted to those in one organization? Cannot several shops support a common lunchroom? Cannot all of the social activities now being carried on in the large plants be handled by one organization for the men of several shops?

A starting point might well be the medical work. Several shops might combine, hire an industrial physician, pay him on a per capita basis for the employees served, establish a schedule of hours so that he could spend a part of each day at each plant under his supervision, put upon him the responsibility of other duties besides those of a purely medical nature, and thus start employees' service which should have all the elements of the work being done in larger plants. The plan seems feasible. It has been indorsed by clear-thinking physicians in industrial practice. The first group of shops that starts such work will in addition to solving some of its own problems set up a research laboratory whose records will be of great value to other similarly situated shops.

New Jersey's Lighting Code

New Jersey is the second state to adopt a code for industrial lighting, copies of which have just been distributed. On page 259, Vol. 45, the code adopted by the State of Pennsylvania was printed and briefly reviewed. The one now adopted by New Jersey is identical so far as the specific rules are concerned.

In the case of the Pennsylvania code rule 5 has been criticized, from the viewpoint that it would work unreasonable hardship upon the manufacturer to carry out its requirements. It reads:

Rule 5. Emergency Lighting: Emergency lights shall be provided in all work space aisles, stairways, passageways and exits; such lights shall be so arranged as to insure their reliable operation when, through accident or other cause, the regular lighting is extinguished.

The New Jersey code explains this rule by the following note:

Emergency lighting systems may be installed in various ways, and specifications of all such systems shall be submitted in duplicate to the Bureau of Electrical Equipment of this department for preliminary approval, before being installed. All such lighting shall be (if electric on separate circuits) entirely independent of the regular lighting equipment, and shall take energy from a source acceptable to the Department of Labor, and which is not liable to failure, through accident or other cause, to the regular lighting system.

The intent of this rule is unquestionable. It purposes to provide light so that employees can safely leave a factory building in case the regular lighting system fails. However, it may work an unreasonable hardship to small manufacturers, for it means a duplication of the lighting equipment and provision for taking energy from a second source.

It is a provision that may perhaps be modified, as experience is gained in these two industrial states in the application of the code.

The feature of congratulation is that New Jersey has now become the second great state to safeguard by law the eyesight of her industrial population.

Freight-Car Shortage

Another industry has come to the front to point out the difficulties being encountered because of the freight-car shortage of the United States—the fertilizer industry. The official association of the fertilizer manufacturers states that it will be impossible for the railroads to furnish the necessary number of cars next spring to handle the fertilizer for the spring planting, if the shipments are congested into such a short period of time as has been usual during the last few years.

One cause of the lack of cars is the failure of the railroads to build new equipment during the past four or five years. This failure has been well known, and at any time during that period the possibility of a shortage could have been foretold whenever there was a large accumulation of freight to handle. You cannot wear out rolling stock and have it too.

Profits Über Alles

By Berton Braley

From "Coal Age"

Now this is the story of Randall, the Solon from out of the West,
Who said to the Wise Men of Congress, "My brethren, methinks it is best
To start a new system of postage; the second class rate is too low ——"
"Let's cut out the franking!" said some one, but Randall protested, "Oh, no!
The frank is a privilege precious, forever fulfilling our needs
For sending out unspoken speeches, and mailing quintillions of seeds,
We cannot afford to forego it; but I have a far better way
To add to the Government's profits and help make the post office pay ——"

"I know," cried a Congressman, loudly, "your meaning is plain as can be.
You want to abolish the practice of sending the newspapers free
Which don't go outside of their county—believe me, I'm with you, old scout.
It's really a graft most expensive, I'll aid you in cutting it out,
To cease such a species of outlay will save quite a bundle of pelf ——"
"I don't want to stop it," said Randall, "I run such a paper myself!

"My plan is far simpler and cuter," he added in confident tones,
"We'll just soak the magazines harder by slicing the country in zones
And piling on postage for distance clear up to six pennies a pound,
Thus gaining some millions of dollars for Congress to scatter around
In post office buildings for Podunk—large buildings of costly design—
Or free distribution of papers—such papers, for instance, as mine.

"We'd drive many magazines bankrupt, we'd double the price of the rest,
We'd gather a tribute most heavy from people who live in the West,
We'd stir up old sectional feelings, on knowledge we'd levy a tax,
The publishing business would get it where chickens are given the axe,
But what do such little things matter? It's 'cash money' profits that count,
The people can go without reading if only the postal rates mount,
The technical journals can wither, the magazines all fade away,
That won't hurt my small county paper—so up with the postage, I say!"

Now this is the story of Randall, the Solon from out of the West,
And this is the innermost meaning of what he has tried to suggest,
He may not have said what is quoted, but if his new law is put through,
The words we have rimingly noted will prove to be direfully true;
The spread of instruction is threatened, and if you **don't want** to allow
This drag on the progress of knowledge, just write to your Congressman,

NOW!

An Innovation at Johns Hopkins University

EDITORIAL CORRESPONDENCE

SYNOPSIS—Last summer a few business men of Baltimore challenged the Johns Hopkins University to establish practical courses for men and women who were working in the factories, stores, offices and schools of the city. The university authorities accepted the challenge. The students in the special courses now number double those taking regular undergraduate work.

Philosophy, medicine, postgraduate work, research—for these the Johns Hopkins University in the beautiful City of Baltimore, Md., has been widely known and justly celebrated. What a seeming turnover of idea and purpose to give courses for working people!

To the great credit of the university this innovation is already a successful reality and Baltimoreans think more of their great educational institution than ever before.

There is a bit of a story connected with the beginning of this work. Last summer a celebration was held to commemorate the one-hundredth anniversary of the making of illuminating gas in America. Baltimore was the place of the festivities, for in that city gas was first produced. Among the prominent speakers was J. E. Aldred, Chairman of the Board of Directors of the Consolidated Gas and Electric Co. of the city.

Mr. Aldred, as we say, started something. He went after the universities and schools of higher education, so it is said, upbraided them for the fewness of the men and women that they helped, expressed emphatic disapproval of the courses given and criticized the training of the graduates turned out. Naturally, other speakers who were college-bred differed decidedly with their views. It is reported that one of these men told Mr. Aldred that were it not for the education that men had received in universities and the research done in such institutions, he would be running a tallow-dip factory instead of supplying gas and electricity.

A little later Mr. Aldred and a few of his business associates asked the university if it would establish courses for working people if the cost of the undertaking was guaranteed. The university accepted the proposal—or better, challenge—and the work was started in September and October last.

Some twenty firms and business men of Baltimore subscribed to a fund of $10,000 to insure the financial success of the innovation.

RESULTS ALREADY ACHIEVED

The first half-year has just closed. Some 1,300 students have been enrolled—225 in the "Night Courses for Technical Workers," 625 in "Courses in Business Economics" and the rest in the courses for teachers. The total is more than double the regular undergraduate registration.

One firm is paying the entire fees for all of its employees who attend the classes. At least two others have agreed to pay one-half of the tuition of every employee who finishes a course and receives a certificate from the university. Several companies have advanced money for the fees, permitting their workmen to pay it back in small installments.

The students come from all kinds of business positions. In the courses for technical workers are chief operating engineers, salesmen, designers, draftsmen and machinists.

In the business courses are stenographers, private secretaries, salesmen, saleswomen and office employees in banks, brokerage houses and stores. Punctilious attendance and enthusiastic attention are the rule, not the exception. Several students have already said that they were more than paid for the cost in time and money. One of the professors contrasts the spirits of the day and night students by saying, "The day students are working for a degree; the night students are working for knowledge."

NIGHT COURSES FOR TECHNICAL WORKERS

An idea of the nature of the courses and the instruction is given by the following outline of the "Night Courses for Technical Workers."

MECHANICAL ENGINEERING

1. Machine design and the study of the materials of machines; lectures and drafting room.

Design of machine parts—gearing, framing, turbine and boiler—leading to the laying out of a complete power plant. This course is accompanied by a parallel course in the drafting room.

2. Elementary heat engines and power production; lectures and laboratory.

Sources of power; fundamental principles of thermodynamics as applied to perfect gases; properties of steam and gases; the cycles used in heat engines; combustion; fuel analysis; gas engines and producers; power-plant efficiency.

3. Lectures on the principles of industrial organization. Selections will be made from the following subjects:

Legal, financial and administrative organization of industrial enterprises. Selection of location and character of plant. Operating organizations and systems for cost and timekeeping. Labor problems. Sales organizations, contracts and specifications.

ELECTRICAL ENGINEERING

1. Elements of electricity and magnetism (first half-year); direct-current machinery (second half-year).

2. Elements of alternating currents (first half-year); alternating-current machinery and practice (second half-year).

These courses will cover the following: Electrostatics, electric and magnetic potential, electromagnetic induction, electric conduction, and their extension to the field of practical application. The course includes the elementary treatment of the theory of the direct-current generator, the direct-current motor, direct-current distribution, and the elements of alternating-current practice.

CIVIL ENGINEERING

1. Elementary hydraulics, lectures, recitations and laboratory practice.

The pressure and flow of water and the fundamental laws of hydrostatics and hydrodynamics.

2. Structural mechanics and elements of the strength of materials; lectures, recitations and drafting room.

3. Strength of materials and design of structures; drafting room and laboratory practice.

The application of the principles of mechanics (particularly statics) to the simpler problems of engineering construction.

Of the foregoing the popular courses are the three in mechanical engineering, Course 1 in electrical engineering and Course 2 in civil engineering. The enrollment for mathematics and physics has not been large, possibly because these classes were started after the others.

The character of the work is indicated by this quotation from the announcement:

"In view of the probable lack of uniformity in preparation of students attending the evening classes, it is expected that the work will be of an elementary character. The various subjects will be developed after a careful re-

view of the fundamental principles upon which they are based, and the extent of the work covered will necessarily be determined by the proficiency of those in attendance. It is hoped that this plan of college courses for technical workers will develop so that satisfactory work may be credited, under suitable regulations, toward a degree."

The tuition fee is fixed at the rate of $10 for one hour per week for the school year. Most of the courses require two hours per week, making the fee $20.

The instruction is largely through lectures or explanation. In some cases textbooks are used. In the technical courses the working of problems is a feature that is emphasized. The examples so far as possible are drawn from practical things, machinery, machine details or questions in regard to their design and operation.

Motives for Taking the Courses

Why are men taking these special technical courses? Let us listen to the testimony of a few of them. One man wanted to use a throttling calorimeter but did not know how it worked nor why. Another had made a complete set of drawings of a duplex pump and then wanted to know what the various parts did. A stationary engineer who had been able to earn a handsome bonus by effecting economies, took the course in industrial management, and after a few lessons said, "I have already learned how to organize my work better and make still greater savings." A contractor lost an attractive contract, he believed, because his competitor was a technically trained man while he was not.

To sum up, the principal motives for taking the courses seem to be three: (1) The need of information and help to do daily work; (2) the desire for university training; (3) the wish to benefit from mental stimulus.

Each of these three wishes, desires and needs is normal. The university and business men of Baltimore have started a helpful work in providing educational means.

Developments in Machine-Shop Equipment in 1916

In the opening paragraph in the review of developments in machine-shop equipment during 1915, published a year ago, is this sentence: "The record in a striking way shows the great influence of the European War upon the basic American industry." This statement is even more pertinent for the year 1916 than it was for its predecessor. The normal trend of machine-tool development has been still further sidetracked, and the restraining effect that rushing business has on new design is again emphasized.

The total number of new equipment items appearing in the records of the *American Machinist* during 1916 is only 329. This is the smallest for any of the past six years, during which time the classification of these items now followed has been in force. The comparison with the five preceding years is appended:

Calendar Year	Items of New Shop Equipment Appearing in the "American Machinist"
1911	437
1912	375
1913	399
1914	503
1915	425
1916	329

The drop from last year is nearly 100 items, and the total is 46 items below the record for the low year of 1912. Truly, rushing business is permitted to lay a paralyzing hand on the efforts to bring out new designs.

A detailed analysis of the year 1916 is given in the accompanying table.

COMPARISON OF MACHINE-SHOP EQUIPMENT DEVELOPMENTS, 1914, 1915, 1916

Kind	Number of Items Published		
	1914	1915	1916
Automatic machines	10	1	1
Bolt, nut and pipe threading and cutting machines	6	1	0
Boring machines and boring mills	18	8	4
Cold, band and hack saws	12	10	8
Drilling machines	53	38	18
Gear cutters	9	10	2
Grinders	42	36	27
Lathes	33	45	77
Machine-tool attachments, separate	0	17	14
Millers	21	18	17
Miscellaneous machines and apparatus	86	104	49
Planers and slotters	11	2	4
Power hammers	2	1	2
Punches, presses and shears	39	42	13
Shapers	5	2	0
Small tools and gages	118	71	51
Supplies and parts	29	14	38
Tapping machines	9	5	4
Total	503	425	329

In two cases only does the record of 1916 exceed that of 1915—in lathes and in supplies and parts. The lathes brought out during these two years number respectively 45 and 77. This increase reflects the demand for machines to turn shells. A further comparison shows only 33 lathes reported in the banner year of 1914. The increase in the item for supplies and parts probably has little significance.

The machine tools developed especially for munition manufacture number 45. To this total it seems fair and conservative to add the number of the lathes brought out in 1916 in excess of the year 1914, which was practically uninfluenced by the war. This difference is 44. Adding this amount to the previous number 45 gives a total of 89; that is, it seems fair to say that at least 89 machine tools that entered the record of new machines put on the market during 1916 were especially developed because of the requirements for the production of munitions of war. This is indeed a large proportion.

Two of the groups of machine tools that can be profitably split up into their classes according to size and kind are the lathes and the machine tools especially developed for munition manufacture.

The total of the 56 lathes divides into 19 classes, as follows: 8-in., 3; 8½-in., 1; 12-in., 2; 13¾-in., 1; 15-in., 1; 16-in., 2; 17-in., 2; 18-in., 4; 19-in., 3; 20-in., 1; 20½-in., 3; 21-in., 3; 22-in., 4; 23-in., 3; 24-in., 3; 26-in., 3; 26½-in., 2; 30-in., 2; turret lathes, 13.

The 45 machines developed especially for producing war material divide as follows: Turning and boring machines for shells, 23; drilling machines for shells and fuses, 3; grinders for shells, 1; miscellaneous machines for a wide variety of operations on shells and fuses, 18.

There are some facts that indicate that the trend of development during 1917 may be more nearly in keeping with that which was under way at the close of 1914. In spite of the fact that machine-tool building shops are busy today, in many places new designs are under way either on the drawing board or in the experimental room. In some cases outside designers are being employed to supplement the efforts of the regular shop staff.

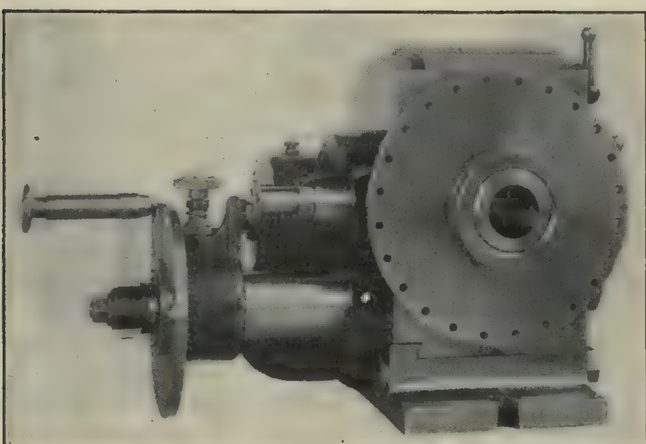
A guess that may be a hazard is that there will be many fewer war machines brought out during 1917 than during the two preceding years and that there will be more machines intended for general manufacturing. The tendency toward greater automaticity still seems to hold.

Shop Equipment News

Micrometer Index

A new attachment, known as a micrometer index, has been put on the market by the Brown & Sharpe Manufacturing Co., Providence, R. I., for use in connection with its special head and universal index centers. The advantage of the new index is that it gives readings to ½ min., whereas the smallest direct reading with the old style, using the 49-hole circle, was 11.02 min.

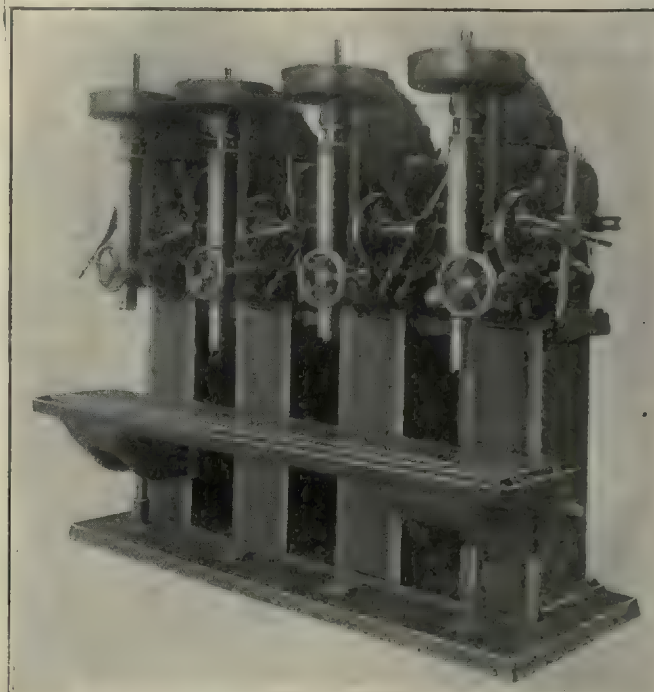
The attachment consists of a housing containing a worm on a vertical shaft, at the upper end of which is located a dial graduated to half minutes. The worm meshes with a wheel mounted free on the spiral-head wormshaft. The regular index plates are fastened to the worm, and connection with the spiral-head wormshaft is obtained by the regular index crank and pin engaging with holes in the index plate. The micrometer index interferes in no way with the spiral head. When in use, the index-plate stop pin engages a hole in the attachment casting and prevents the same from rotating, allowing rotation to be made only through the worm and wheel. When it is not desired to use the micrometer index, the indexing is carried on in the usual manner.



MICROMETER INDEX FOR UNIVERSAL CENTERS

Vertical Drilling Machine

Baker Brothers, Toledo, Ohio, have recently added a heavy vertical drilling machine to their line. A gang of four such machines, with a continuous table, is shown in the accompanying illustration. The machines are said to be of such capacity as to drive a 1½-in. high-speed drill to maximum efficiency. Speeds and feeds are obtained by means of gears. Six drilling feeds are furnished as standard equipment, with a quick change to reaming feeds, which are 3⅓ times the drilling feeds. The feed pinion and rack are hardened, and the worm gear is provided with a safety shear pin to protect the feeding mechanism. The bearing between the spindle sleeve and the head runs the entire length of the head. A spring device holds the belt securely on or off, and in the off position a brake is applied that stops and holds the spindle. The machines are furnished in 1-, 2-, 3- or 4-spindle units, with independent or continuous tables. The tables are provided with pockets for cutting lubricants and are equipped with elevating screws.

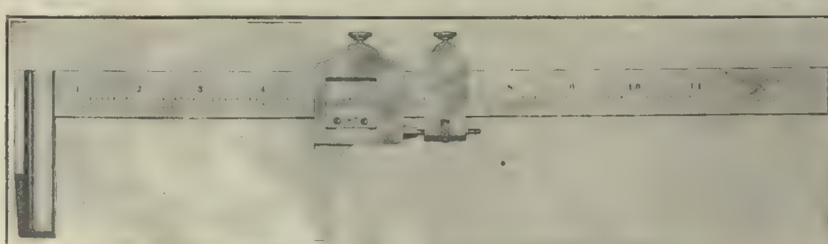


A FOUR-SPINDLE GANG DRILLING MACHINE

Speeds, 25 to 614 r.p.m.; drilling feeds, 0.005 to 0.024 in. per revolution; reaming feeds, 3⅓ times the drilling feeds; spindle bored for No. 5 Morse taper and slotted across the end; center of spindle to face of column, 10 in.; maximum distance of spindle to table, 32 in.; vertical adjustment of table, 18 in.; length of feed, 12 in.; driving pulleys, 15 in. in diameter; face, 2½ in.; weight, 2,500, 5,100, 7,650 and 10,250 lb. respectively for 1-, 2-, 3- and 4-spindle machines.

Vernier Height Gage

The vernier height gage shown in the accompanying illustration has recently been placed on the market by the L. S. Starrett Co., Athol, Mass. The bar is graduated to read by means of the vernier to 0.001 in. on heights up



HEIGHT GAGE BASED ON THE VERNIER PRINCIPLE

to 8 in. The base is hardened and ground square with the bar.

Two special attachments are furnished when desired. The first is an extension that is fastened to the slide, allowing measurements to be taken from either the top or the bottom side of the jaw. The second attachment is used to measure the depth of recesses or to take measurements inside of the frame of a jig or fixture or other similar piece of mechanism. The bar is 10 in. long and the base, which is recessed at the bottom, measures 1x2¾ in.

Shearing-in Press for Die Makers

A press especially designed for the use of die makers, for shearing in dies and punches, is being placed on the market by the Manhattan Machine and Tool Works, Grand Rapids, Mich. The machine is provided with a

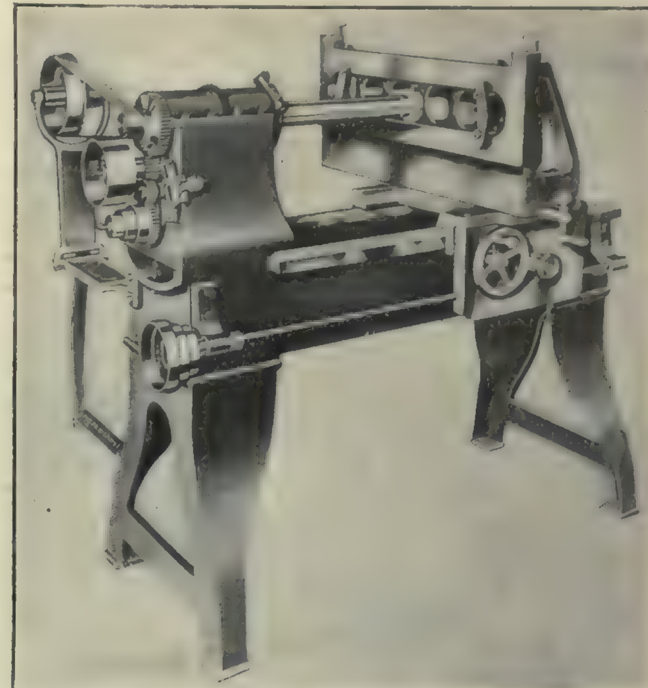
DIE MAKERS' SCREW PRESS

Size of bed, 18x36 in.; space between standards, 26 in.; thickness of bed, 6 in.; diameter of standards, 3 in.; maximum height of bed to ram, 24 in.; diameter of screw, 2 in.; weight, 1,500 lb.

large bed with fifty-two ⅝-in. tapped holes by means of which dies may be secured in any desired position. The press is a one-man machine, and it is so built that the operator can reach and move the handwheel while watching the work, which is in many cases very necessary.

Cylinder Regrinding Machine

The illustration shows a cylinder regrinding machine that has recently been placed on the market by the B. L. Schmidt Co., Davenport, Iowa. The machine is intended for use in repair shops and garages. The bed is of the box-section type, provided with a vee at the front and a flat at the rear. The spindle is 4¾ in. in diameter and 9½ in. long, and is oiled at the center by a ring oiler.



CYLINDER REGRINDER

Length of bed, 55 in.; width of bed, 15⅛ in.; height from bed to center of spindle, 12 in.; floor space, 5x3 ft.

The carriage bears on the bed throughout its entire length and the cross-slide has a bearing surface 22x8 in. Three feed changes are provided by means of cone pulleys, and the reverse is accomplished through the medium of a pair of tumbler gears. The angle plate has a separate adjustable front plate, which facilitates the centering of the cylinders. The machine will handle work varying in size from a motorcycle cylinder to a six-cylinder block 31½ in. long, and will bore cylinders from 2½ to 8 in. in diameter and up to 15 in. long.

Christmas Bonus Fund

An original and interesting bonus plan is that which has been adopted by the Cincinnati Planer Co., Acme Machine Tool Co., and the Greaves-Klusman Tool Co. during the last year. In addition to a special bonus of 10 per cent. of the total earnings of employees each month, which is payable the second Thursday of the month following, these three concerns last February conceived the idea of additionally rewarding those employees who are earnest in the performance of their work and regular in attendance. So they created a Christmas savings fund, consisting of 5 per cent. of the total earnings of the employees, which is paid to the employee with 3 per cent. interest on the day before Christmas. To make up the fund, each employee who is absent or late on not more than one day in the month without excuse is credited with 5 per cent. of his earnings for that particular month.

Raw-Material Inventory of 1917

By Charles Piez*

"How am I going to inventory my raw material?" This question confronts the manufacturer as the year draws to a close. He may have on hand or contracted for a considerable tonnage of raw materials at prices materially below the market, and he may be sorely tempted to include in his year's profits the appreciation in values resulting from his foresight. This would only be in line with the usual policy of inventorying raw products at the market price and would not be opposed to customary accounting methods. But conditions this year are not usual, and usual or customary methods may not therefore be safely applicable to them. The advance in prices of raw materials like pig iron, steel and copper has not only been marked, but it has continued with scarcely a break for 18 months. It is a poor buyer indeed who in such a market could not show considerable profit on his purchases. The trend is still upward in spite of the extraordinary advances in steel and pig iron during the past 90 days, and stocks of these materials look like ready money to the fortunate possessor, no matter what price he paid for them. Why, then, should he not inventory them at the existing market price and take his profit?

The recent spectacular drop in the prices of securities supplies the answer. The rise in raw-materials prices has been as substantial as the rise in price of the war brides; and the drop is likely to be as severe, though not as spectacular. Even if this drop is not imminent, even if the present exceptional price level is maintained for another year, the manufacturer will ultimately be faced with the reverse of the present problem—a stock of raw materials contracted for at high prices and a rapidly falling market. And his net profits growing out of his material purchases during the entire period of inflation and resurgence to the normal level will be the difference between his profits from the rise and his losses from the drop which will inevitably occur at some time in the future.

At present he is only half through this period. He can show his profits from the rise; his losses are still matters of the future, and he has supreme confidence that his foresight is such as to enable him to continue to show profits.

But the conservative manufacturer will consider that, as he has but half completed the transaction, he had better not consider the increase in the values of his raw material as a profit. He will consider that he is temporarily custodian of a goodly sum, a part of which may remain with him if his judgment is sound and luck stays with him. But he will decide that he had better set aside a certain amount as a reserve against the drop that is inevitable. Conservatism, and that is the quality to apply to methods of figuring profits this year, will dictate that if pig iron and steel be inventoried at the present market prices a reserve of at least $10 per ton on the pig-iron stock and a reserve of at least $20 per ton on the steel stock be set aside before profits are figured.

It does not pay to send out an order for a pearl necklace because you are surrounded with blue chips in the middle of the game. Wait, for you may be owing the bank before the game is over.

*President, Link-Belt Co.

New Publications

Steel Hopper-Bottom Coal Car—Published by Norman W. Henley Publishing Co., New York City. Price, 25c.

This is a chart showing the anatomy of a steel hopper-bottom coal car. Each part is numbered and its proper name given in a reference list at the lower portion of the chart.

The Slide Rule—By C. N. Pickworth. One hundred twenty-four 7¼x5-in. pages; illustrated. Published by D. Van Nostrand Co., New York City. Price $1.

This is the fourteenth edition of this work and the contents have been extended to include a section dealing with the solution of algebraic equations by the slide rule. Suggestive notes are given which should prove of interest on this subject.

Worm Gearing—By Hugh Kerr Thomas. Second edition. Ninety-four 9¼x6-in. pages; illustrated. Published by McGraw-Hill Book Co., Inc., New York City. Price, $1.50.

In this edition corrections of a few typographical errors that appeared in the first edition have been made. Part of Chapter IX has been rewritten, and three short appendices have been added to bring the text abreast of the author's most recent investigation.

The Engineer in War—By P. S. Bond. One hundred and eighty-seven 7¼x5-in. pages; illustrated. Published by McGraw-Hill Book Co., Inc., New York City. Price, $1.50.

In this work is presented a brief outline of the relation of engineering to the conduct of war and the adaptation of the principles and practices of civil engineering to military requirements. The book is divided into 11 chapters that deal with various phases of the subject. The work is written in an interesting manner and is well illustrated. A glossary of the military terms used is given at the end of the book and should be found helpful.

Homan's Automobile Handbook—By J. T. Homan. Two hundred and forty-eight 7¾x5-in. pages; 79 illustrations. Published by Sully and Kleinteich, New York City. Price, $1.

This work is divided into 20 chapters, which deal with the following subjects: The motor car briefly described; the transmission apparatus of a motor car; planetary speed changers; clash-gear speed changers; the friction drive; the magnetic transmission; the motor-car engine; engine elements and adjustments; the operation of a motor-car engine; power estimates for motor-car engines; multiple-cylinder gasoline engines; rotary gasoline engines; cylinder-cooling devices; vaporizing and mixing the engine fuel; the ignition apparatus described; the lubrication of moving parts; operation of a motor car and engine; adjusting the ignition; adjusting the mixture; causes and symptoms of engine trouble.

Each subject is well illustrated, and the matter is presented in a readable manner that should appeal to anyone interested in automobiles.

Business Items

For the Manufacture of its improved floor type boring, milling, drilling and tapping machine, the Landis Tool Co. has erected a new factory in Waynesboro, Penn., of fire-proof construction. The building is 105 ft. wide, 176 ft. long, concrete floor, concrete tile roof, steel sash and steel partitions throughout and is divided into three sections.

The Trafford Engineering Co., Trafford Park, Manchester, England, has taken an option on the city park of Cork, with a conditional guaranty that it will erect a manufacturing establishment to cost between $1,000,000 and $2,000,000. The company intends to manufacture worm-drive motor trucks on a very large scale, and it guarantees to employ at least 2,000 adults at a minimum wage of a shilling (24c.) per hour.

The Thomson Spot Welding Co., which has been recently formed under the Massachusetts laws, has acquired all of the patents for the process of spot welding, and spot welding machines formerly held by the Thomson Electric Welding Co. and the Universal Electric Welding Co. It has also acquired all the physical assets and all the spot welding patents, etc., of the Toledo Electric Welder Co., of Cincinnati, Ohio, which is being liquidated after having been forced in litigation to admit the validity of the Harmatta patent. The butt welding machine business formerly conducted by this company has been taken over by the Thomson Electric Welding Co., of Lynn, Mass., who will manufacture these machines in the future and look after the needs of the Toledo Electric Welder Co.'s customers.

Forthcoming Meetings

Society of Automobile Engineers. Annual meeting, Jan. 9-11. United Engineers Building, New York City. Colver F. Clarkson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Wheel-Shop Dismounting Press

By Frank A. Stanley

SYNOPSIS—Special equipment of a car-wheel shop of the Minneapolis, St. Paul & Sault Sainte Marie Railway Co., including the dismounting press, hoisting devices for axles and wheels and means for transporting them after dismounting. All the details are shown in the illustrations.

In an earlier article a description was given of the new wheel shop of the Minneapolis, St. Paul & Sault Sainte Marie Railway Co., at Minneapolis, Minn., and reference was made therein to a novel dismounting press for removing wheels from axles. It is the purpose of the present article to illustrate somewhat in detail the principal features of construction and operation of this machine.

FIG. 1. CAR WHEELS READY FOR DISMOUNTING

As stated in the former article, the wheels and axles as they come from the road are rolled on cross-tracks through a swinging door into the shop and passed directly to the dismounting press. Fig. 1 shows several pairs of wheels passing through the horizontal doorway and rolling upon a set of tracks, which are offset slightly to permit the wheels on successive axles to clear one another and thus occupy a minimum of space.

The dismounting press is directly opposite the ends of the rails. To compensate for the staggered positions of the different sets of wheels and axles each unit, consisting of axle and pair of wheels, as it passes off the track rolls onto a platform that has a transverse movement sufficient to bring the inner hub of each left-hand wheel into line with the left-hand face of the supporting yoke of the press.

This travel of the platform, which represents a movement of about 16 or 18 in., is accomplished through the medium of an air cylinder and piston below the shop floor. The control is effected by means of suitable valves operated by a narrow strip of steel resting on the floor plate above, so that as a pair of wheels roll forward and pass over the controlling strip the platform is moved laterally to carry wheels and axles to a definite position in line with the press yoke.

The rails have a slight inclination downward toward the press, enabling the wheels to be rolled forward with slight effort. As the wheels approach the press, the flange of the left-hand wheel contacts with the inner face of a narrow bar of steel secured to the floor at a slight angle in the horizontal plane, causing the inner face of the hub to run forward snugly against the opposing face of the press yoke. This is illustrated clearly in Fig. 2, where a pair of wheels on their axle ready for dismounting are shown in position in the press with the projecting wheel resting upon a narrow platform that has a longitudinal movement in an opening in the floor, so that this wheel will always be properly supported during the process of forcing the axle out of the other wheel. It constitutes really a floating table which travels back and forth as required to accommodate the wheels and which is always on a level with the shop floor to permit the wheel to roll on and off freely. To take different sizes of wheels, the entire press is adjustable vertically by four screws at the outer corners, the screws being rotated in unison by a power-driven chain passing over four sprockets, one on each screw.

Ram Head and Axle Support

In order that there shall be no cramping of the work or unnecessary stress upon the ram, due to distortion of the axle or to irregularity of its face, the ram is provided with a flexible head, Fig. 3. This consists of a hemispherical member with a flanged base by which it is

FIG. 2. THE DISMOUNTING PRESS

attached to the end of the ram, and it carries upon its body a spherically seated member attached to the base by a ball-ended spring-controlled bolt. This arrangement permits the working face of the device to swivel in any direction whatsoever, so that its steel faceplate may always rest squarely against the end of the axle, obviating all possibility of cramping or binding when pressure is applied to the ram.

In line with the axle at its opposite end there is a long air cylinder with a piston rod that carries a pair of very heavy spring-controlled hooks for grasping the outer end of the axle immediately behind the journal flange. This pair of hooked jaws is supported by a suspending

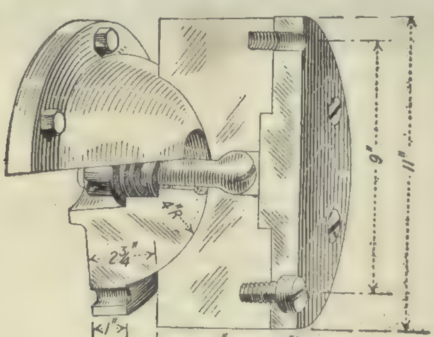


FIG. 3. DETAILS OF FLEXIBLE RAM HEAD

member having at the upper end a trolley wheel running on a bar extending forward to the top of the press. The arrangement is quite clearly shown in Fig. 2, and a detail of the jaws and trolley support is given in Fig. 4.

The effect of the trolley support is of course to hold the hooked jaws closely in line with the end of the axle, thus at the same time taking their weight from the outer end of the piston rod, which in its extended position projects several feet from the air cylinder. The outer end of the upper jaw is kept from dropping below normal position by a hinged supporting link at *A*, and the lower jaw is similarly controlled by the spring *B*. This spring operating upon the rear ends of the jaws closes the working ends sufficiently so that as they slide forward over the axle flange they snap down upon the axle body and provide a substantial grip immediately inside of the

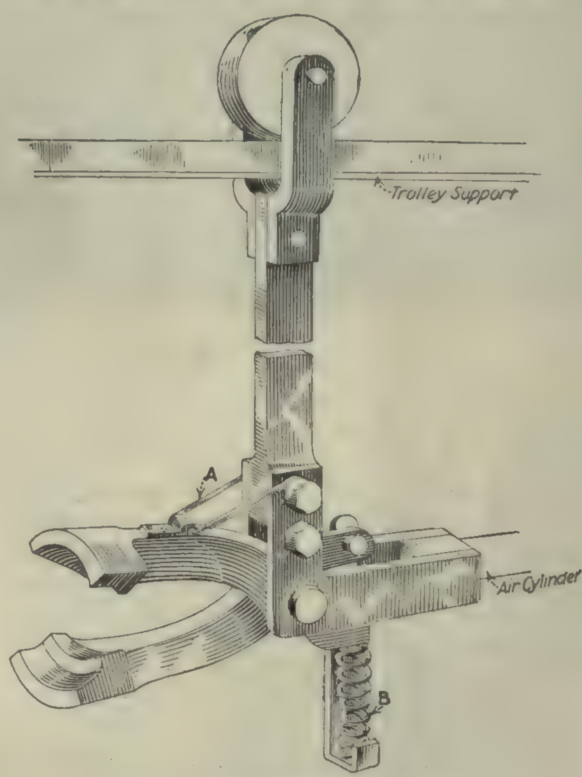


FIG. 4. HOOKS FOR AXLE END

flange, as indicated by the sketch. In this position they are clearly represented in Fig. 5.

As the axle is pressed back out of the wheel hub, the air piston is operated to draw the axle and the remaining wheel away from the press, as in Fig. 6. Here, as will be noticed, the carriage under the wheel has traveled to the right with the work, while the other end of the

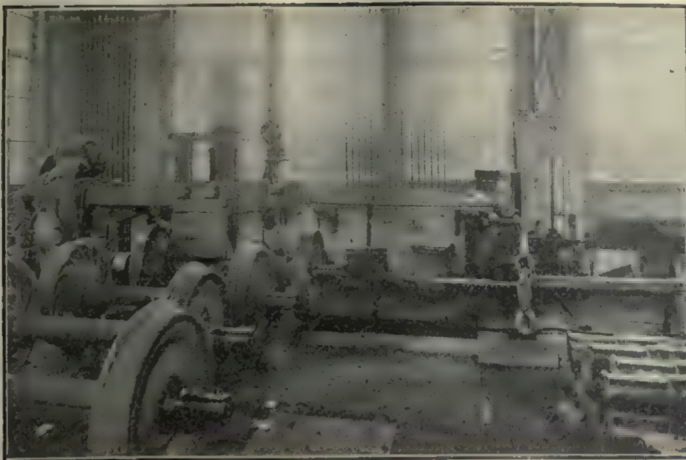


FIG. 5. AXLE HOOKS IN USE

FIG. 6. AXLE SUPPORT—FIRST WHEEL DISMOUNTED

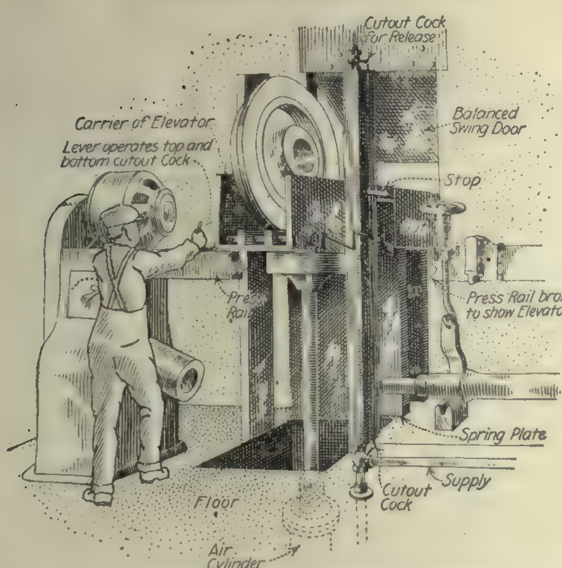


FIG. 7. APPARATUS FOR LIFTING SCRAPPED WHEELS

axle is supported by a spring-suspended sling mounted upon the top bar of the press and adjustable by hand-wheel and screw to bring the supporting roller to the necessary height to carry the end of the axle properly.

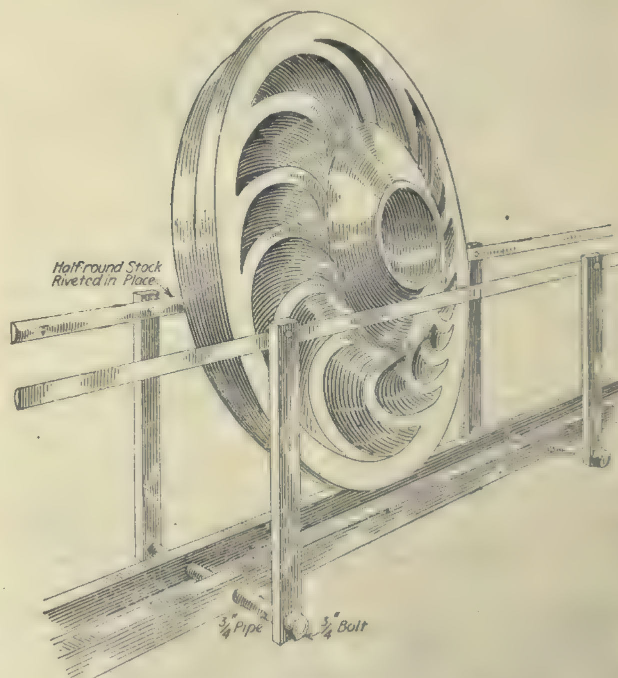


FIG. 8. CHUTE FOR SCRAPPED WHEELS

FIG. 9. REVERSING AXLE IN PRESS

FIG. 10. REMOVING FREE AXLE FROM PRESS

The next step in the dismounting process is to roll the dismounted wheel to an air hoist at the back of the press, where it is lifted into line with an inclined chute down whch the wheel rolls to a car alongside the platform back of the shop.

Details of Hoist and Chute

The hoist is shown in Fig. 7. In normal position it rests with its carrier—a narrow, inclined metal box open at the ends—level with the floor. When a wheel is rolled into the carrier, the rear of the wheel flange rests against a spring plate bolted to the inner face of the shop wall. When the lever on the press rail is operated, a stop on the vertical rod at the rear actuates the cut-out cocks that control the piston, and the carrier and wheels are elevated into line with the inner end of the chute, as seen in Fig. 7. The wheel then rolls out through an opening in the wall, which is normally closed by a balanced swing door, and passes down the chute. The carrier is then lowered to original position, ready for the next wheel.

The construction of the inclined chute is shown in Fig. 8. Here, as will be seen, the chute is made up of steel plates, properly spaced and tied together at the bottom by through bolts, these bolts carrying also a pair of rails made of rectangular stock, which are spaced and secured by sections of ¾-in. pipe. As the wheel rolls down the chute on one of the rails, it is inclined slightly and rests in its travel against a half-round bar riveted to the upper edge of the chute.

With the first wheel out of the way as described, the remaining wheel on the axle is rolled around, as in Fig. 9; the long air piston at the right is advanced to grasp the axle end, and the second wheel is dismounted, as in Fig. 10. An air hoist on a crane jib is then swung over the center of the axle, as illustrated in the latter view. The axle is grasped bodily by the tongs on the air lift and is then passed out of the shop on a special carrier; or if it is to be at once re-turned and put into service, it is placed on a pile at the rear of the lathe.

Shop Schools for Apprentices

By Entropy

Very few machine shops are keeping their annual turnover of employees under 100 per cent.; more find it close to the 200 per cent. mark. A few of the larger shops conduct regular apprentice-training schools. Some of them get large advertising values from these schools, which seems to be an anomaly, since the largest of them has not over 2 per cent. as many pupils or apprentices as the shops have employees. If the courses require four years, it is not to be expected that more than a quarter of the whole number of pupils will be turned out as graduate apprentices in any one year, which will then figure out to supply approximately one-half of 1 per cent. of the shops' total demand for mechanics. Any system that meets so nearly an infinitesimal fraction of the demand for workmen can claim to be nothing more than an experiment station. It is in no sense solving the problem.

Training by the industry within its own shops has a value to the boy who is trained; but to the employer who pays for the training its value is problematic, because there is no reason to suppose that such a boy will be much if any more inclined to stick to the shop than the other employees—and that is not the spirit of the times.

These graduate apprentices naturally become journeymen mechanics in the true sense of the word, and very rightly so from their own viewpoint. They have learned what they can within a certain shop. They have been held closely, and they realize that there is an outside world about which they know nothing. They have associated for four years with men who have roamed and who have told them fairy tales as well as facts. It is part of their education to travel.

In the old days this custom worked no hardship on the employer, because when his apprentice became a journeyman he was able to hire another journeyman who had been as carefully instructed as his own. It was merely an exchange. But now there are so few boys who are being given any training at all that no exchange is possible. The graduate apprentice leaves, but there is no trained man to come with the ideas of another shop to take his place. The money sunk in him has disappeared, or gone to help someone in another city.

One Apprentice to Five Workmen

If everyone would turn to and train up his fair share of boys, as was the practice in the old times, no one shop would be overtaxed. The average working life of a machinist is something over 20 years after the age when he should have completed an apprenticeship. His apprenticeship should require four years, from which it is right to conclude that, if each shop took one apprentice for each five workmen, the ranks would always be kept full. It would not reduce the flow of workmen through the shop; as many would have to be hired to take the places of those who journeyed on as now, but there would be a supply of men trained according to someone's ideas to fill these places.

Now if everybody is going to do this, it becomes a business in itself. Anyone who has tried to run a trade school or to handle a group of boys in a shop will agree that it is very difficult to find foremen-instructors who can handle such a problem with justice and efficiency. Therefore, being a business in itself, distinct from a manufacturing business, it can be carried on by specialists or professionals to better advantage than as a side issue to a manufacturing business.

The natural thought, if one agrees with the statements so far made, is that it should be a public function. It is; and yet those who have tried it out under public auspices have found certain difficulties that are not likely to be removed in the next generation, which make it problematic whether the question can be answered by the public. This obstacle is that branch of politics known as favoritism. Immediately a trade school or any other public institution is established, it becomes a dumping ground for useless friends of superfluous politicians.

Civil Service May or May Not Help

The only thing that appears to have any deterrent effect is civil service; and when it comes to setting up a set of specifications for the selection of a competent instructor in machine work and writing an examination that will keep a college graduate who has majored in poker and cigarettes from getting the job, it is a really serious task. When such favorites get attached to the payroll, it is next to impossible to dislodge them. The really enthusiastic foremen who are on the job to make it a good one get discouraged when they see that the political favorites

get by with incompetence and laziness. The best resign, leaving the field to men whose ability to handle the work before them can only be expressed with the aid of a minus sign.

Some day the American public is going to wake out of its dream and throw the rascals out, and then turn over and go to sleep for the next hundred years in the calm security that hypnotizes all of us. In the meantime and while we are waiting for the millenium, why not get together within the industry and organize what will be frankly trade schools, owned and operated by the manufacturers through the medium of stock companies, where boys shall be offered opportunities that they cannot afford to pass by? If the time should ever come when the public is in a position to take over these schools and operate them effectively, let it do so; but in the meantime why not face the problem collectively, since the graduates must of necessity wish to work for various employers—a wish that we recognize as natural and right?

Such a school shop should be less expensive than one run under semi-political auspices, because it will be more efficiently run. At the same time it must recognize that it is a school and that it must train some pretty unpromising material in order to supply enough to meet the demand. It must be patient and tolerant, for it must take boys and train them at an age when they have no sense of proportion and no sense of conventional right and wrong. They may do no more wrong than they will when they become men; but they lack skill in covering their tracks, and they innocently do not realize that there is any reason for so doing.

Such a shop school may appear to show a loss. It will, if it is efficient; but it is better to have every losing department of a shop out in the open where the loss can be studied and recognized than to have the loss distributed among different departments where it is concealed by the bookkeeping methods. The latter process smacks too much of the alleged habits of the ostrich.

It requires no capital and only a little extra expense to bring together all the machinery, tools and work on which a lot of beginners are experimenting at the company's expense and set them to work under systematic guidance. It may appear to cost more, because now the spoiled work is averaged in with that of the more highly skilled men; but the loss is the same in either case.

Piercing Operation Using the Slug as a Punch

By Frank Metzler

Designers of tools, ways and means, etc., are occasionally put to some disadvantage in the solution of an apparently easy task. Such happened to be the writer's experience several years ago, and the solution so successfully accomplished seems worthy of mention.

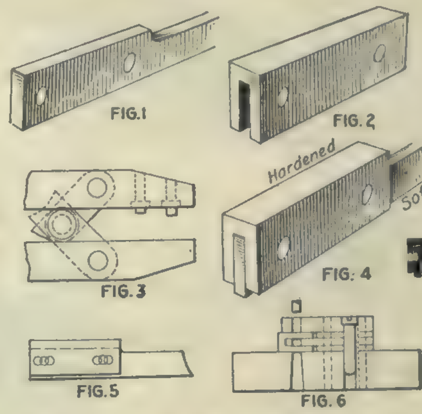
The problem of fastening to the bar, Fig. 1, in a very secure manner, the channel-shaped piece shown in Fig. 2, had bothered a certain industry to quite a degree until finally the common practice resolved itself into an operation of soldering. In order to depart from this the following method was developed:

Two holes are put through each side of the channel piece, as shown, and the part is then case-hardened. It is then applied to the bar in the correct location, fitting snugly in order that it will remain undisturbed when the hand punch is applied. The hand punch, shown in Fig. 3, has two piercing punches, one somewhat shorter than the other. Both, however, are of a definite length to perform their proper functions and of a diameter to fit the holes.

With the channel piece properly located, the longer of the two punches is inserted into each hole alternately and the pliers compressed until the jaws come to a stop on the channel piece, resulting in the piece being firmly doweled to the bar, as illustrated in Fig. 4, where it is quite evident that the one side of the channel piece becomes the die and the other the guide for the punch.

Should it be desired to remove the channel piece at any time, the short punch is inserted, and when full compression is secured, the slug is brought back into its original position and the piece removed.

Further, should it be desired to shift the channel piece either one-half the hole diameter or any fraction thereof,



DETAILS OF THE WORK AND TOOLS

the result obtained is as though there had been no previous disturbance of metal, as shown in Fig. 5.

In experiments the original slug was cut four times and its purpose not defeated. The bar is made of three-quarter hard cold-rolled stock.

The tooling of the process for making the holes in the piece shown in Fig. 2 was exceedingly interesting. The first and common resort is the drill, but the burring incident to this method precluded its use. The next thought is the punch press, and the design as shown in Fig. 6 was decided upon.

The slot in the channel piece was fairly accurately machined, so that sufficient support and entrance and discharge were properly had. The punch in its descent forced the slug from the upper side into the center section, and preceding the punch in its descent it pierced a hole in the lower side. Thus the slug of the upper became the punch for the lower. The slug, being confined by the hardened center piece of the die, cannot become distorted and flatten out as might be expected.

The success of the process is evidenced by the large quantity pierced before the punch gave way. In fact its life was equal to the life of a punch piercing a thickness of metal equal to one side. The lower hole was pierced as clean as the upper, and of the same diameter, with no swelling of the metal, which might have been expected; nor was any burr evident. In fact the ejector mechanism, of a delicate character, though not shown, had no difficulty whatever in performing its function.

Jigs for Making Parts of an Adding Typewriter

By Robert Mawson

SYNOPSIS—Describing and illustrating some jigs employed when machining elements used on adding typewriters. The tools are of modern design and incorporate features of interest to jig and fixture designers. Latches and knurled-head screws have been used on these tools to reduce the time required for inserting and removing the part.

Many interesting jigs and fixtures are employed by the Ellis Adding Typewriter Co., Newark, N. J., during the various machining operations followed in the manufacture of its adding typewriters.

The jig used for drilling the crank wheel is made with two bases set at an angle with each other. By this method the holes are drilled in the casting radially. The tool used for drilling the trip cam is designed with a link that swings inside a clamp. As the clamp is swung forward and the knurled-head screw tightened, the pressure forces the piece to be drilled back against the locating stop. On the jig used when machining the gear case the casting is located on a plug, and a hook bolt holds it against a locating pin. The cover is dropped down and held by a hook.

The jig used for drilling the return gear is designed with a turned pin that fits into a previously machined hole. The cover is then fastened back by means of a pin that fits inside a cam surface on the cover. Attached to the cover is a clamp that bears against the gear, thus holding it in position. On the tools used for the gear box a base is provided on which the jig rests, as some of the holes are at an angle. This base is used when drilling the angular holes, and the latter are thus machined in the desired relative position and at the correct angle.

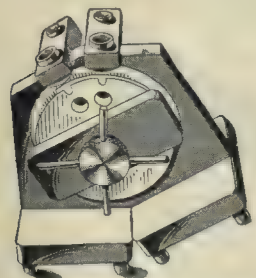


FIG.2

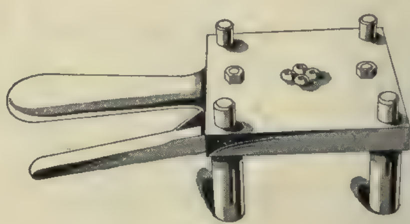


FIG.4

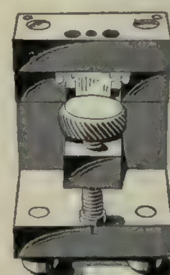


FIG.6

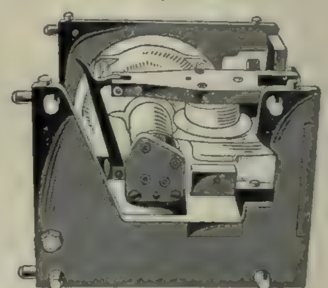


FIG.8

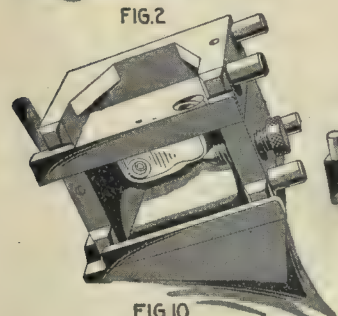


FIG.10


FIG.12

JIGS FOR MACHINING TYPEWRITER PARTS, WITH WORK SHOWN IN POSITION

FIGS. 2 AND 2-A

Operation—Drilling crank wheel, Fig. 1. The casting is placed on a turned stud, being located by a sliding pin that fits into a previously machined hole. An open washer and knurled nut hold the casting in position.

Holes Machined—Two No. 50 drilled, the holes afterward being tapped 3 mm. in diameter by 1 mm. pitch.

FIGS. 4 AND 4-A

Operation—Drilling return gear, Fig. 3. The blank is located on a turned pin and held in the jig by a clamp that is fastened to the under side of the cover. The cover is designed with a cam that fits over a pin, thus holding the gear securely in the jig.

Holes Machined—Two No. 42 and two No. 50 drilled. The latter holes are tapped 3 mm. in diameter by 1 mm. pitch after the gear has been removed from the jig.

FIGS. 6 AND 6-A

Operation—Drilling trip cam, Fig. 5. The piece is located between two pins and held in position by a swinging clamp operated by a link. The knurled-head screw tightened against the base of the jig throws the clamp forward against the piece, thus holding it in position.

Holes Machined—Two 4-mm. and one No. 50 drilled. The latter hole is afterward tapped 3 mm. in diameter by 1 mm. pitch.

FIGS. 8 AND 8-A

Operation—Drilling gear case, Fig. 7. The casting, which has previously been bored and faced, is located on a 32-mm. pin that fits into a previously bored hole. The casting is then swung back and held against a locating pin by a hook bolt. The cover is then dropped down, being held by a latch.

Holes Machined—Four $^{17}/_{64}$-in., four No. 50, seven No. 41 drilled; one 7-mm. spot drilled and reamed; three 8-mm. and one 4-mm. drilled.

FIGS. 10 AND 10-A

Operation—Drilling gear box, Fig. 9. The casting is located on a 13-mm. pin that fits into a hole previously bored. The casting is swung round to a stop by a knurled-head screw. The cover is then dropped down and held by a swinging latch. A loose base is provided with the jig, so that the angular holes may be drilled in the correct planes.

Holes Machined—Three No. 50, one $^{21}/_{64}$-in. and one No. 12 drilled.

FIGS. 12 AND 12-A

Operation—Drilling ball race for carriage, Fig. 11. The piece is dropped into the jig and pushed against a locating stop. The cover is then dropped down and held by five latches

Holes Machined—Ten No. 28 and two No. 35 drilled.

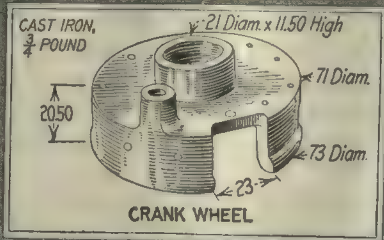


FIG 1

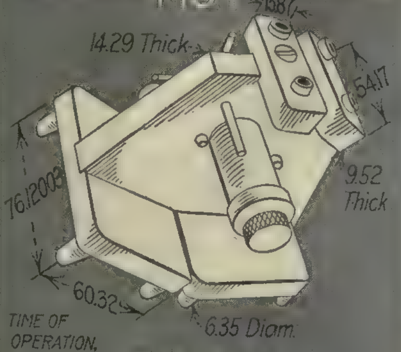


FIG 2-A

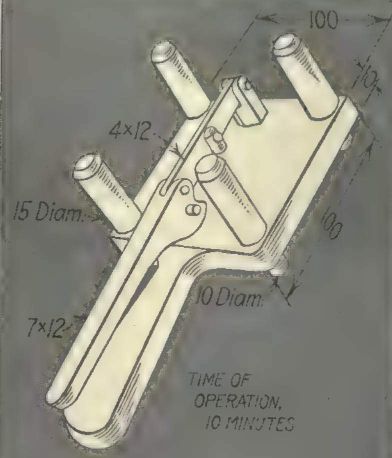


FIG 4-A

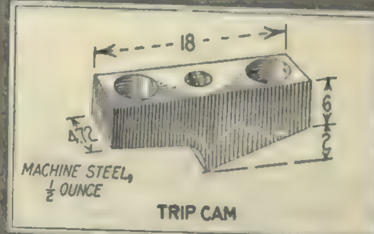


FIG 5

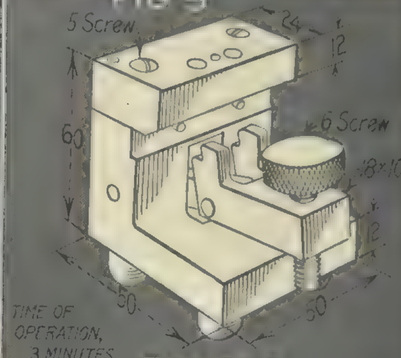


FIG 6-A

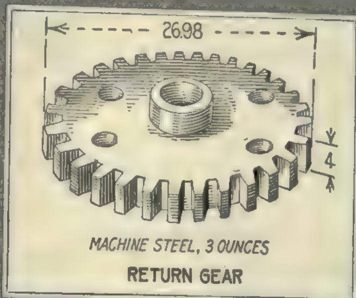


FIG 3

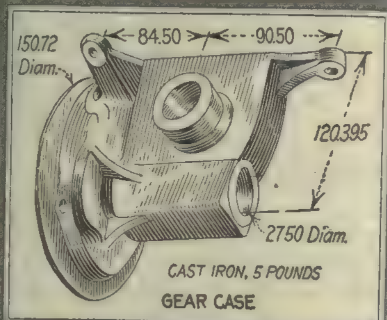


FIG 7

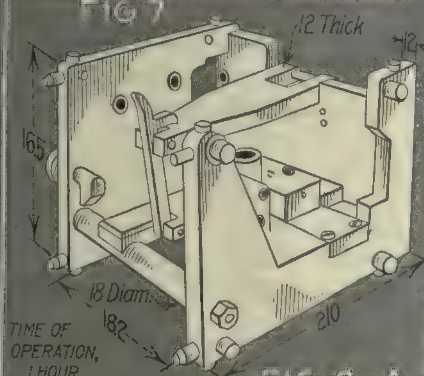


FIG 8-A

NOTE
ALL BUSHINGS USED FOR GUIDING TOOLS ARE BLACKENED. ALL JIG AND FIXTURE BODIES ARE MACH'Y STEEL STRAPS AND FASTENINGS. MACHINERY STEEL; GUIDE BUSHINGS ARE TOOL STEEL, HARDENED AND GROUND

DIMENSIONS GIVEN ARE IN MILLIMETERS

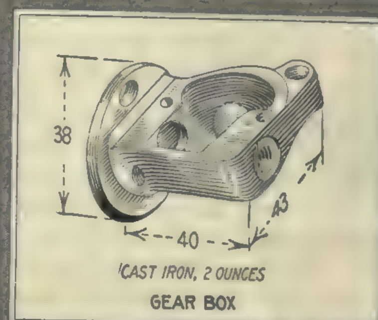


FIG 9

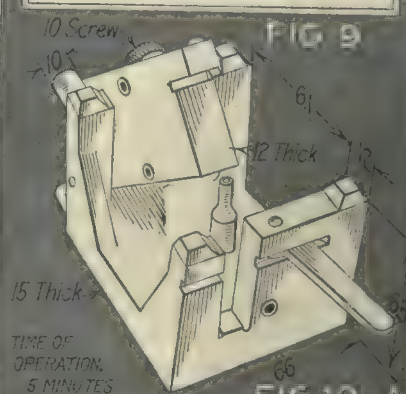


FIG 10-A

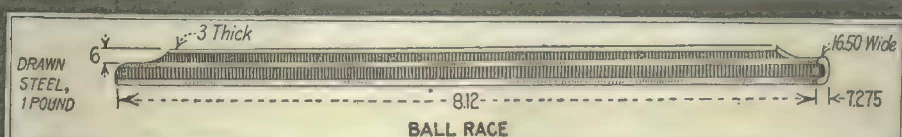


FIG 11

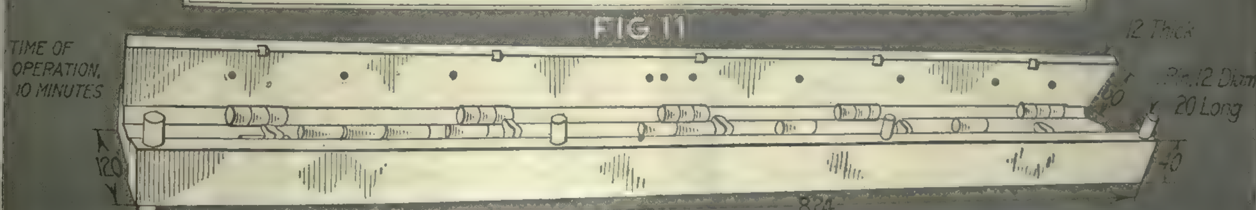


FIG 12-A

DETAILS OF FIXTURES AND JIGS FOR ADDING-TYPEWRITER PARTS

Economical Spacing of Holes in Toolwork

By Hugo F. Pusep

Much has been written on the subject of accurately spacing holes, and different methods have been described whereby holes can be bored to within 0.0001 in. Such methods as involve the use of plugs, buttons, disks and size blocks are pretty well known to the majority of tool makers and need not be dwelt upon here. It is possible by the methods named to locate and bore holes very accurately, when sufficient time is taken. But as a general rule the center distances in the majority of jigs and fixtures need not be closer than 0.0005 or 0.001 in., which is especially true of automobile work.

Even greater errors are allowed in jigs or dies where the holes drilled or punched are used as bolt or rivet holes—in short, where a thousandth or so either way does not make very much difference in the assembling of parts. As a matter of fact, in several toolrooms where I have worked the use of buttons for locating holes for boring is absolutely forbidden on account of the time taken in setting them; and in such cases it is up to the tool maker himself to devise the best way out of the dilemma.

Locating Holes Without Buttons or Special Plugs

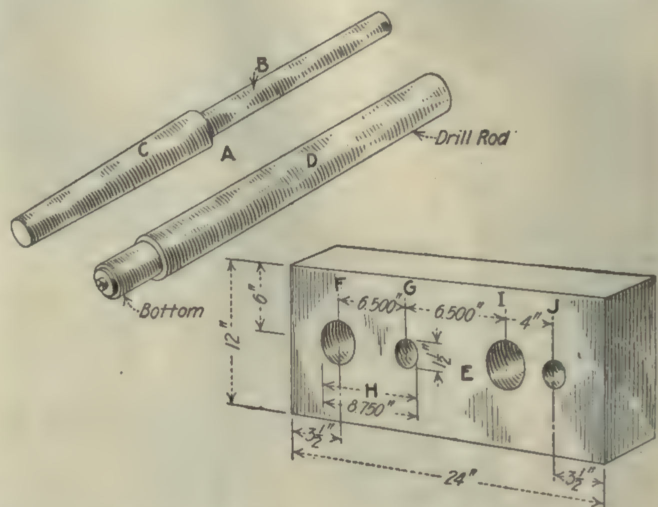
The purpose of this article is to show how holes can be located and bored to fairly close limits without the use of buttons or special plugs. The methods described have worked successfully in practice, and it might be added as an encouragement that it is quite possible to work to a 0.0005-in. limit by the following methods, provided of course that the tool maker is careful and knows his business.

Nearly all toolrooms have a hardened and ground arbor, one end of which fits the taper in the miller spindle. Such an arbor is shown at *A*. The projecting part *B* is cylindrical and is concentric with the taper shank *C*. This is a very good way of locating holes from finished surfaces or plugs inserted in other holes. For the benefit of those who have not used an arbor of this kind it might be said in explanation that the part *A* is *supposed* to run perfectly true when the taper part is driven into the miller spindle; then the arbor is brought to correct position by measuring over a plug, placed in a hole previously bored, and the arbor itself. But the great trouble is that this arbor very seldom runs *true*.

The reason for this usually is that the tapered hole in the miller spindle has become scored from long use of end mills, cutter arbors, etc. To remedy this defect, a tool maker often resorts to the makeshift of chucking a rod in the drill chuck in the miller and turning the end to run perfectly true, and then makes his measurements from this rod. While in this way holes can be located accurately, it has one drawback; namely, every new location requires the truing up of a new rod. Where a jig with a number of holes is concerned, it is a slow process at best.

To overcome these difficulties the simple expedient of a button arbor can be resorted to. It is made from a piece of drill rod *D*, one end of which is faced square to the body, and it is drilled and tapped to receive the screw that secures the button on the end. In operation the rod (which should be of as large a diameter as the drill chuck will take in order to overcome the tendency to spring) is held in the drill chuck, and the button is trued up with an indicator. It takes but a minute or so to make this button run dead true, after which it is but a simple matter of manipulating the miller table and the knee to bring the button to correct location opposite the position of the next hole.

There are fixtures and dies where a number of holes are to be bored positive distances from each other, but where the distances in relation to sides is given in scale measurements. As an illustration, let us assume that a



THE TWO ARBORS AND A PIECE OF WORK

cast-iron plate *E* has to have four holes bored, the center distances of which are to be correct to 0.001 in., but the distances in relation to sides to approximate scale measurements. In this case the hole *F* is bored to finished size; the miller table is then moved 6½ in. by the graduations on the feed handle, and the hole *G* is roughed out to within ⅛ in. or so. Vernier calipers are now used to measure the size of the holes *F* and *G* and also for measuring the distance *H*. Subtracting half the diameters of *F* and *G* from *H* gives the center distance from *F* to *G*. Should the distance be found correct, then the hole *G* can be bored to finished size. Otherwise, the miller table can be moved in order to eliminate the error by reboring. The holes *I* and *J* are located and measured in the same way as were *F* and *G*.

Advantages of This Method

By this method no plugs are necessary, and the accuracy of spacing depends entirely on the sense of touch of the tool maker. I have bored holes by this method, the center distances of which were correct to 0.0003 in. This method, where the holes to be spaced are all on the same plane, is the quickest of which I know. If the holes are of fairly large diameter, they can be laid off approximately with dividers and the core roughed out in a drilling machine, using the miller for finishing only.

Boring time for holes in jigs, fixtures and dies can in many instances be cut in half by using just a little reasoning and by planning different operations ahead, so that there is no need to waste two or three hours roughing out in the miller the core for a hole 2 or 3 in. in diameter, when the same operation can be performed in 20 min. on a heavy drilling machine.

A Book on the Looks and Details of Machines—VI

By John E. Sweet

SYNOPSIS—This last installment is devoted to fastenings, which occupy an important place in machine construction. Professor Sweet's comment in regard to them is, "The final result cannot be the best unless the best way in each particular case is adopted." Devices and practice known by him to be good are shown for wood joints, cotters, keys, riveting, locknuts, studs, body-bound bolts, slotted washers, gear mountings, clutches and ratchets.

In the construction of machines a good part of the work is in fastening parts together, and the final result cannot be the best unless the best way in each particular case is adopted. Of the many ways and means, gluing, soldering, brazing, welding, mortise and tenons, splicing and dovetailing, shrink fits, forced fits, pins, keys and cotters, links, screws, rivets, bolts, studs and capscrews—each is the right thing in the right place.

Glue holds wood together by soaking into the grain of each piece and then hardening; if the joint is open in places and the air can get to it, the glue decays and the parts easily separate. Soldering as a means for holding steel pieces is less used than could be made profitable. Its holding power is often under-estimated, as one may realize by endeavoring to break asunder the body and blade of a steel try-square. Like glue, a good fit and a little solder seem to be the secret.

The bicycle business has developed a new art, so to speak—of brazing. Electric welding disclosed the possibility of welding different metals, such as brass and steel, and this was soon followed by absolutely perfect welds between the same metals by a deoxydizing flame.

There seems to be no better way to splice soft wood than the plain ship lap, Fig. 134, or double ship lap, Fig. 135. This is also the best possible form for joining wire, either square or round, for brazing. Hard wood is best joined by a half ship lap and key, Fig. 136; and parts of metal, where soldering, brazing or welding cannot be used, by half ship lap and rivets, Fig. 137.

It is possible in making the allowance for shrink fits that a large allowance will be no tighter than with less; for if the metal is stretched while yet red hot, the grip will be only that which comes on from cooling down. Practice seems to indicate that the same amount allowed for a forced fit will be ample, and with steel shafts in cast-iron hubs one and one-half diameters long, both the hole and the shaft smoothly turned, an allowance of two one-thousandths for every inch in diameter is liberal and will do where a hydraulic or powerful screw press is available.

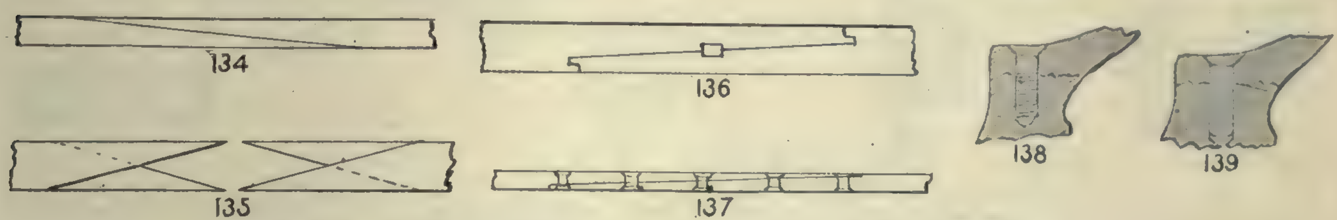
Where a steel shaft is to be forced into a parallel hole in cast iron, it is better to make the shaft slightly tapering, say $^1/_{1000}$ in. larger at the shoulder than at the end, as the cast iron is worn away by the steel as it goes on.

There are two points about forced fits that are not universally known—one, that when being forced in, a shaft may be easily turned; and second, that when in, it is almost impossible to twist it. With a forced fit with 0.002 in. to the inch of diameter there is very little, or in fact, no use for a key.

The holding capacity of parallel fits is often underestimated. One of the most simple of illustrations is wire nails; iron may be nailed together as well as wood, and in certain places it is an admirable way. Assume a place where two pieces are to be permanently fastened, where it is not possible to go completely through one of them. The common method is to use capscrews or studs, Fig. 138, screwed into one piece and riveted over the other. These screws or studs persist in working loose. If in place of the screw threads a good driving fit be made and the studs driven in and riveted over, Fig. 139, they will not only never get loose, but will, if the studs are small, hold more than the screws of the same outside diameter.

Taper fits, when not too steep a taper, are likely to hold when driven by a blow or drawn in by a cotter or nut, Fig. 140, more than anticipated and have the merit that the workman can always make a fit. Formerly it was a favorite way to put piston rods into pistons and crossheads of engines, Fig. 141. Notwithstanding the rod has to be tapered down and about one-third of the remaining metal cut away for the key, they do not fail. After being keyed up as usual, it is more than likely that most of the engines would continue to run all right if the key was removed, simply the friction of the taper fit being enough to stand the direct pull.

When the end of the rod can be enlarged so as partly to compensate for the metal cut away by the key or cotter hole, the result is unobjectionable; and the cost, where cotter-drilling machines are available, is not excessive. The plan, however, admits of no adjustment.



FIGS. 134 TO 139. VARIOUS LAPPED JOINTS AND BLIND FASTENINGS

Figs. 134 to 136—Joints in wood. Fig. 137—Lapped joint in metal. Figs. 138 and 139—Blind fastenings

When the taper fit and cotter are used for crossheads, the end of the rod cannot be enlarged, as the stuffing-rod gland has to pass over. In this case the best results are obtained by reducing the size for a short distance.

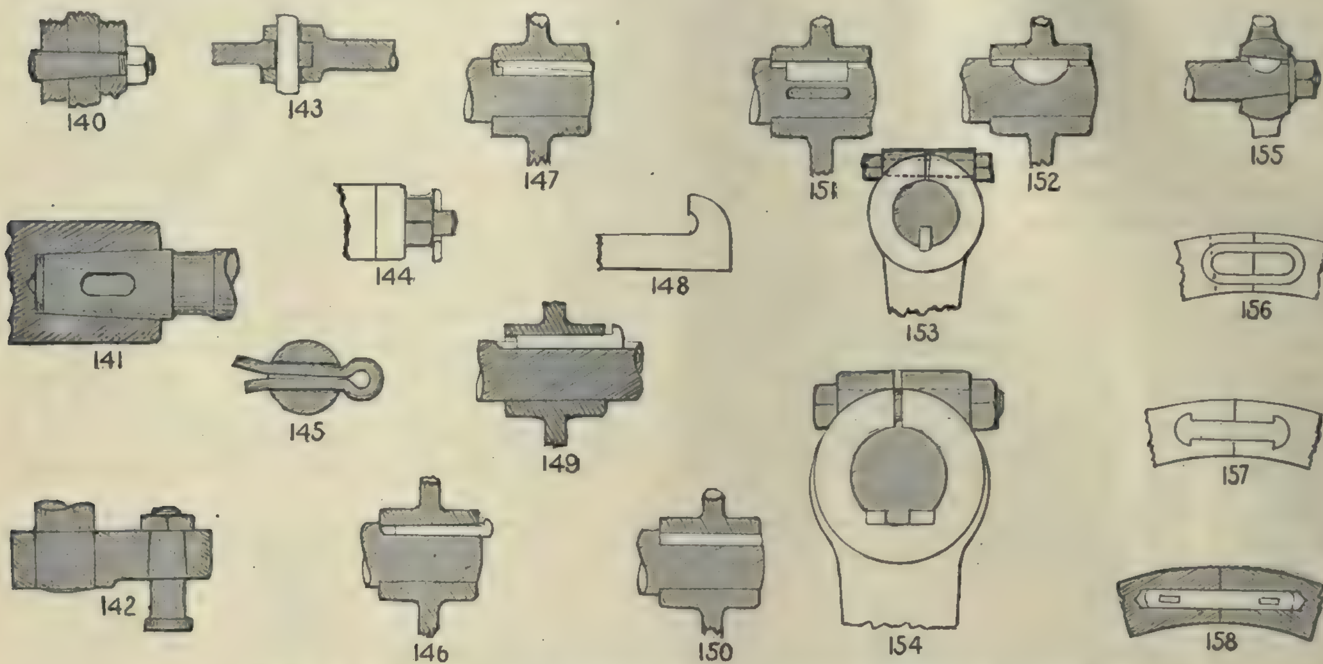
When crankpins are put in with a taper fit and secured with a key or nut, Fig. 142, it gives a chance to insure perfect alignment, as the hole can be scraped to bring the pin correct—something that cannot always be secured by correct boring, as shrinking or forcing the crank on the shaft or forcing in the pin may easily, and more often does than otherwise, throw the pin out of parallel with the shaft.

By a change in machine methods screw threads have taken the place of cotters, though in many places they are left-handed improvements. Machinery screws and bolts are cheaper than cotters, but cotters seem to be less likely to work loose, can be manipulated with a hammer and in less time than nuts and studs can be removed with a wrench. A conspicuous example where cotters are best is in rock drills, for no matter how well they are made the nuts that are made for wrenches are set up by a hammer, Fig. 143.

Split and spring cotters are among the best of devices to prevent the loss of small parts. They are more useful in locomotives, cars and agricultural machines than in stationary machines. Nuts are prone to shake loose when used in the above-mentioned machinery, but with a split cotter, which only needs a drilled hole in the end of the bolt, Fig. 144, the nuts cannot be lost, even if excessive vibration does occur.

The split-cotter business is a good illustration of the wrong thing being just right, and the right thing wrong. The makers are very particular to get the two ends even and right, whereas if made with one end from $\frac{1}{8}$ to $\frac{1}{4}$ in. longer than the other, Fig. 145, they can be clinched or opened at the ends with any sort of hammer. When the ends are even, a chisel is necessary; besides, when the two ends are uneven, it is much easier to enter the spring cotter in the hole.

To secure pulleys, rocker arms, etc., on shafts, a taper key with a hook on the end, Fig. 146, is a common and barbarous way. If the hole fits, it takes very little to hold it from either turning or working off; but where the hole is a poor fit, a taper key and brute force may be the best way to make it secure. Even then the dangerous projecting hook is unnecessary. A double key, Fig. 147, one shorter than the length of the hole, can be used, the short key being driven back with a drift to loosen the fit.



FIGS. 140 TO 158. VARIOUS METHODS OF FASTENING MACHINE PARTS

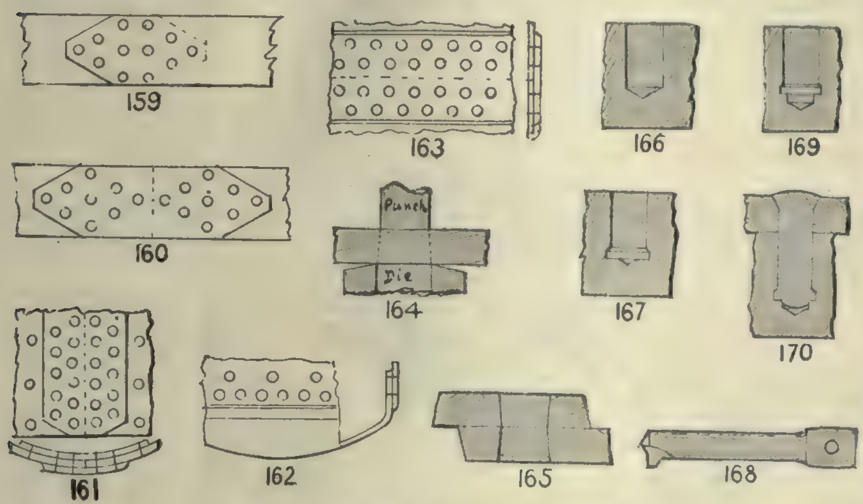
Figs. 140 to 143—Taper-fit fastenings. Figs. 144 and 145—Split cotter pins. Figs. 146 to 152—Key and feather fastenings. Figs. 153 to 155—Hub fastenings. Figs. 156 to 158—Flywheel-rim joints

When the piece is fastened in, in the middle of the shaft, Fig. 149, then the hook key will do. In that case the hook with a round corner, Fig. 148, in which a round-edged drift can be used, is a vast improvement on the ordinary way. Where the two parts fit together as they should, a plain feather, Fig. 150—that is, a square piece fitted half into each—or such a one as is used to some extent in Europe, a piece cut from a hard-drawn steel bar, mortised deeply into the shaft by a cotter drilling machine, Fig. 151, or a Woodruff key, Fig. 152, will prevent turning. Of the various methods of preventing end movement a grip fit, Fig. 153, with a perfectly fitted feather or with two keys, Fig. 164—one of them a taper one—is, next to a forced or shrink fit, the best. The two keys are only better than the single feather because a perfectly tight fit can be maintained, which is absolutely essential where the lever has alternate strains put upon it.

A setscrew on top of the feather will often do; or when it is necessary to make a connection that will be easy to remove and replace, a taper fit with feather to prevent turning and a nut to hold the hub on, Fig. 155, is an ideal plan.

Links are often used to secure the joints in flywheel rims, Fig. 156, but the material cut away is much more than is the case with T-head ties, Fig. 157, or the center bolt and cotters, Fig. 158. Rivets are better than screws or bolts to hold things together when the things are to be held permanently.

In boiler or bridge work or where the riveted joint is such as to subject the rivets to a shearing strain, the maximum strength of the joint is reached when the strength of all the rivets equals the strength of the plate and the rivets terminate in a single rivet in a line across the piece, Fig. 159. If the joint is a butt joint, covered by a plate, then the rivets in the middle of the cover must end in a single rivet, Fig. 160. Otherwise the cover plate will be weakened in the middle. By this arrangement neither the plate nor the joint cover is weakened beyond a single rivet hole. It is not possible to carry out this idea in the joints of a boiler, because of the necessity of having the rivets close together where the calking is to be done; but it is partially accomplished by using a narrow cover plate outside and a wide one inside, Fig. 161, putting in an extra row of rivets each side and a double width of spacing. By this arrangement the plate is only weakened one-half as much as if the inner plate was omitted. Besides, there is another important point: In the case of a double-riveted lap joint, the lap is twice as rigid as is the plate on each side of it; in the case of the butt double-cover joint, the joint is only 50 per cent. more rigid than the sheet adjoining, and this is another application of the principle of a gradual reduction to secure strength.



FIGS. 159 TO 170. RIVETED JOINTS

The longitudinal strain on a boiler is only one-half of the circular so that if the circular seam is half as strong as the shell, it is then stronger than it is possible to make the boiler in the other direction; but with a single row of rivets it may not be strong enough. Accordingly, it is usual where the best work is done to put a double row of rivets in the circular seam.

When the heads are of thicker stock than the shell, then the inner row of rivets should be given double spacing, Fig. 162, or only one rivet where there are two in the outer row, because the head is strong enough anyway and the shell is stronger with the single row.

In the best work the circular seams are butt joint with a weldless-joint cover put over the joint and double riveted, Fig. 163. As the cover is stronger than the shell, the rivets can be wider spaced and still be able to calk the joint.

In the best work—in fact, in all riveted work—the rivets should fill the holes. This they cannot do if the riveting is stopped before the rivets are nearly cold, as the shrinkage allows them to become loose. A common and the poorest way to make the rivet holes is to punch them. Where only two thicknesses are to go together, as in a lapped seam in a boiler, a fairly good job can be made by using a punch so much smaller than the die, Fig. 164, that the hole will be about 5 deg. tapering on each side. Such a hole can be punched without materially straining the metal; but when this is done, the two parts must be put with the small ends of the holes together, Fig. 165. A better plan is to punch the holes 1/8 in. or so too small and then, after the joint is brought to place, ream the holes to size. The best plan is to roll the sheets, if for a boiler, and put all parts together and drill to size in place. When the boiler sheets are punched or drilled first, the tendency is, when rolled up, to kink through the rows or rivet holes and to a certain extent weaken them. It sometimes becomes desirable to upset and head a rivet in the bottom of a hole. This can be done in the following manner: First, drill the hole to the depth required, Fig. 166, then enlarge it at the bottom, Fig. 167, by a wabble drill, Fig. 168; drill down with a smaller drill, Fig. 169, somewhat farther. This leaves a square shoulder upon which the end of the rivet abuts. As the rivet is driven into the hole, Fig. 170, this annular margin upsets and forms a secure head. Parts put together in this way may not be as secure as if riveted through, but more secure than in any other way.

While the ordinary standard bolt and nut serve the purpose for holding together, in the majority of cases when subject to jar or alternate strains the nuts are liable to work loose and the bolts to break at the ending of the thread. The reason for both is plain, and both can be remedied in three different ways without resorting to ingenious nut locks. When it is not important that the bolt shall fit the hole, the body may be turned or forged down to the bottom of the thread, Fig. 171, between the nut and bolt head. Bolts have been made by forging flutes, Fig. 172, reducing the cross-section by the same amount that is done by cutting the thread, which except in the case of large bolts is expensive, and by drilling out the proper-size hole in the center, Fig. 173, from the head end nearly down to the thread. This reducing the body of the bolt adds enormously to its ability to stand shocks, and the added elasticity is equivalent to an elastic washer to prevent the unscrewing of the nuts.

Experiments demonstrate that the amount of reduction in cross-section does not need to quite equal that removed by cutting the thread. To demonstrate the value of this: The fall of a drop that broke an undrilled bolt, falling two feet, required a fall of seven feet to break the drilled one. The undrilled one stretched less than 1/4 in. and the drilled one over 2 in.

Various devices have been employed to prevent nuts from working loose. Double nuts, Fig. 174, are the most common, cheapest and usually successful. A positive method is to use a smaller size, Fig. 175, and a finer pitch thread for the upper one. When double nuts on the same thread are used, the upper one of a smaller size, Fig. 176, but tapped to the large size, looks better

and in the case of a machine supplied with wrenches, such as an engine, fewer wrenches are required.

The common way to make adjustments such as that of setting a valve or the packing glands on piston rods, etc., is to use check nuts, two nuts jammed together on a thread, Fig. 177.

When the strains come in one direction, as is usual, it is thought to be the correct thing to put the thicker nut of the two outside, as that is the one that has to take the strain. Experience shows that to be more a matter of theory than necessity, as in any event the thin nut would break the rod, and the rod never breaks between the nuts—in fact, they break the rod without even becoming loose one upon the other.

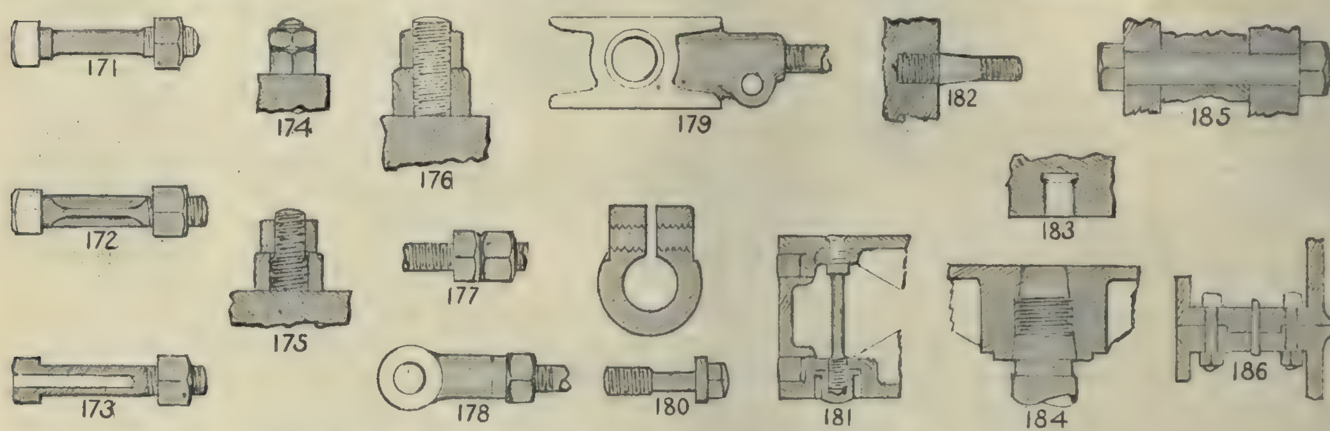
Rods that have to be adjusted are often screwed into slides or other pieces and secured by a check nut, Fig. 178, but a much better plan is to tap the piece, split it and grip on the thread, Fig. 179.

A rod so put in can be turned in different positions with a fair prospect of its being true, while with a check nu. prospect is reversed. The usual method is to drill through one half full size of the capscrew and thread the opposite half. The hole may be tapped completely through both, Fig. 180, the capscrew turned down to the bottom of the thread, and the screw put in from either side. When two slides or pieces have to be alike, except right and left, this "kink" enables one to be used in either place. There are places where this method of gripping on a thread seems to be the only successful fastening.

In the securing of the two parts of built-up pistons, those with a spider and follower, it is a common practice to use capscrews, which unless very tight in the threads are liable to work loose and often, too, with disastrous results. Studs riveted in with as long body as possible, Fig. 181, turned down to the bottom of the threads and brass cap nuts are much better. Studs are better than capscrews in many places, particularly where frequent changes are made, as the capscrew will wear out the thread in the casting, whereas studs can be renewed when the threads are worn off; and, too, capscrews seem to be more prone to work loose. Studs often break and invariably close down on the casting, which renders it necessary to drill out the stub end. A remedy is to make the end that screws into the casting one size larger, Fig. 182, so that when one is broken the break is sure to occur at the ending of the small thread, which leaves a projecting end by which the broken stub can be removed. Studs that have a considerable length between the threads would be better turned down between the threads, except for the difficulty of putting them in, as truss rods in bridges and roofs have enlarged stub ends—that is, larger-sized pieces welded on for the threads. Such bolts are better, not because they take less iron, which is usually the incentive, but because they give an elasticity to the structure or elongate and divide the strain equally among the various members.

In engines it is essential and sometimes in machines it is desirable to put studs and capscrews into tapped holes that do not go completely through. Owing to the necessity for shallow holes, a perfect thread is necessary. Better work is secured when the holes are chambered out at the bottom, Fig. 183, which can be done by using a wabble drill, as previously described for rivets.

A successful method of securing pistons to rods is to make a taper fit at each end and a screw thread in the middle, Fig. 184, and then to shrink on the piston. The taper prevents further forcing in, the thread from pulling out and the shrink fit from unscrewing. In this, as in all shrink fits, it is important that the pieces heated be heated throughout, or at least as hot on the outside as around the hole. Otherwise the hole may be made smaller instead of larger by heating.



FIGS. 171 TO 186. BOLTS, NUTS, STUDS AND OTHER SIMILAR FASTENINGS
Figs. 171 to 173—Bolts and nuts. Figs. 174 to 180—Check nuts and checking device. Figs. 181 to 186—Studs and similar fastenings

Body-bound bolts (either straight or taper fits), Fig. 185, are a common method of securing parts; the taper bolts have only a slight taper and heads that come to a bearing when the bolts are driven home. Where the fastening is permanent, the plain parallel bolt is about as good; but where there is likely to be occasion to take the work apart, the taper is much the better—in fact, turned bolts driven in reamed holes do not make at all a good method. Where possible, as it is in numberless places, a much better way is to tongue and groove the parts together, Fig. 186, using dowel pins to prevent lateral displacement and common loose bolts that can be easily put in place or removed.

If the tongue and groove be in the right direction to prevent displacement, it is better than the body-bound bolts and usually much cheaper; particularly in inconvenient places it is very much easier to get the parts separated.

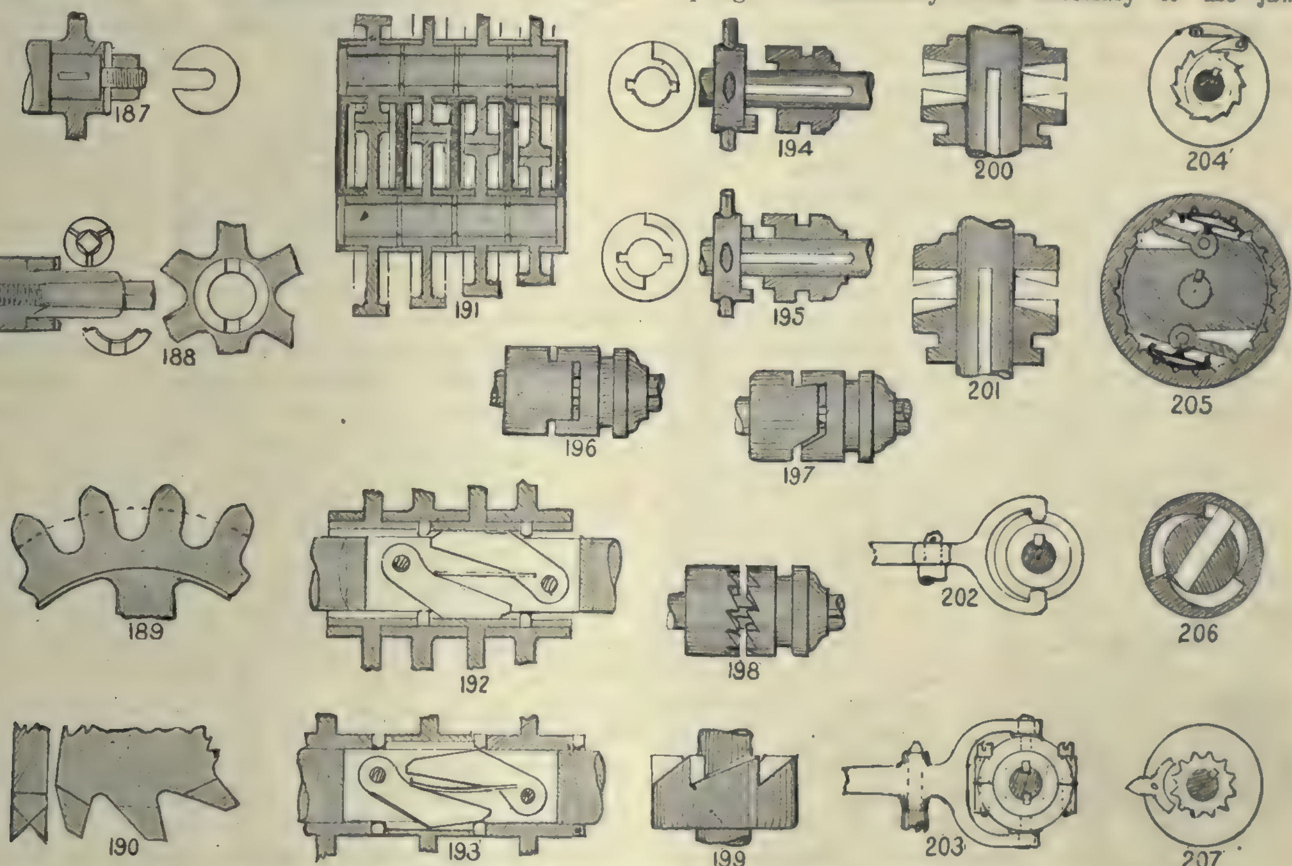
Where quick changes are to be made, such as the change gears of a lathe, the common nut and washer are too slow. The slotted washer and small nut, Fig. 187,

are better, as then it is only necessary to slack back the nut and slide off the washer; but there is an objection to this, for about twice out of five times the man drops the washer. Another plan more expensive, but absolutely non-objectionable, is to drill and ream a taper hole in the end of the spindle and screw in a taper pin, Fig. 188, with a head smaller than the hole in the gear, shrink on a tongued washer, slot the boss of the gear to fit, instead of a feather, and split the end of the spindle in three parts. The least turn of the screw will bind or release the gear, and there is nothing to get lost.

Modern designers are substituting other arrangements for change gears; but notwithstanding that, they are to be used extensively yet, and the better or more convenient the arrangement for making the changes the less the occasion for the more complicated devices. Besides, with the arrangements that call for throwing gears into mesh there remains one feature that can be improved. When trying to throw the one gear into the other, the ends of the teeth strike, and often it takes three or four trials before they enter. The remedy is easy if one has the courage to practice it. It requires no more than it does to depart from common practice and use short-tooth gears. Let the teeth be pointed, Fig. 189, and they will enter readily. It means special cutters or cutting them with a pointed cutter. A special cutter can be cheaply made by using a plain cutter of the right thickness and beveling each alternate tooth one way, Fig. 190, chamfering one side, then beveling the other alternate teeth the other way to bevel the other side.

In the mechanisms used as substitutes for change gears there are two systems: One is to throw out an intermediate from one fixed gear into another of a different size, and another plan is to keep all the different pairs of gears in mesh and connect and disconnect different ones to their shafts as required. As originally made, this latter method is slow to operate and all the gears are in motion all the time. A better plan is to suspend all the gears by their bosses in such a way that none will be supported by their shafts, Fig. 191, and then connect and disconnect the pair required. This can be done in various ways, but pivoted keys, Fig. 192, seem to give as good a way as any. The washers between the different gears prevent the keys from engaging in two gears at the same time, Fig. 193, and the keys can be drawn into the required gears instantly and without stopping. A single key would answer, but that is a poor plan, though less objectionable than a plan often followed in jaw couplings. Occasionally it is necessary to use jaw couplings where a complete revolution is required, so that when the two parts of the machine are coupled they will hold the same relative position every time. Usually this is done by having only a single tooth on each part of the coupling, Fig. 194. Such couplings act badly, as a twisting strain is thrown on each part and the sliding part soon wears so as to wabble. This is not necessary, as each part may have two teeth or jaws and yet make a complete revolution, before engaging one pair of teeth, formed on a different radius than the other, Fig. 195, so that only the inner one can engage with the inner one of its mate and the outer one engage with the outer one of its mate.

When couplings have to drive in both directions, it is necessary to consider the conditions. If they must be free from lost motion or shake, as the watch maker would say, they must be parallel fits, Fig. 196, because



FIGS. 187 TO 207. VARIOUS GEARING, CLUTCH AND RATCHET DEVICES

Figs. 187 and 188—Gear fastenings. Figs. 189 and 190—Pointed gear teeth to permit easy engagement. Figs. 191 to 193—Gear mountings. Figs. 194 to 201—Jaw clutches. Figs. 202 and 203—Clutch shifters. Figs. 204 to 207—Ratchet devices

if tapering fits they would tend to work apart, or at least unless on a vertical shaft, when the weight might hold the clutch in contact. In this case a slight taper might be admissible.

A slightly tapering jaw or working face would be easier to uncouple with a heavy load, but the necessity to hold it always in mesh is objectionable. Where a clutch drives in one direction and is subject to jar and liable to disengage, the teeth may hook under, Fig. 197, to insure their holding in contact, but would be hard to disengage when driving. Where driving in one direction and it is desirable to throw in under motion, a ratchet form of tooth, Fig. 198, is best, as it gives time to make the engagement and the teeth are stronger. For quick action a multiplicity of teeth reduces the loss of time and also gives less time for throwing in.

Ratchet teeth, if correctly formed, are either shallower at the inner ends than at the outer, or the bevel side of the teeth is made a warped surface, Fig. 199. If machine cut, then the teeth are shallower at the inner ends, Fig. 200, and the draftsman or constructor has a proposition before him in determining by a diagram or figures just what angle to set each blank to produce the right results. Or he may adopt another plan, which is simple. Though it does not give the same result, the one produced is quite as good, Fig. 201. Cut one blank square with the miller and cut with a cutter of the required shape. The result will be teeth with the bottom straight across and the top sloping inward. Then in cutting the mate, tip the blank up until by experiment the points of the teeth are level; the two will fit perfectly.

In operating sliding clutches a common sloppy way is to form a groove in the sliding part and operate it with a fork having two horns engaging with the groove, Fig. 202. The horns cannot fit, and soon wear out. The correct way is to make a perfectly fitting band in halves, Fig. 203, but bolted together and the forked shifting lever pivoted to the band.

The ordinary ratchet and pawl, Fig. 204, or *click*, as the watch makers call it, is objectionable in two respects—putting a twisting strain on the parts, and noisy when running back. The remedy for the twisting strain is using two pawls, Fig. 205; the remedy for the noise is a silent pawl. A very simple and efficient ratchet and pawl is made by mortising a sliding bar through the shaft, Fig. 206, the ends engaging alternately with the teeth of an internal ratchet. This is usually made with a three-tooth ratchet, which with the double-ended pawl makes it equivalent to an ordinary six-tooth one. A five- or even a seven-tooth ratchet could be used in the same way where the service is light.

It is not infrequent that a reversible ratchet is desired, and the common form is one-sided, Fig. 207. In many cases they can be concealed and set in mid-position or to feed either way without trouble.

Fitting Lathe Carriages and Ways

By Edward Moreau

While discussing the subject of fitting and assembling certain parts in new engine lathes, I was astonished to hear some one question the necessity of performing some operations that had always appeared to me as indispensable. I submit the points in contention to the readers of the *American Machinist*, and doubt if any of them will deny the accuracy of my statements.

After the bed has been planed, and the legs bolted to it, the surfaces upon which the carriage slides (be they V or flat) should be straightened and trued up by hand-scraping simultaneously with the truing up of the contact surfaces of the carriage. Scraping the carriage alone will not give the result sought, and the truth of its V's will be of little value if the V's of the bed are not true. This operation should not be neglected in an accurately built lathe, as it is obvious that the carriage when moved along over uneven surfaces will follow the irregularities, however small the variations may appear, thus deviating from a straight line.

The mere smoothing and polishing of the ways with the file and emery cloth cannot take the place of truing by hand-scraping. In fact, filing without using any means to ascertain the degree of truth of the part is bound to do more harm than good. The only method that should be employed, after testing the carriage over the bed, is to correct by scraping both parts, repeating the process until both show perfect bearing all over. A marking that will show clearly the bearing points on both the bed and the carriage must be used for testing; this is very important, as it will enable the scraper hand to carry the process to a degree of accuracy not otherwise attainable.

When finished, surfaces and V's that have been scraped to a fairly accurate fit should present the neat appearance known as "frosting," and should not require any further application of the scraper to adorn them.

Ways finished in this manner will keep their good appearance for a long time, as the carriage bears over practically the entire surface and there are no higher spots to show quickly because of rapid wear. On the other hand, if the V's have not been trued up and have received instead only a fancy decoration, scraped on and intended to give the appearance of a fine finish, the friction of the carriage when at work will in a short time rub off the scraper marks on the few high places where there is a bearing, while the low places will retain the marks, thus showing the imperfection of the work. Of course, the same remarks apply also to the fitting of other parts, as the tailstock and the saddle.

Another point certainly beyond all question is that no lost motion should be felt when turning the crank handle to move the cross-slide. While it should show no play at all, the crank handle should not require any considerable effort to move it; nor should it require a harder pull at any point of its revolution. These conditions indicate a defective fit either in the sliding members or in the parts bearing the end thrust of the screw, or perhaps an incorrect position of the screw or nut. The careful mechanic should remedy such defects when fitting and assembling these parts.

Motorcycles in Denmark

Latest statistics, compiled Sept. 1, 1916, put the number of registered motorcycles in Denmark at 7,766, with total indicated horsepower of 23,066, or an average of 3 hp. per cycle against 2¼ hp. in 1914. Of the total number of motorcycles in 1916 Copenhagen had 1,862; 2,350 were in the provisional cities, and 3,554 in the rural districts.

Lapping Hardened-Steel Surfaces

By Earl E. Cline

SYNOPSIS—The process of lapping consists of embedding grains of abrasive material in a surface, usually of metal, and by means of this abrasive-embedded surface grinding a harder metal surface. The fundamentals of lapping flat surfaces are set forth in this article.

The metal of the lap should invariably be softer than the metal of the work to be lapped. Thus for lapping hardened steel, either soft steel or cast iron makes satisfactory laps, while for lapping cast iron, the lap should be made of copper, lead or some other metal that is softer than cast iron.

The reason for this is obvious. The abrasive grains must be embedded in the lap so that they act as do the grains of the abrasive in emery, or any other abrasive cloth or paper, where the grains are held by glue.

The reason for having a metal lap instead of using abrasive papers or cloths is that the metal for the lap can be shaped to a definite form. Thus for flat surfaces, a flat lap plate is made; for a cylinder, a cylindrical ring lap is made; for a ring gage, a plain cylindrical lap; for a thread-gage lap, either a male or female threaded lap of the correct size and pitch is made, and so on.

Contrary to Common Belief the Lap Also Wears

The lap is charged with a hard abrasive that alone is supposed to come in contact with and cut the work to be lapped. One would perhaps think, therefore, that the lap thus coated is protected by the abrasive from wear. This, however, is not the case, as the lap wears more or less according to the way the lapping is done, the manner in which the abrasive is applied to the lap, and other variables.

Much depends on the nature of the abrasive used to charge the lap. In this respect toughness is as important as hardness, if, indeed, it is not more important.

It is essential that the abrasive be well embedded in the lap and that all superfluous abrasive be removed from the lap before the work of lapping is begun.

Should there be loose grains of abrasive, they will roll around between the surface of the lap and the work and produce a frosted surface on the latter. As the metal in the lap is softer than the metal in the work, and as these loose grains are free to move around on the surface of the lap as well as on the surface of the hardened work, the soft lap will be cut or worn more than the hardened work. This wear will not be uniform, and the lap will soon become out of shape and require to be redressed to form.

In a previous paragraph mention was made of the desirability of toughness. Take a piece of the hardest artificial abrasive as it comes from the electric furnace. It is only slightly softer than the diamond, and yet it is so brittle that you can crush it between your fingers. Now take some of the same abrasive that has been ground; it does not matter what grain you select, any will do from the coarsest to 60 min. Place it on a flat piece of iron or steel and rub the flat of a knife blade over it. The grains will crush readily, no matter how fine they are. Now imagine a lap charged with such brittle grains. Each time the work is passed over them, particles are broken off, and we have the condition of loose grains between the lap and the work and the consequent excessive wear of the lap and poor surface on the work owing to the loose grains referred to in the preceding paragraph.

This explains the statement so often made by tool makers: "I do not like the hard electric furnace abrasives for lapping. They wear the lap much more than emery."

Qualities That Are Desirable in a Lapping Abrasive

While great stress has been laid on the desirability of toughness, toughness is not everything in an abrasive for lapping. Hardness is of great importance, and cheapness is another important factor in the make-up of a good lapping abrasive. If this were not so, then diamond dust, made from "bortz" (gem diamonds that are off color or too full of flaws to be valuable) or dust made from the black diamond, commonly called "carbon," would be the ideal lapping abrasives. But ordinary bortz dust in small quantities costs $3 per carat and carbon dust twice as much or even more. It may here be mentioned that carbon is amorphous diamond and is generally considered to be much harder than bortz. Rough stone carbon costs approximately $90 per carat, about as much as a fairly good gem diamond of equal size, while the rough stone bortz costs anywhere from $1.50 per carat up to where it is usable for jewelry. The "diamonds" advertised at $40 or so per carat by some of the cheap jewelry houses in our large cities are nothing but bortz, worth from $5 to $10 a carat and cut at a cost to the jeweler of about $2 per carat.

The objection to emery as an abrasive is that while it is hard and tough, as a rule, its hardness and toughness, like the hardness and toughness of all natural minerals (even the diamond) vary.

A Satisfactory Artificial Abrasive

Alundum is an artificial abrasive produced by the Norton Co. This abrasive is not only tough, but uniformly tough; not only hard, but uniformly hard; and while it is neither so hard nor so tough as the diamond, for the price of a single carat of diamond dust you can get about ten pounds of alundum.

The method of charging the lap is an important factor in the success or failure of lapping. Let us imagine that we have some hardened flat steel surfaces that we wish to lap. The lap is a flat rectangular block of cast iron. It may be of any size, depending on the size of the work. For the ordinary run of gage work, a block 9x12x2 in. thick will be found satisfactory.

The lapping block should be cast face down, so that the face is solid and devoid of blow holes, although blow holes will not affect the accuracy of the work except so far as they form a lodging place for loose abrasive, which is apt to work out during the lapping process and roll around between the work and the lap.

The surface of the lap should be planed. The writer prefers a lap that has been planed all over, allowed to season for several months and then finish-planed, also all over. The method of seasoning pursued with very satisfactory results is as follows:

After the rough planing cut is taken over the lap to ascertain whether it is good enough to use as a first-class lap, it should alternately be heated and cooled. Where a foundry forms a part of the establishment, this heating and cooling is easily arranged for by having the laps remain alternately a week in the core oven and a week in the yard. If this treatment can be given for an entire year, so much the better. When heating, it is well to remember that the laps should not be made too hot. Never heat the laps to a red heat, as it will make them too porous. Where no other means is available, the laps can be seasoned well by giving them alternate baths in boiling and cold water or oil. Another great aid to seasoning is vibration. If the laps during the seasoning period be occasionally vibrated violently for a few hours, it will materially accelerate the seasoning. Where there are polishers' benches, the necessary vibration can be imparted to the laps by occasionally laying them for a few hours on or near the polishing stands. While the writer cannot give any explanation as to why the heating and cooling and the vibrating hasten the seasoning of the laps, he is positive that this treatment does accelerate the seasoning and is beneficial. One year of such treatment produces a lap that is practically permanent.

The finish-planing of the lap should be carefully done by a skilled mechanic. The final cut should be taken with the clamps as slack as possible. For very accurate work, the lap should be scraped to a true surface plate, but for the regular run of ordinarily accurate work, the laps will be flat enough if they are carefully planed as specified. Some advocate narrow gutters in the face of the lap, about $\frac{1}{16}$ in. wide, $\frac{1}{32}$ in. deep and ½ in. apart and at 90 deg. to each other, but the writer prefers a plain, flat lap.

Charging the Lap with Abrasive

The method of charging the lap has a great influence on the success or failure of lapping.

The writer uses FFF and FFFF alundum, which are fine enough for most work. There exists work, however, for which No. 65F is none too fine. The abrasive powders should be kept in glass bottles, preferably with wide mouths. The glass should be clear, so that one can see that it is clean before the abrasive is put into it; for it must be remembered that a single grain of coarse abrasive on a lap charged with a fine abrasive will perhaps spoil a costly gage. For shape, the bottles in which Bromo-Seltzer is packed are about right. Having put the abrasive into the bottle, a piece of fine bolting cloth, or two or three thicknesses of common cheese cloth are tied over the mouth. This permits the abrasive to be dusted over the surface of the lap. To cover the tops of the bottles and exclude dust and grit when the bottles are put away, the writer uses some drawn brass shells obtained from a press shop; but previous to obtaining these he used small baking-powder tins.

A squirt can of kerosene and one of gasoline or benzine are necessary adjuncts to the lapping bench, as is also a charging block. The writer uses a block of pack-hardened steel, 3x2x⅝ in., or a hardened-steel roller. The rectangular block is flat on the bottom—that is, the side that does the charging. The edges all the way round on this side are slightly beveled, so that they will not scrape the abrasive grains off the lap but will allow them to pass under the charging block and be forced into the lap.

When preparing to charge the lap, three or four drops of kerosene are first squirted on the face of the lap, followed by a good squirt of gasoline or benzine, after which some of the abrasive is shaken out of the bottle over the wetted portion. The charging block is then rubbed in circles over the entire face of the lap. While the charging block should be pressed firmly down on the abrasive and lap, care should be taken not to press too hard. However, this is a detail that can only be learned by experience, and a little practice will result in the necessary skill.

After the entire face of the lap has been gone over with the charging block and abrasive, and the latter has been forced into the lap, the excess abrasive should be wiped or, for fine work, washed off. For wiping off, a clean rag should be used, care being taken to use a rag that will not leave a lot of lint on the lap face.

For washing off the excess abrasive from the lap, either kerosene or gasoline may be used; the latter, however, gives the better results.

Holding the Work to the Lap

The work to be lapped is held by the tips of the fingers and rubbed back and forth over the face of the lap, either in straight lines or with a circular motion. The amount of pressure to be applied depends on the size of the piece and its shape, and to a great extent on its thickness. It must be remembered, however, that too much pressure will scrape the abrasive from its seat in the lap and also cause excessive curling.

When a piece of flat steel is lapped, the numbers of minute points of the abrasive particles exert a sort of stretching effect on the face of the steel with which they come in contact. There is also slight local heating, and if the lapping is carried on for too long a period at a time, the piece curls. For this reason, it is wise not to hurry the work. If really flat work is required, it should be laid aside to "rest" every little while. Just when to stop lapping and lay the piece away to cool, it is impossible to say. That also can only be learned by experience. If the lapper has an accurate knife-edge straight-edge handy while he is lapping, he can test the work from time to time and more rapidly acquire the skill and knowledge of how his work is behaving and when to work and when to cease.

The work for flat lapping should be ground to about 0.0001 in. oversize—that is, if the grinder is in good condition and the workman a skilled lapper. For an unskilled man, I would suggest that the work be ground 0.0002 in., or even more, oversize. Lapping is slow work, and provided a man is skilled, the nearer the ground work is to the finished size the better; but enough must be left for finishing on the lap.

Work from even the finest surface grinder and from the finest wheels has scratches. While these scratches are not very deep, it is true, they are still of definite depth, and when compared with the lapped surface, and its infinitely finer scratches, they are very deep.

A really first-class job from a good B. & S. surface grinder will lap to a perfect surface on the removal of less than 0.00005 in.

The first rough lapping to "get a bearing" can be done with gasoline or kerosene as a lubricant, just enough to keep the lap wet. The finish lapping to get a highly polished surface should be done with a dry lap. It must be remembered that a lap chokes just like a file. The tiny abrasive teeth become clogged, and they must be cleaned. A rag wet with gasoline will be found satisfactory for this. The rag is rubbed over the surface as soon as the lap gets dull and glazed and refuses to cut. This condition can readily be felt by the lapper. A fresh, clean lap grips the work just like a new file.

After cleaning with the gasoline, the lap should be dried with a piece of clean rag if the finishing cut is on. As the lapping goes on, the cutting points of the abrasive become dull and it becomes necessary to recharge the lap. Recharging is essential when cleaning the lap with gasoline fails to materially improve the cutting qualities of the lap and is done in precisely the same way as charging. It is good practice to have a series of laps for the various grains used, and keep the laps for these grains and not attempt to charge any one lap at different times with different grains. The reason for this is obvious—the coarser grains will make scratches in the work. The bottles with the various grains should be kept isolated, so that the grains from one bottle cannot be blown by a draft of air to another. Some of the grains lodge on the cheese cloth on the mouth of the bottle so that the possibility of the grains becoming mixed is not so remote as might be imagined. The laps themselves should also be kept separated, and not be allowed to touch each other. Cleanliness and care are of prime importance. Good work seldom results from careless and dirty methods.

From time to time as the work progresses it should be removed from the lap and thoroughly cleaned and measured. This, of course, refers to where the piece is being made to a positive size. Where a flat surface only is required, the work should be tested with the knife-edge straight-edge previously referred to.

Difficulty of Accurate Measurement

And now a word about measuring. One often sees in the technical papers mention of someone having measured to the fifth decimal place with an ordinary micrometer. This is nonsense. There are few men who can measure accurately to the fourth decimal place, and there is no micrometer that can be depended on to do so. If the reader does not believe this, let him test it in the following way: Take the best micrometer in the shop and adjust the anvil adjusting screw so that the micrometer does not read correctly. Then take a Swedish gage, and ask several of the best tool makers in the shop to measure it with the "disadjusted" micrometer without looking at the marking on the block. Put down the various measurements, and you will find that they vary by more than 0.0001 in. Then "redisadjust" the micrometer and get the same men to measure the block again. You will probably find that no man's corrected second measurement agrees with his first. Neglecting the expansion due to the heat of the hand it takes but a slight difference in pressure on the anvil of a micrometer to make a variation of more than 0.0001 in. Some day one of the micrometer makers will make one that has a dial or similar indicator in combination with it, so that the measurer can be sure that he obtains the same pressure when comparing sizes. Such a micrometer will greatly increase the value of the Swedish gages, as it can be used as an accurate comparator, the dial gage to a great extent eliminating the personal error.

Manufacture of Power-Forged Chain

The various operations involved in the process of power-forging chain, as developed under the supervision of Naval Constructor F. G. Coburn, at the Boston Navy Yard, are briefly as follows:

Shearing—The bar of round stock is rolled from the storage skids onto rollers which guide it through the shears and against the stop that gages the length of the "bolts." After cutting off, the bolts are packed in special baskets for transfer by crane to the scarfing furnace.

Scarfing—One end of the bolt is heated in a special oil furnace for a distance of about a foot, and the end is then bent and upset by a single operation in the upsetting machine. During the same heat the bolt is scarfed under a 2,500-lb. steam drop hammer, using special steel dies. The "flash," or web, is then removed by a trimming press. The operation is repeated for the other end, and the bars are packed in baskets for transport to the bending-machine furnace.

Bending—The scarfed link is heated throughout to about 1,100 deg. C. in a special oil furnace, from which it is swung by a special jib crane to the hydraulic bending press. Here it is bent by wiping it around a mandrel having the shape of the inside of the chain link. This operation leaves the links practically closed, and it is necessary to pry apart the scarfs with a crowbar in order to thread the links in the chain.

Welding—The link is first preheated, threaded into the end of the growing chain, and the scarfs closed under a heavy hammer. It is then brought to a welding heat of about 1,350 deg. C. in a special oil-burning chain forge and welded on special "dolly dies" under a light hammer (250 to 350 lb.). To give the link the proper shape, it is brought to welding heat a second time and finished in the dies of the heavy hammer (1,800 to 3,000 lb.).

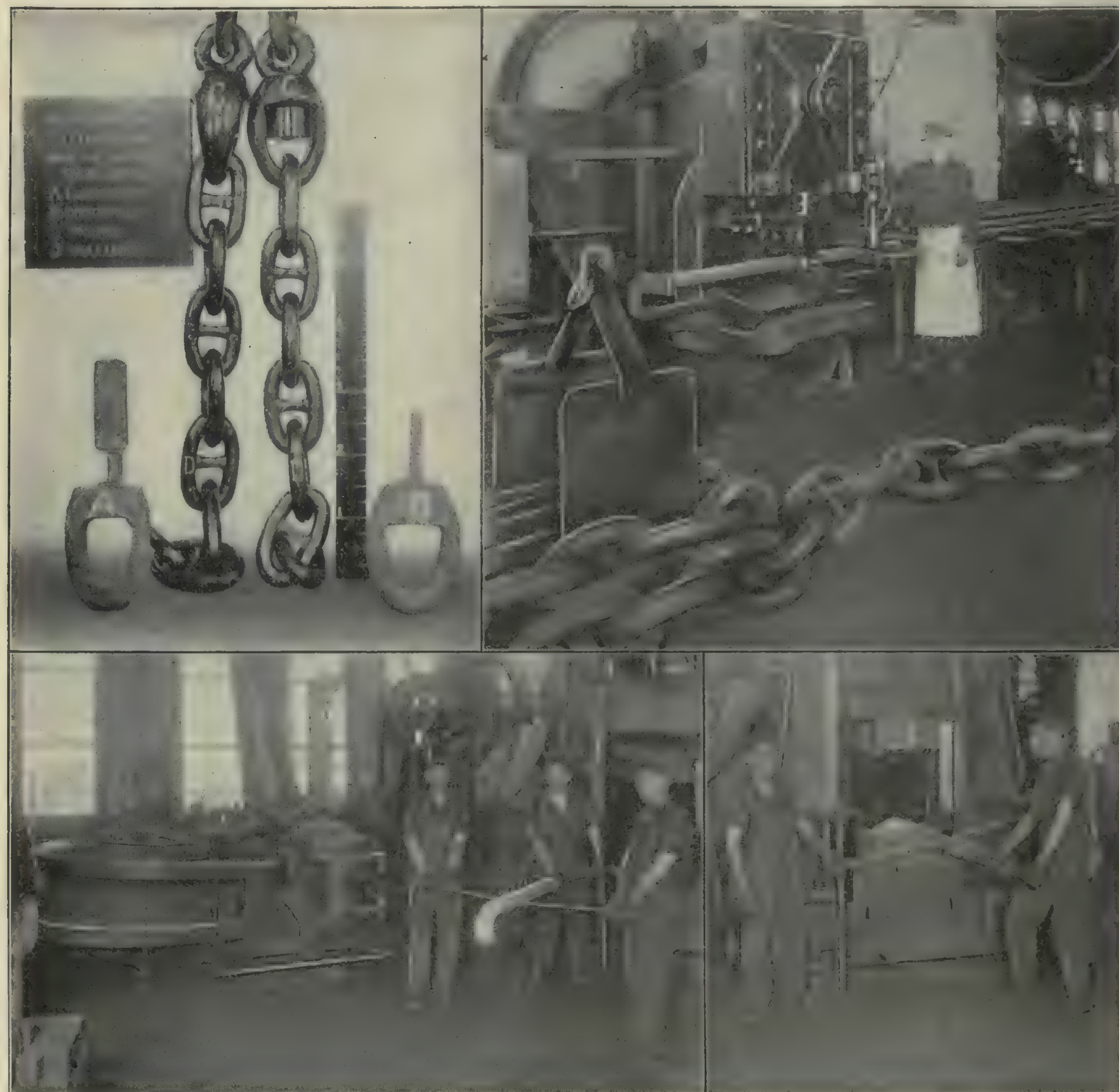
Trimming—The last welding process leaves a "drop-forge flash" inside and outside on the welded end of the link, which is trimmed off by hand.

Studding—The drop-forged chain stud, which is inserted to preserve the shape of the link, increase the strength and prevent kinking of the chain, is held in place with the link on its side under the steam hammer and pinched in place by a light blow of the hammer.

Heat-Treatment—This is accomplished by loading the chain onto a steel flat-car, which is run into a long annealing furnace fired by oil burners. The temperature is brought evenly to about 950 deg. C., well above the upper critical point, as determined by the indications of nine base-metal thermocouples distributed about the furnace, one couple being placed in a bolt of iron under the pile of chain on the car. After the desired temperature has been maintained for 10 min., the car is hauled out of the furnace and the chain allowed to cool in the air before proofing.

Proofing—Each shot of chain is given a "proof test" with the hydraulic testing machine up to values given in the chain tables. After proofing, each link of the shot is examined for defects; and if unsatisfactory links are found, they are cut out and replaced by the repair crews. In addition to the proof test, a breaking test is made on a "doublet" taken at random during the making of each shot. If this does not equal the tabulated standard, others are tried on each side; and if they fail, the whole shot is condemned. The proofing load is approximately 60 per cent. of the breaking load. The tables of stresses are standard with the Navy Department, being based on what is considered good practice in both this and foreign countries.

Painting—Shots that have been proofed and found satisfactory are coated by hauling through a hot bath of asphalt paint, and are then stowed ready for shipment.



FIGS. 1 TO 4. POWER FORGED CHAIN AND VARIOUS PROCESSES IN ITS MANUFACTURE

Fig. 1—Outboard shots of 3⅜-in. chain for U.S.S. "Pennsylvania." Fig. 2—Shearing bars into bolts. Fig. 3—Bending the end of the bolt. Fig. 4—Forging the scarf

Russia's Production of Platinum Greatly Reduced in 1916

The British consul at Ekaterinburg, Russia, reports that during the current year the production of platinum in the Urals has been seriously affected by the scarcity of labor in the case of hand washings by tributers, and in the case of mechanical dredging plants by the difficulty of obtaining spare parts for dredges. The production of platinum in 1916 is estimated at 100 to 120 poods (3,600 to 4,300 lb.), or one-third of the normal. To this decrease in output, as well as to speculation by local buyers, may be attributed the rise in the price of platinum. These figures, are of course only approximate, but they show why this material as well as many others produced by the countries at war has risen so in price.

FIGS. 5 TO 10. VARIOUS DETAILS OF THE MANUFACTURE OF POWER-FORGED CHAIN

Fig. 5—Bending the bolt to shape. Fig. 6—Prying ends apart. Fig. 7—Threading preheated link into chain. Fig. 8—First welding operation. Fig. 9—Finish welding. Fig. 10—The new double welding unit

Employment Bureaus for Classifying Workmen

By E. W. Johnson*

Everyone wants to reduce the labor turnover. As a "safety-first" measure it would have a most beneficial result, for accidents are mostly caused by employees who will not stay in one place long enough to absorb the right ideals. The state has passed laws requiring all kinds of safeguards. It has also passed laws providing compensation for injuries. It spends large sums of money annually enforcing these laws. Why, then, should the state not assist in reducing accidents by helping to remove the cause of a large part of them?

A study of employment records, or a few interviews with representatives of that large class of workmen who drift from job to job, or a checking-up of the workmanship of a dozen applicants for employment to see how their ability matches up with their claims, will show very clearly that men constantly misstate their ability and travel from place to place in the hope of landing a "soft" job. If only there could be some plan devised by which men can be known by their true value, a large part of this wandering and consequently a great percentage of labor turnover could be eliminated.

State Labor Bureaus Desirable

As a means to this end it is proposed that the state establish labor bureaus in all large industrial centers and that they provide a system and means by which they can investigate the standing of workmen in the trades or crafts. A workman desiring to change employment or having left one company to seek employment elsewhere could apply for a certificate of his standing as a workman; and in case he is a good workman or a fair workman, this would be of great assistance to him, as well as to his employer, for the reason that an employer hesitates greatly to pay the maximum wages to an applicant when he has no knowledge whatever of that applicant's ability, except his own claims.

It is believed that a plan of this kind would tend greatly to stabilize labor, for the reason that a workman would surely wish to retain a job until he had established sufficient ability in it to enable him to secure a certificate rating him as a first-class workman.

Many plans are being proposed for state and national employment bureaus, and it would seem that no logical or workable plan has yet been found. If, however, the ideas suggested above could be thoroughly tried out, there seems to be no question that they would form the nucleus of a real and effective state employment plan.

Classifying Employees

To make it effective would require a proper classification of employees, which would have to be understood by all those connected with it; and it is proposed to provide for this somewhat along the lines indicated by the following classifications, which have been worked out for the mechanical and electrical trades for use in a large manufacturing concern:

Class A—Leaders in charge of groups, experimental workers and those on the highest-grade production or tool work. General knowledge of machine tools, speeds, materials, etc., judgment, accuracy without the use of jigs, and a high degree of skill and dependability are required.

Class B—Accurate, dependable workers with considerable ability and experience, but without the thorough knowledge or experience required of those in Class A. Generally, operators on accurate or heavy work that is usually repeated. Accuracy, knowledge of speeds and materials, reading of blueprints and the use of gages are required.

Class C—Workmen who have become proficient on lines of work that are usually repeated.

Class D—Workmen who can be brought, in a short time, to be efficient producers on lines of work that are usually repeated.

Class E—Workmen with little, if any, previous training; unskilled laborers on work requiring a small degree of skill, accuracy or knowledge.

*General superintendent, Westinghouse Electric and Manufacturing Co.

To Win Argentine Trade

About two hundred American manufacturers have joined in a new organization known as the Argentine Mercantile Corporation. The purpose is to trade with the great South American republic.

The reason for selecting Argentina as the sole field for this coöperative attempt is the importance of that country as a customer, its assured commercial future and the necessity of concentrating the energies of the corporation.

The plan for handling the business includes the establishing of salesrooms in Buenos Aires, where every line handled by the corporation will be displayed. It is also expected to have demonstration rooms near the salesrooms, where machinery and mechanical appliances can be shown in operation. This will be known as American Machinery Hall.

No competing lines will be handled by the corporation. No retail selling will be done, for the customers sought are the established merchants of Argentina. However, the salesrooms and demonstration halls will be objects of interest and will be open to the general public.

The plan of operation of the corporation embraces a board of directors in the United States of thirty-one of the noncompeting manufacturers. In Buenos Aires there will also be a directorate of eleven Argentinians of recognized business standing. It is expected that eventually some five hundred American manufacturers will be members of the company.

The first board of directors includes the following: Carl G. Davis, treasurer, American Saw and Manufacturing Co., Springfield, Mass.; E. P. Sedgwick, treasurer, Chicago Hardware and Foundry Co., Chicago, Ill.; L. S. Richards, treasurer, Havilite Corporation, New York; D. E. Storms, director, Dauch Manufacturing Co., Sandusky, Ohio; J. J. Dauch, president, Hinde-Dauch Paper Co., Sandusky, Ohio; James E. Holland, vice-president, John Holland Gold Pen Co., Cincinnati; Paul L. Pryibil, Pryibil Machine Co., New York; William B. Connor, exporter, New York; T. T. Pincard, president, Burlington Construction and Engineering Co., New York; E. R. Chapman, treasurer, Brooklyn Union Gas Co., New York; C. H. Carroll, H. L. Merry, William Hill Hunt, E. F. Walker and P. H. Sims.

Some Operations in Assembling Typewriters

Editorial Correpondence

SYNOPSIS—The assembling department of the typewriter factory brings together the great number of parts from the different departments and puts them in place in order to produce the completed machines. The handling of the parts in this department is done with appliances that facilitate the progress of the work, and care is taken to see that the frame of the machine is not marred in its progress through the shops. The setting of the type bars so that the type will print uniformly on the paper is accomplished by a special test indicator, that enables the locating brackets to be correctly positioned.

The accompanying illustrations are of interest in connection with the work of assembling typewriters at the plant of the Noiseless Typewriter Co., Middletown, Conn.

Fig. 1 is a general view in this department, giving an idea of the magnitude of operations therein. It shows the long lines of benches extending for hundreds of feet down the shop, with benches in the immediate foreground filled with typewriter frames ready for the mounting of certain parts for the machines still farther down the line which are more advanced in the process of assembling. The machines start at this end of the room and progress toward the upper end through their various stages until finally complete.

This view, in connection with Fig. 2, which shows the machine complete except for the placing of the type bars and carriage, gives a fair idea of the extent of operations in the factory. There are of course a great number of interesting details in connection with such operations, and it is possible to present only a few of them in this article. One such detail is the fitting up of the ends of the key levers—that is, the circular pads for the fingers, known as the keys—the method being shown in Fig. 3.

Here a girl sits at the bench with the typewriter frame in front of her, in which have been assembled the key levers and certain other parts, while behind the machine is a tray containing the round disks printed with the characters—the letters of the alphabet, numerals, punctuation points—these being arranged in the tray in the same order that they are to be placed on the keys. This tray also has compartments for the glass covers that are placed over the printed disks, and other compartments to carry the brass rings that are forced down over the round end of the key lever to hold the indicating character and the glass disk in position.

In assembling, the girl picks up a printed disk, places it on its round seat formed on the end of the key lever, drops the glass disk over this, slips the nickel-plated brass ring over the whole thing and clamps it down tight with the gripping pliers shown in the right hand. For certain keys, owing to the position or to some special feature in the formation of the seat on which the indicated disks rest, she has other forms of pliers, an entire set being shown at the right of the typewriter frame. This operation, like practically everything else which is done continuously and which depends upon the deftness of

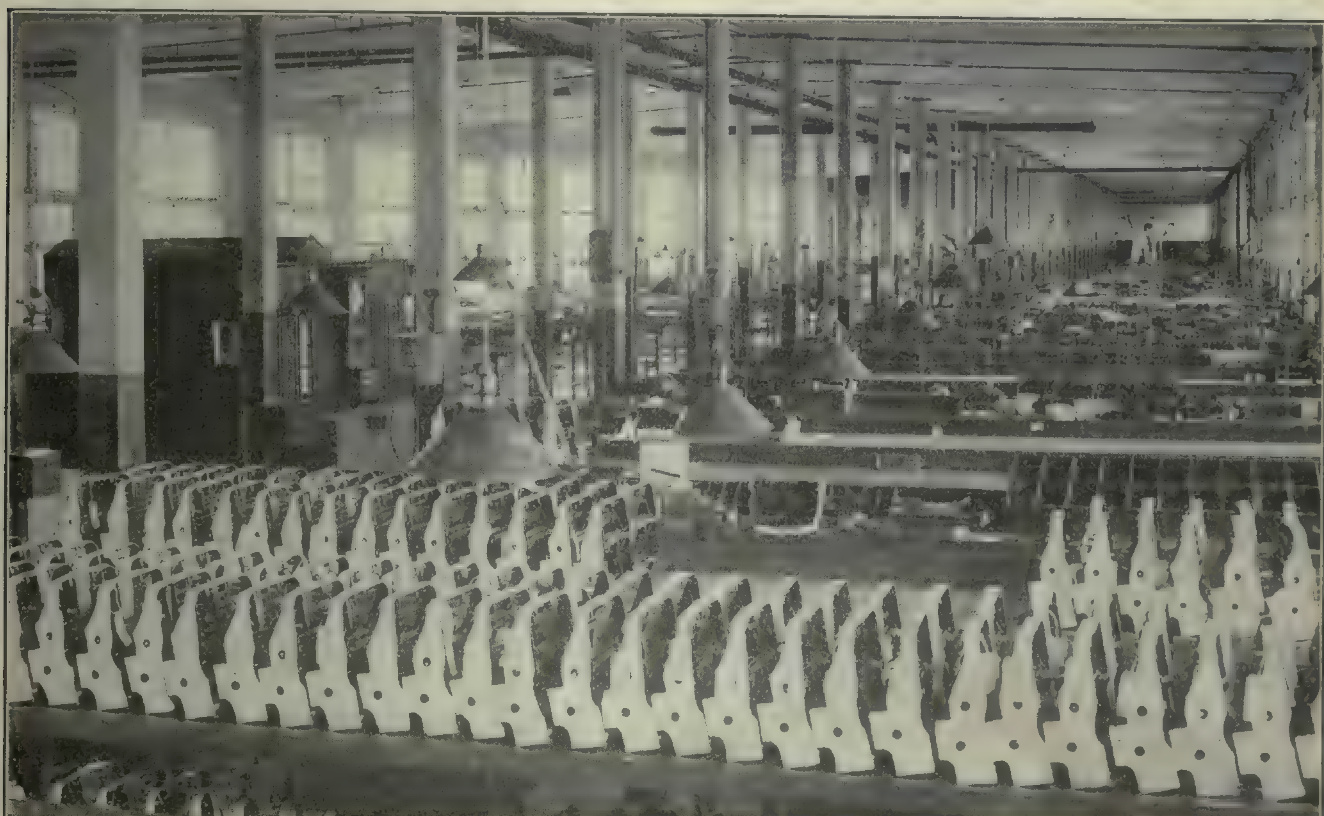


FIG. 1. ASSEMBLING DEPARTMENTS OF THE NOISELESS TYPEWRITER FACTORY

a person's fingers, is carried on very rapidly, as it practically becomes mechanical after a long period of practice.

Fig. 4 illustrates an interesting device used in the assembling department for facilitating the setting of the brackets that control the operation of the type bars. This view shows the typewriter pretty well assembled, except that the key characters have not been put in place and the carriage has not been mounted on the center tie. Instead, the center tie is provided with a test indicator of special form, which spans the gap between the upright portion of the tie and the position that will later be occupied by the flat printing platen carried by the typewriter carriage. This indicator is used to test the extreme forward position of each type with the type bars thrown ahead by the action of the key lever.

As has been pointed out in other articles upon the practice in this factory, the brackets that support the toggle mechanism for operating the type bars are adjustable within certain limits, but the type bars, the type, the toggle mechanism and the brackets are all made so accurately that very little adjustment from the neutral position is ever required in the assembling process. However, to bring each and every type character to a definite position at the maximum forward point of the stroke, this indicator is applied as illustrated. As the type advances, the indicator shows whether it has come to the standard point or not.

If the type bar is not far enough toward the front of the machine, light adjustment of the bracket is made to carry the toggle mechanism as far ahead as necessary. Conversely, if the indicator shows that the type advances too far forward, the bracket is withdrawn to the necessary point. This is of course a precision test of the finest character for facilitating the assembling process. The

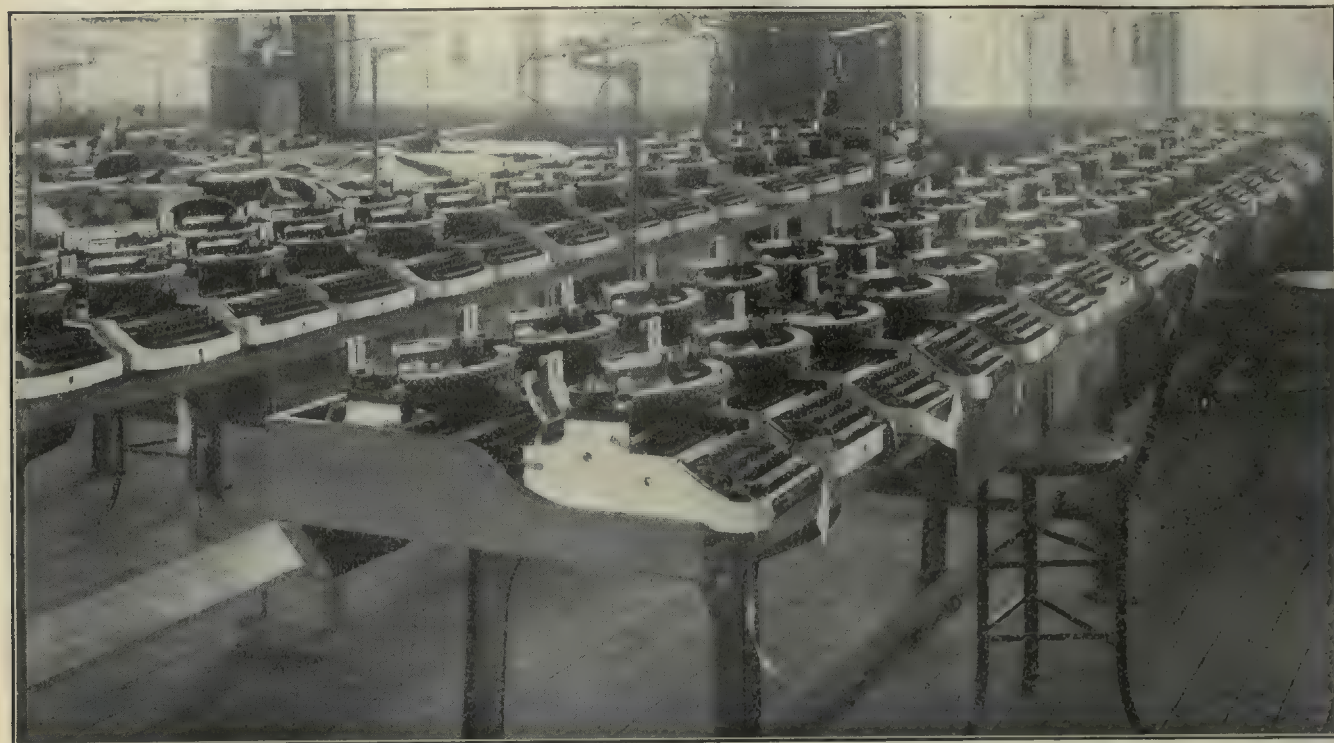


FIG. 2. TYPEWRITERS READY FOR ASSEMBLING OF TYPE BARS IN PLACE

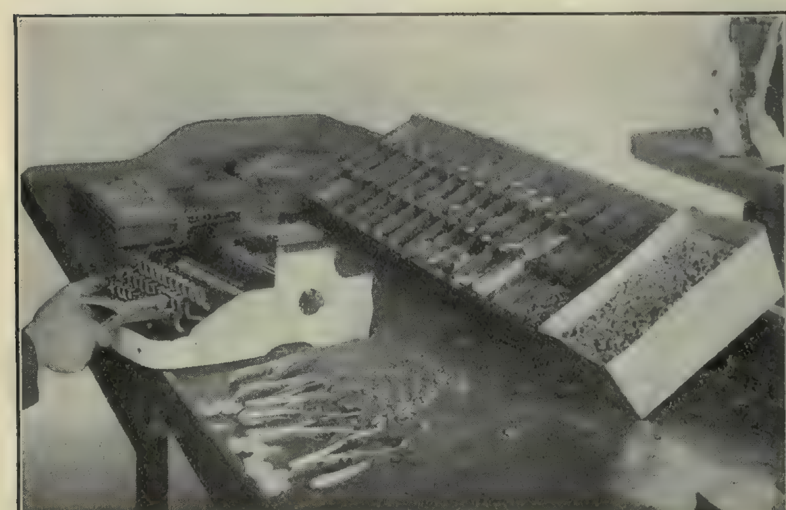


FIG. 3. FASTENING THE FINGER PADS TO THE KEYS BY MEANS OF PLIERS

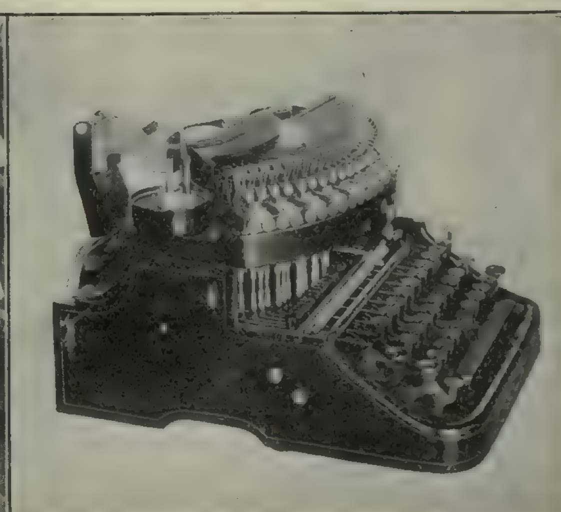


FIG. 4. TEST INDICATOR FOR ADJUSTING TYPE-BAR BRACKETS

types themselves on the bars have already been tested for printing in a preliminary gage, as previously described. The alignment in this machine—that is, the advancement in this machine to an absolute definite maximum forward position—is secured within a small fraction of a thousandth of an inch or less by this indicator. The slightest deviation, either ahead or back from the predetermined position to which each type shall move, is established absolutely by the indicator pointer whose fluctuation magnifies the deviation in the type-bar position a great many times. This makes it possible to locate these type-bar carrying brackets so that in operation the type are all dead in line and will apply a uniform degree of pressure upon the paper when backed up by the printing platen on the carriage of the assembled machine.

Referring back to the other views in this article, it will be seen that the typewriter frames are protected all through the assembling process, so long as they have to be handled to any extent, by means of a wrapper extending completely around the frame. This material is in its texture somewhat similar to heavy blotting paper, but is very much tougher. It has a soft absorbent surface and is so thick that it is impossible to bruise the frame by any ordinary degree of carelessness. The material is cut out to the exact form of the frame and held in place by a suitable clip, so that tools and other typewriter parts cannot possibly come in contact with the enameled surface of the frame. This saves a great deal of time and expense that would otherwise be necessary in going over frames that have become scratched or otherwise marred through the many handling processes in assembling the various parts in their respective positions.

Measuring an Odd-Tooth Gear

By Robin Duff

A few days ago 200 gears were to be ground, with 25 teeth of a special shape. There was a shaft integral with the gear, and this shaft was to be ground also. The limit of inaccuracy on the outside diameter of the gear was 0.001 in. The odd number of teeth made it impossible to measure with a micrometer the direct diameter, and an attempt to measure across two teeth obliquely did not give reliable results.

The manner in which the gears were ground was, first, cutting off a piece of round stock the same length as the gear and its integral shaft; then the temporary piece was ground to the size of the gear diameter, as given by the blueprint. The gear was put on centers in the machine, and by drawing in the grinding wheel to the crossfeed stop, as determined by the trial piece, the operator was able to get the first gear to the same diameter as the trial piece. Setting the trial piece on centers in a lathe and fastening a dial indicator in the tool post, so that it registered zero while against the piece, made it possible to machine the gears to the correct diameter.

The teeth of the gears had previously been given a roughing, or gashing, cut preparatory to a finishing cut after grinding. It may be that they were to be held in a bushing while cutting. As there was no certainty that the depth of the roughed-out teeth was uniform, a tentative diameter could not be derived by the usual method of measuring with a micrometer an additional wire inserted in a tooth space.

The indications are that a number of these gears will be obtained soon to grind for the same firm. How shall we arrange to measure the outside diameter accurately and more rapidly?

Magazine Feed on B. & S. Automatics

By H. A. Burns

Some months ago I was given the task of producing primer bodies from stampings. Hand screw machines had been ordered particularly for the work but the makers were late in delivering. The only machines available in the shop at that time were twelve No. 2 B. & S. automatic screw machines which were making needle holders for the No. 80 fuse.

Until such time as the screw machines arrived, I decided to take over six of the B. & S. automatics and use them as semiautomatic machines, there being a difficulty in the way of using them automatically owing

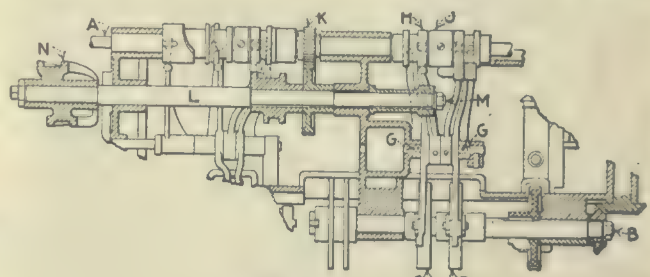


FIG. 1

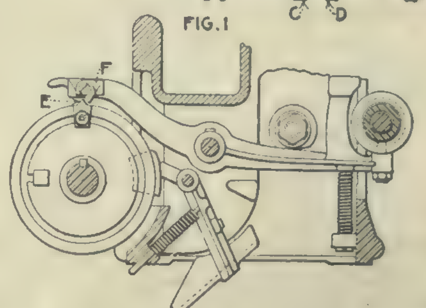


FIG. 2

FIG. 3

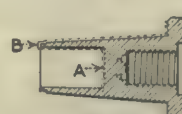


FIG. 4

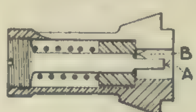


FIG. 5

FIG. 6

FIGS. 1 TO 6. DETAILS OF THE MAGAZINE FEED

Fig. 1—Collet opening and closing mechanism. Fig. 2—Arrangement of tripping device. Fig. 3—Detail of sleeve. Fig. 4—Primer body. Fig. 5—The collet. Fig. 6—The stop

to the short length of time available for placing the work in the collet. The machines are so built that the collet opens, the work is fed forward and collet closes again in 1 sec. This leaves only about 1/3 sec. to feed the magazine forward and insert the work into the collet. This was overcome in a simple manner; but before explaining the method it may be advisable to explain the working of the collet opening and closing mechanism.

Referring to Fig. 1, *A* is the driving shaft from which the camshaft *B* obtains its motion. The shaft *B* carries in addition to the cross-slide cams, two drums *C* and *D*, which actuate the collet opening and closing mechanism and turret-turning mechanism respectively. The drum

C carries adjustable cams as shown at E, Fig. 2. When E passes the dog F on the lever, it lifts the lever which is fulcrumed at G (Fig. 1) and so frees the clutch H, which by means of springs is immediately moved lengthwise into gear with the clutch J, which is keyed to the driving shaft.

The clutch H therefore revolves, carrying with it the gear K, which in turn rotates the shaft L, the gear ratio being such that for two revolutions of the driving shaft A, the shaft L makes one revolution. The shaft L carries on one end a sleeve M and on the other a cam N which actuates the opening and closing mechanism, and is so arranged that during the first half revolution it opens the collet and during the second half revolution it closes the collet. On M there is a flat and when the sleeve has turned one complete revolution, the lever again rests on this flat and at the same time disengages the clutch H.

It will be understood from the explanation that if the shaft L is stopped when it has made half a revolution the collet will be open and remain so until the remaining half revolution is made.

Now in order to do this all that is required is to mill another flat on the sleeve M, as shown dotted in Fig. 3. The shaft L (Fig. 1) then only makes half a revolution when the lever falls on the flat and prevents it from rotating further by disengaging the clutch H. In this position the collet remains open until another adjustable cam on the drum C lifts the lever and allows the shaft L to make another half revolution, which also turns the cam N and so closes the collet. This then enables the machine to be used, taking full advantage of all the automatic movements. The following illustrations will show how the primer was made.

Method of Operation

The stamping shown in Fig. 4 was finished off on the faces where the dotted line appears and only required the head forming to size and the tapped hole formed from solid. The thickness of the metal wall between the two holes was the limiting factor.

The feed tube and the feed finger were taken out of the machine and the collet, Fig. 5, and the stop, Fig. 6, were used. A magazine was made and fastened to the back toolpost on the cross-slide and was fed forward to the center of the spindle while the collet was open.

The stop, Fig. 6, advanced and pushed the primer into the collet until the face A, Fig. 4, of the primer came in contact with the positive stop A, Fig. 5, in the collet, at the same time the face B, Fig. 4, of the primer pushed back the bushing in the collet and compressed the spring.

Immediately the surfaces A came into contact the stop spring was compressed if there was too much lift on the cam. The primer was held in this position until the collet was closed and then the magazine and stop retreated and made way for the other turret tools and the forming tool, which automatically followed each other in quick succession.

After all the operations were finished, the collet opened and the primer was ejected by expansion of the spring in the collet and the only thing required was to fill the magazine and carry away the finished primer bodies as they came from the machine. In this manner the work was produced rapidly with only a slight change in the machines which were at hand.

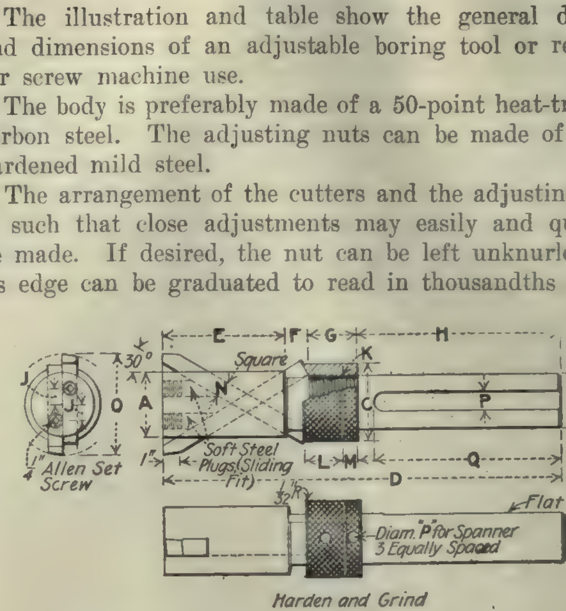
Adjustable Boring Tool

By R. F. Nowalk

The illustration and table show the general design and dimensions of an adjustable boring tool or reamer for screw machine use.

The body is preferably made of a 50-point heat-treated carbon steel. The adjusting nuts can be made of case-hardened mild steel.

The arrangement of the cutters and the adjusting nut is such that close adjustments may easily and quickly be made. If desired, the nut can be left unknurled, or its edge can be graduated to read in thousandths of an



Inches	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1½-2																	
1⅛-1⅝	1	¾	1 3/32	6	1 7/8	5/16	¾	3 7/16	3/16	¼	7/8-16	9/16	¼	¼	1½	¼	2 7/8
¾-1⅛	¾	½	25/32	4 11/16	1 3/8	¼	¾	2 5/16	3/16	1/8	9/16-20	½	¼	¼	1⅛	3/16	2 7/8
½-¾	3/8	5/16	15/32	3 9/16	7/8	3/16	½	2	3/16	–	3/8-20	3/8	¼	1/8	¾	3/16	1¾

ADJUSTABLE BORING TOOL FOR SCREW MACHINES

inch. Owing to the fact that the cutters are clamped near the cutting ends, short pieces of square rolled stock can replace the cutters at the ends next the adjusting nut. In this way, short high-speed steel bits might be used.

The machining of the square holes presents no serious difficulty, and those made up were first drilled in a drill press and later filed out. Of course, should it be desired to make up a quantity, it would be better to go to the expense of tooling up for broaching these holes.

After hardening, the cutters should be assembled in the tool and the cutting edge ground with the holder on centers. If the tool is to be used for a reamer, it may have the clearance ground on it while in the grinder, or if used for a boring tool, it may be backed off in the grinder.

Cutting a Perfect Gear with a Broken Cutter

By E. A. Clark

While cutting an 80-tooth three-pitch gear on a Fellows gear shaper, the cutter became caught and one tooth was broken out. As the gear was needed for the completion of an order to be shipped at once, we simply continued cutting with the tooth out of the cutter.

By allowing the blank to go around the second time, the broken tooth would come to a place that was already cut, and the part of the cutter that was intact would cut the space that the broken tooth had left. By making two revolutions instead of one, the gear was cut, and it appeared to be as good a finished wheel as if the cutter had been perfect.

United States Munitions*

The Springfield Model 1903 Service Rifle

The Cocking Piece

SYNOPSIS—Although a small part the cocking piece plays an important part in the firing mechanism of the rifle. Its manufacture involves the use of several different types of machines, from the automatic to the profiler. It also includes the use of tools and fixtures out of the ordinary as well as special grooving tools and gages. The profiling of the point and the cutting of the cam which draws back the firing pin are very particular operations.

The cocking piece is made from a drop forging of Class D material, 0.56 in. square. This, as the name implies, holds the firing pin in a cocked position and, together with the firing-pin rod, constitutes the unit known as the firing pin. The main parts of the cocking piece are the body *B*, the knob *C*, the lug *D*, the cocking cam *E*, the nose *F*, the sear notch *G*, the locking shoulder *H* and the locking groove *I*, Fig. 891.

The cam on the side of the point is quite a particular piece of work as it is this inclined surface which forces the whole firing-pin assembly back into the firing or cocked position as the bolt is given a quarter turn. It is prevented from turning by the point or tongue sliding in a suitable slot in the sleeve. This cam is cut to a lead of one turn in 2.5 in., and seems quite steep for such a purpose. It works out admirably in practice, however, which is the final test of any design or method.

Great care is taken, however, to have the surface of this cam perfectly smooth. To this end the milling receives very careful attention and it is difficult to find a finer or smoother job of formed or irregular milling in any shop. A nine-toothed cutter, Fig. 936, running at 900 r.p.m. is used in milling this cam, and this together with the careful use of cutting oil leaves a splendid surface, which is quite important at this point.

Another particular point is the sear notch, this controlling the action of the trigger in releasing the firing pin and striker and exploding the powder charge in the cartridge. The smooth action of the trigger depends on the surfaces of the cocking piece and of the sear, and these are carefully honed with an oilstone to insure the desired smoothness of action under the pressure of the mainspring.

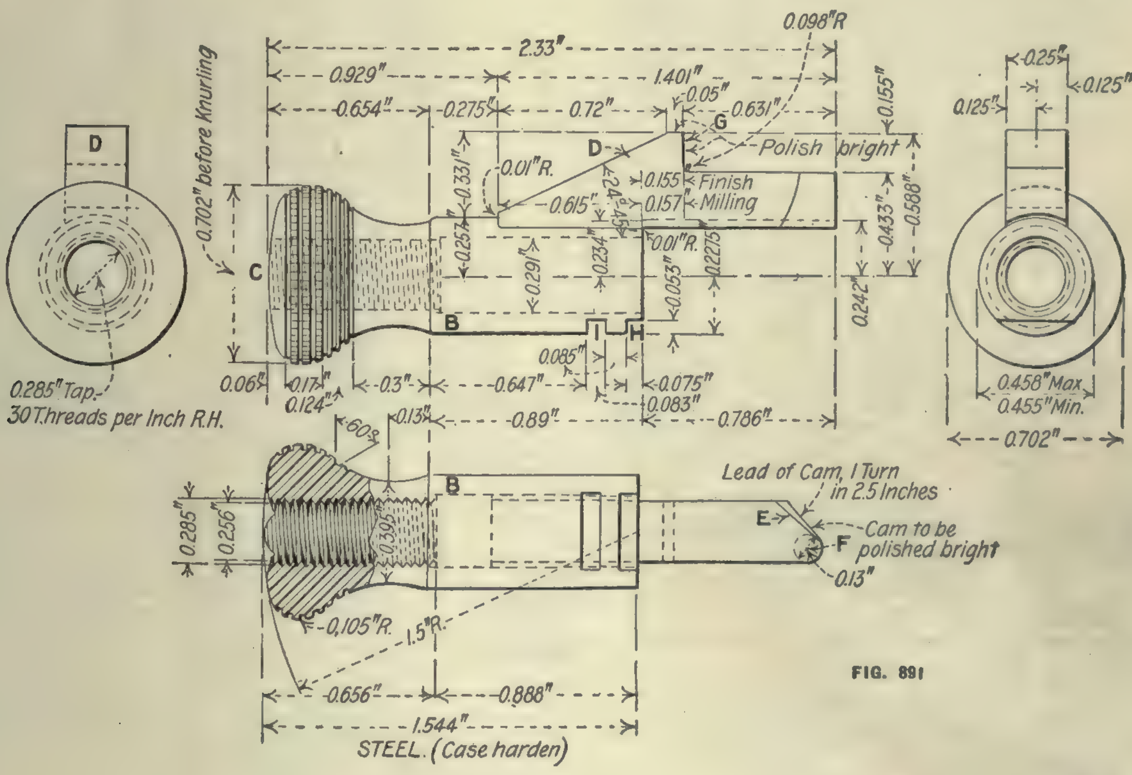


FIG. 891

Besides the two points already mentioned the front surface of body is important in its relation to the total distance from the point of the striker. This face fits against the interior shoulder of the sleeve and the sleeve screws in the bolt, so that the distance the point of the striker will project through the hole in the front end of the bolt depends on a number of factors.

It requires very careful gaging to be sure the assembled distance is correct and is one of the reasons for the final hand facing cutter and its fixture, shown in Fig. 728,

operation 45½ on the bolt itself. These parts tie together so closely, in the final assembly and in the correct working of the rifle, that they can almost be considered as a unit.

The method of countersinking the back end of the knob for riveting over the firing pin rod is both simple and efficient. A five sided punch, forced into the hole in a punch press, gives ample space for riveting the end of the pin and also locks it securely against turning.

Operation
13 Milling sear notch to finish
15 Polishing outer surface except rear end and sear notch
16 Filing, general
17 Casehardening
18 Polishing sear notch
18½ Polishing cocking cam
19 Finishing; honing surface under sear notch

OPERATION A. FORGING FROM BAR

Transformation—Fig. 892. Number of Operators—One. Description of Operation—Breaking down and blocking to shape. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—125 per hr.

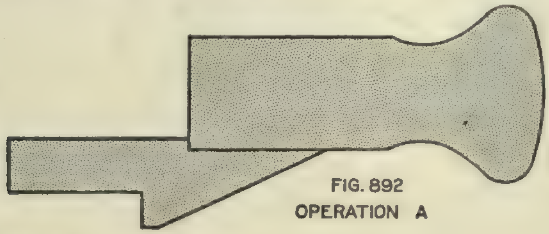


FIG. 892
OPERATION A

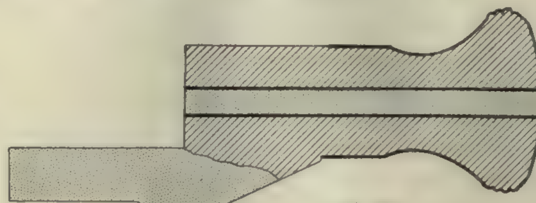


FIG. 893

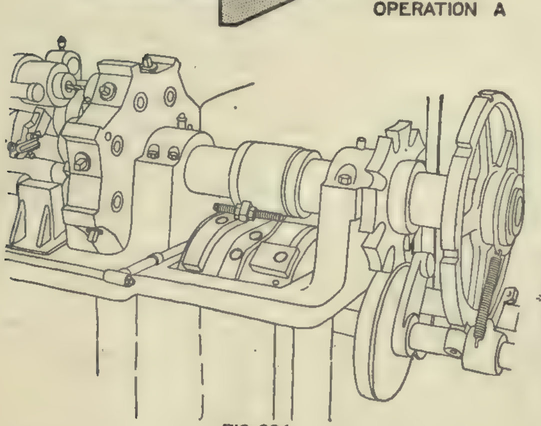


FIG. 894

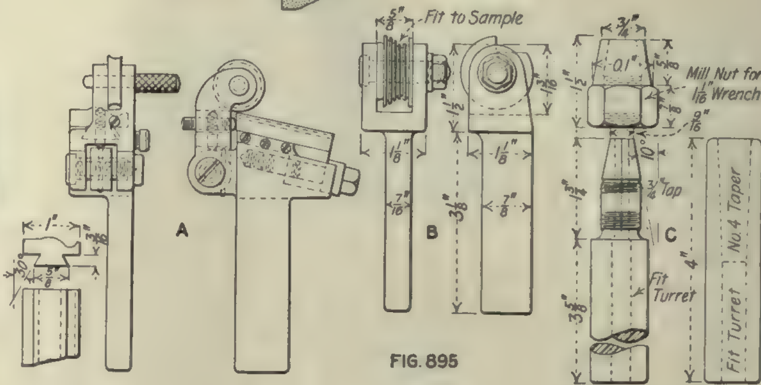


FIG. 895

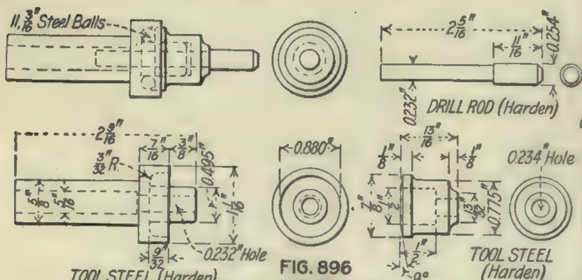


FIG. 896

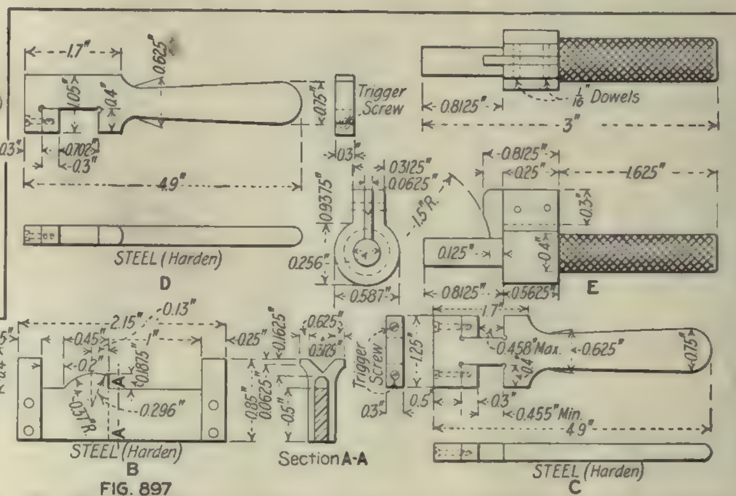
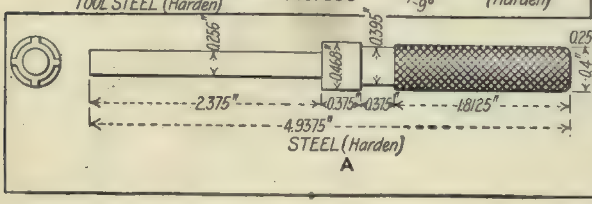



FIG. 897
OPERATION 1

This is a much more simple method than we find employed in some other cases, but it answers every purpose and ought to be applicable to other kinds of work.

OPERATIONS ON COCKING PIECE

Operation
A Forging from bar
B Annealing
3-1 Pickling
C Trimming
D Grinding head
1 Drilling, reaming, facing, grooving, turning and knurling
2 Counterboring front end to length
4 Milling left side to finish
3 Milling right side to finish } 3, 4 and AA grouped
AA Reaming burrs left by operation 4
5 Milling front across bottom and rear of lug to finish
BB Removing burrs left by operation 5
CC Burring (group 5, BB, CC, 11 and DD)
11 Swaging
DD Removing burrs left by swaging
7 Profiling nose to finish
12 Hand-milling, freeing cut to top of tang (12 and EE grouped)
EE Removing burrs left by operation 12
9 Counterboring, firing-pin body size
8 Milling cam
6 Milling safety-lock notches
10 Tapping firing-pin hole

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots with powdered charcoal; heated to 850 deg. C. (1,562 deg. F.) in Brown & Sharpe annealing furnaces; left overnight to cool. Apparatus and Equipment Used—Iron pots, Brown & Sharpe annealing furnaces.

OPERATION 3. PICKLING

Number of Operators—One. Description of Operation—Placed in the pickling solution and left about 10 min.; the pickling solution is 1 part sulphuric acid to 9 parts water. Apparatus and Equipment Used—Wire baskets, cast lead tanks and pulley block.

OPERATION C. TRIMMING

Machine Used—Bliss press. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch holder. Dies and Die Holders—Die set in shoe held by setscrew. Stripping Mechanism—Pushed through die. Production—600 per hr.

OPERATION D. GRINDING HEAD

Number of Operators—One. Description of Operation—Grinding head to allow for spotting. Apparatus and equipment Used—Abrasive wheel. Production—1,000 per hr.

OPERATION 1. DRILLING, REAMING, FACING, GROOVING, TURNING AND KNURLING

Transformation—Fig. 893. Machine Used—New Britain automatic. Number of Operators per Machine—One. Work-Holding Devices—Held by two-jaw chuck, Fig. 894. Tool-Holding Devices—Chuck on spindle of machine. Cutting Tools

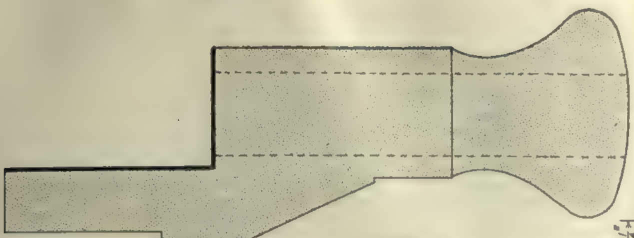


FIG. 898

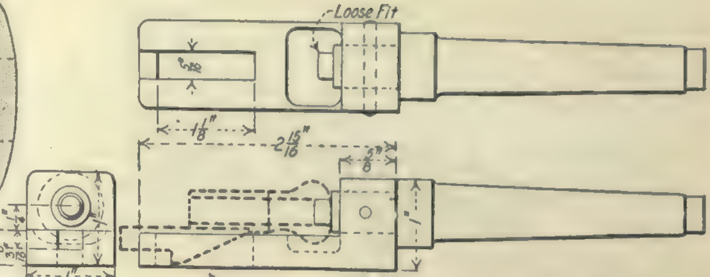


FIG. 900

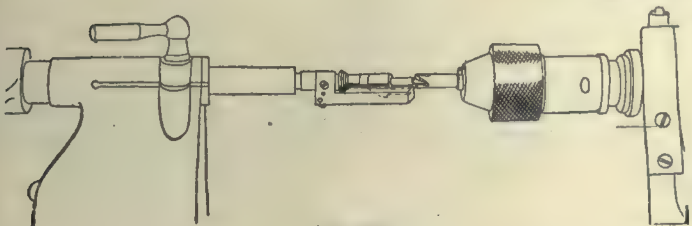


FIG. 899

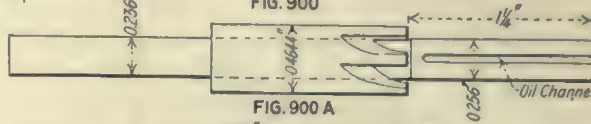


FIG. 900 A

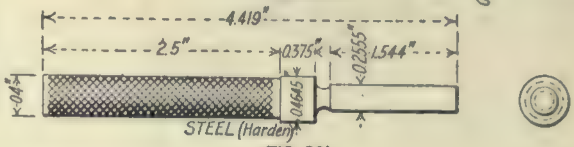


FIG. 901

OPERATION 2

—Fig. 895; A, forming tool; B, circular grooving tool for head; C, drill chucks and collet. Number of Cuts—Seven. Cut Data—450 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—800 pieces. Special Fixtures—Fig. 896, revolving center. Gages—Fig. 897; A, diameter of hole; B, shape and diameter of neck; C, outside diameter; D, large diameter; E, curve of knob. Production—50 per hr.

OPERATION 2. COUNTERBORING FRONT END TO LENGTH

Transformation—Fig. 898. Machine Used—Pratt & Whitney 12-in. speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Held in centering fixture, Fig. 899, on tailstock, guided by pilot; details in Fig. 900. Tool-Holding Devices—Drill chuck. Cutting Tools—Fig. 900-A, counterbore. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 901, diameter and depth of counterbore. Production—50 per hr.

OPERATIONS 3 AND 4. MILLING RIGHT AND LEFT SIDES TO FINISH

Transformation—Fig. 902. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—On stud clamped by vise jaws, Fig. 903; details in Fig. 904; both vise jaws moved by one cam. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 905, milling cutter. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—3,000 pieces. Gages—Fig. 906; A, width and central location of nose; 906-B, diameter of barrel; 906-C, radius of body. Production—100 per hr.

OPERATION AA. REAMING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Reaming burrs thrown up by operations 3 and 4. Apparatus and Equipment Used—Hand reamer, Fig. 907. Production—Grouped with operations 3 and 4.

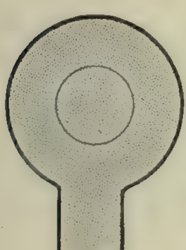


FIG. 902

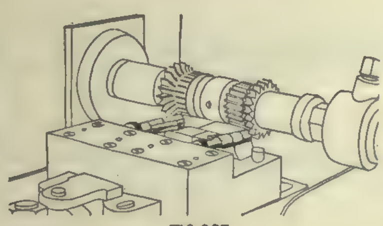


FIG. 903

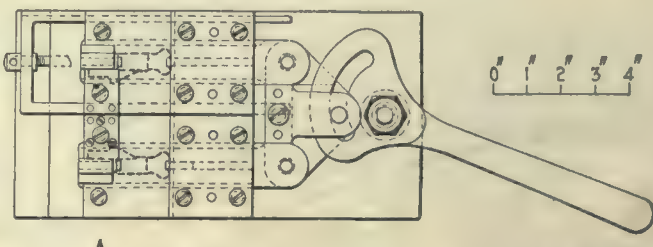
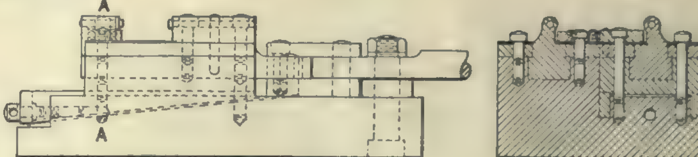


FIG. 904



Section A-A

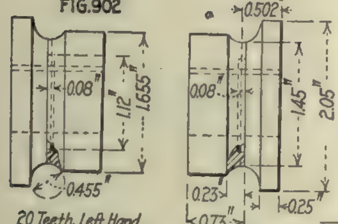


FIG. 905

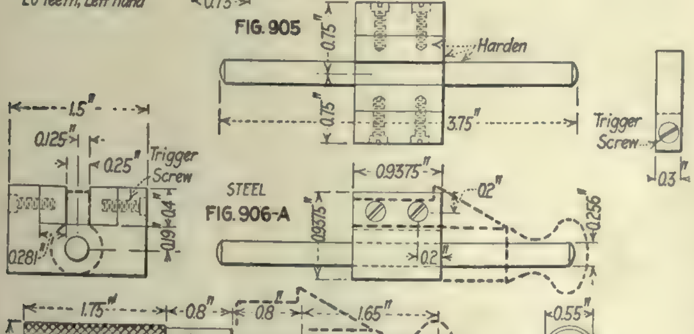


FIG. 906-A

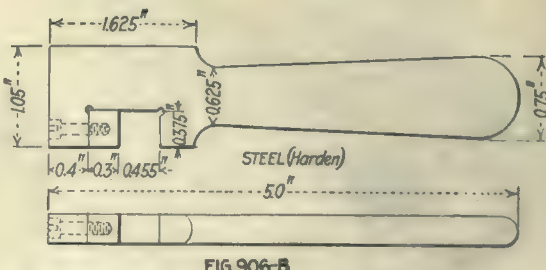


FIG. 906-B

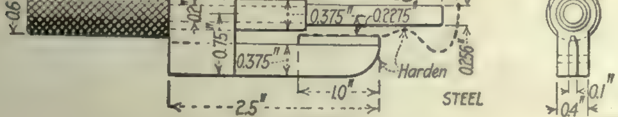


FIG. 906-C

OPERATION 3 & 4

FIG. 907

FIG.908

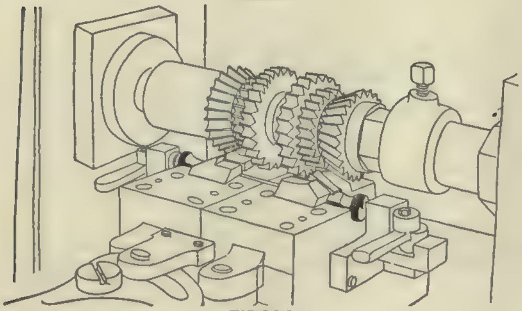


FIG.909

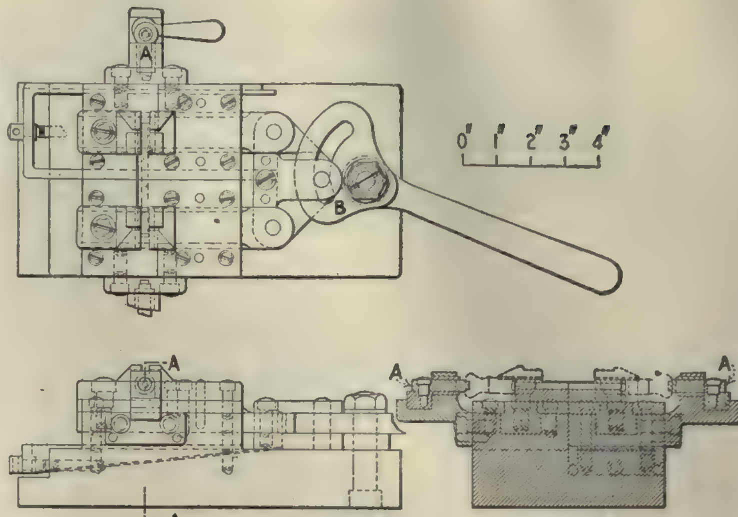


FIG.910 Section A-A

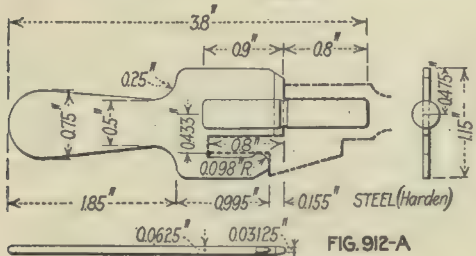
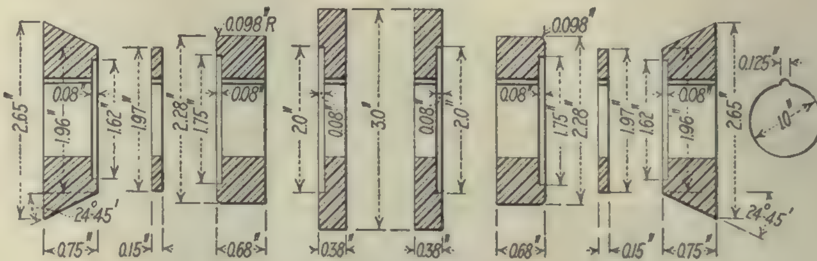


FIG. 912-A



26 Teeth, Left Hand

FIG. 911

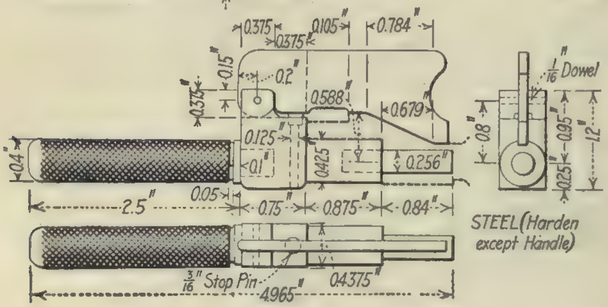


FIG. 912-B

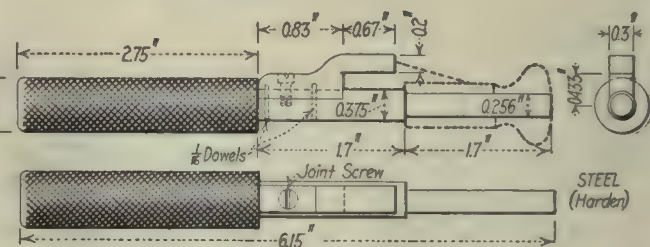


FIG. 912-C

OPERATION 5

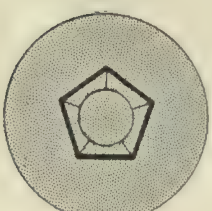


FIG.913

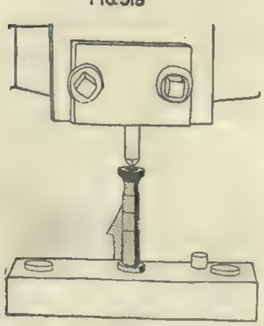


FIG.914

FIG. 915

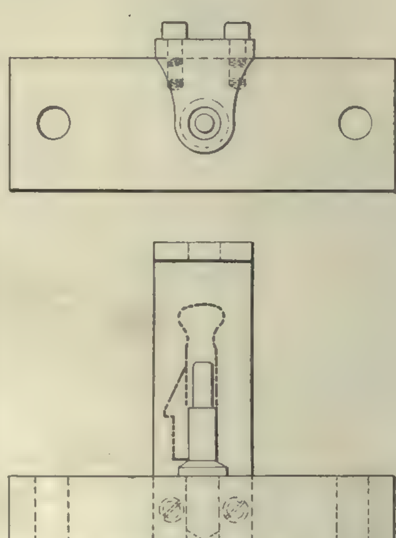


FIG.916

OPERATION 11

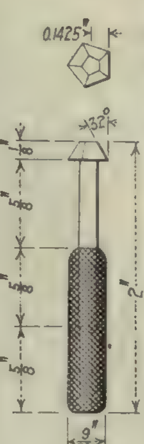


FIG.917

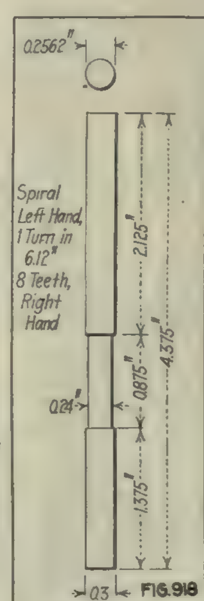


FIG.918

OPERATION DD

OPERATION 5. MILLING FRONT ACROSS BOTTOM AND REAR OF LUG TO FINISH

Transformation—Fig. 908. Machine Used—Pratt & Whitney No. 2 Lincoln type. Number of Operators per Machine—One. Work-Holding Devices—On studs clamped by vise jaws, Fig. 909; studs are shown at A, Fig. 910, which also shows the side clamping by means of a single cam B. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 911, two gangs. Number of Cuts—One. Cut Data—Speed, 60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,000 pieces. Gages—Fig. 912; A, sear notch; B, rear of lug, finger is pivoted; C, location of lug, notch and counterbore. Production—100 per hr.

OPERATION 11. SWAGING

Transformation—Fig. 913. Machine Used—Pratt & Whitney 12-in. swaging press, Fig. 914. Number of Operators per Machine—One. Punches and Punch Holders—Swaging punch, Fig. 915. Dies and Die Holders—Cast-iron block, screwed to back of press, with pin for centering work, Fig. 916. Average Life of Punches—3,500 pieces. Dies—Same. Gages—Fig. 917, shape and depth. Production—75 per hr.

OPERATION DD. REMOVING BURRS LEFT BY SWAGING

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 11. Apparatus and Equipment Used—File and reamer, Fig. 918.

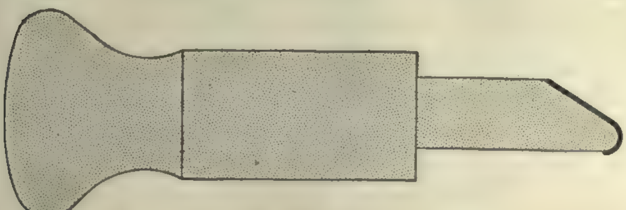


FIG. 919

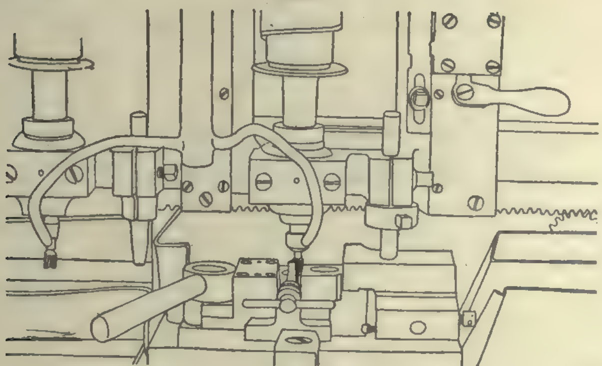
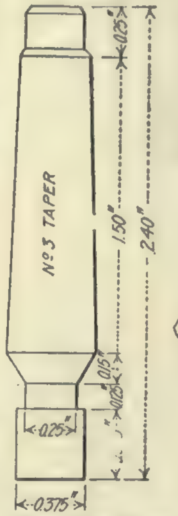


FIG. 920



6 Teeth, R.H. on Face only
FIG. 922

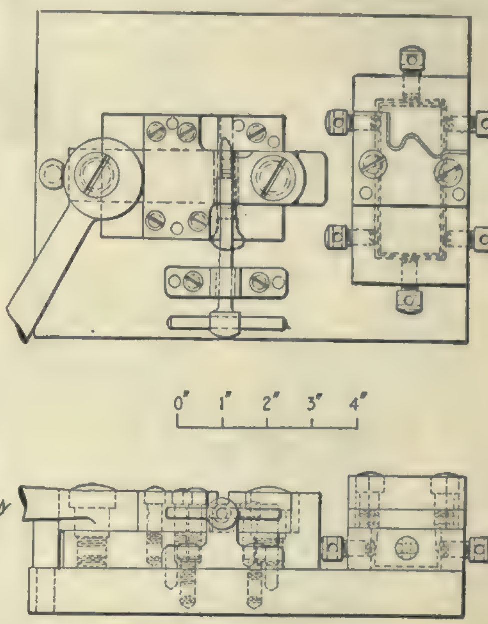


FIG. 921

OPERATION 7

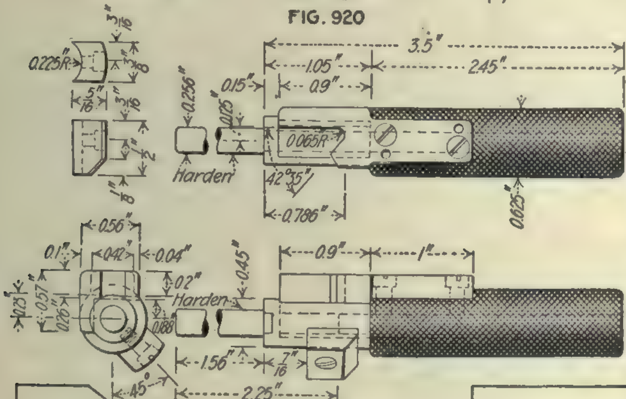


FIG. 923

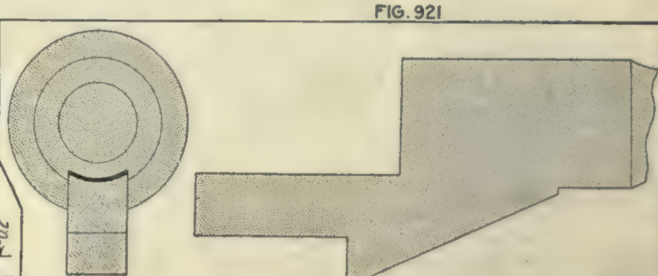


FIG. 924

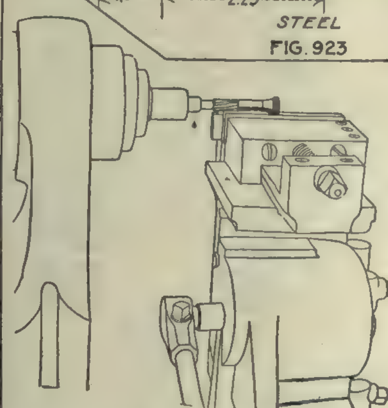


FIG. 925

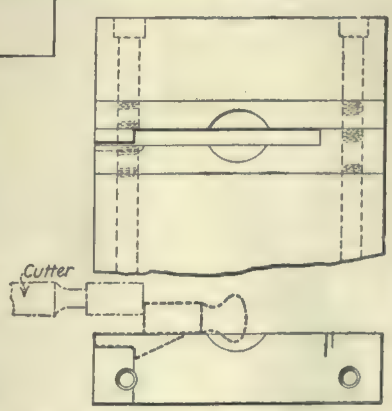
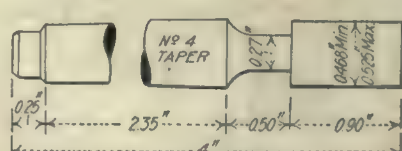


FIG. 926



8 Teeth, R.H. Spiral L.H. 1 Turn 10.50"
FIG. 927

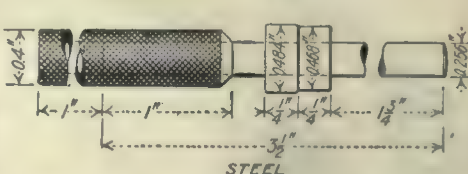


FIG. 928

OPERATION 12

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operation 5.

OPERATION CC. BURRING

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 3 and 4. Apparatus and Equipment Used—File. Production—Grouped with operations 5, 11, BB, CC and DD.

OPERATION 7. PROFILING NOSE TO FINISH

Transformation—Fig. 919. Machine Used—Pratt & Whitney No. 1 profiler, Fig. 920. Number of Operators per Machine—One. Work-Holding Devices—Held on stud clamped by vise jaw, Fig. 921. Tool-Holding Devices—Taper Shank. Cutting Tools—Milling cutter, Fig. 922. Number of Cuts—Two. Cut Data—Speed, 1,200 r.p.m.; hand feed. Coolant—Compound. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 923, length and form. Production—75 per hr. Note—The use of a mandrel for supporting the work again comes into play, as can be seen in Figs. 920 and 921.

OPERATION 12. HAND-MILLING, FREEING CUT TOP OF TANG

Transformation—Fig. 924. Machine Used—Garvin No. 3 hand miller, Fig. 925. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 926. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 927. Number of Cuts—One. Cut Data—Speed, 600 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 928, radius of tang. Production—300 per hr.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 12

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 12. Apparatus and Equipment Used—File. Production—Grouped with operation 12.

Fig. 936. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 937, length and shape. Production—50 per hr.

OPERATION 6. MILLING SAFETY-LOCK NOTCHES

Transformation—Fig. 938. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Stud A, Fig. 939; clamped sidewise by screw B, while cam C forces the work on stud; details in Fig. 940. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 941; two thin milling cutters A, separated by a collar B. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—4,000 pieces. Gages—Fig. 942; A, width of notches; 942-B, location of notches. Production—100 per hr.

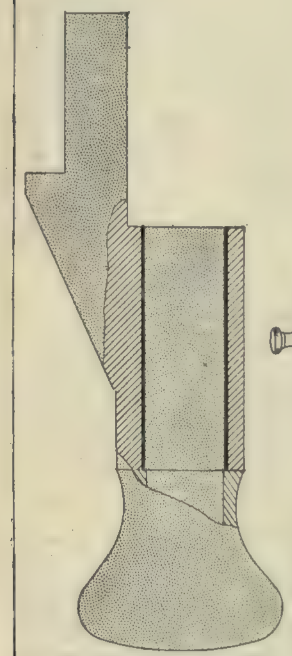


FIG. 929

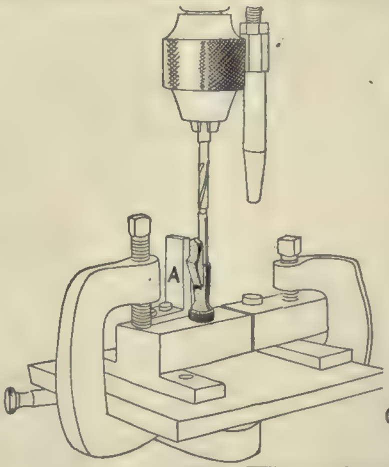


FIG. 930

OPERATION 9

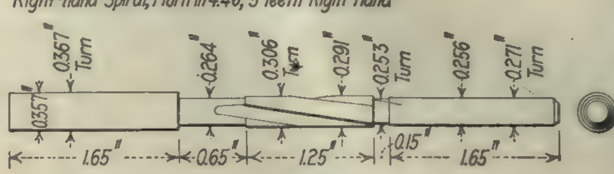
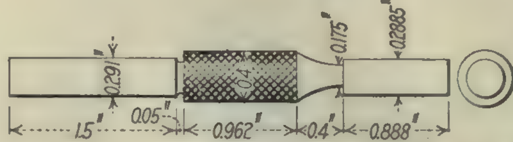


FIG. 931



STEEL (Harden)

FIG. 932

FIG. 933

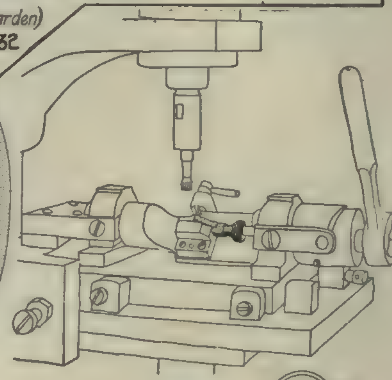


FIG. 934

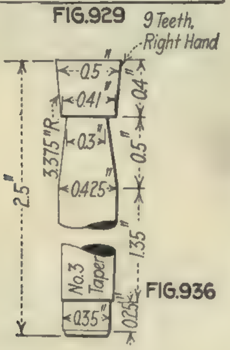


FIG. 936

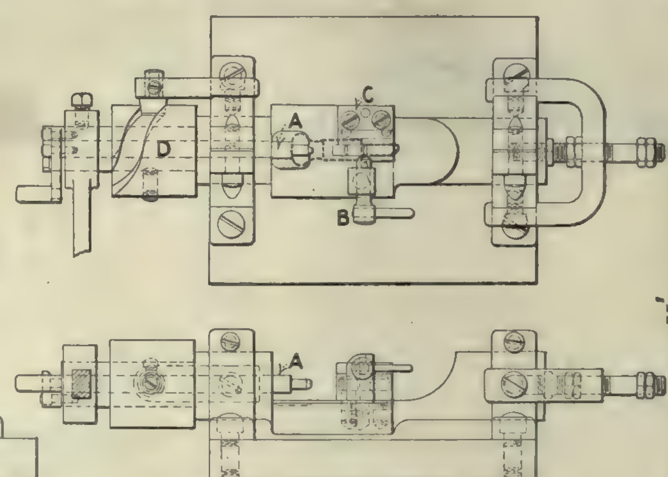


FIG. 935

OPERATION 8

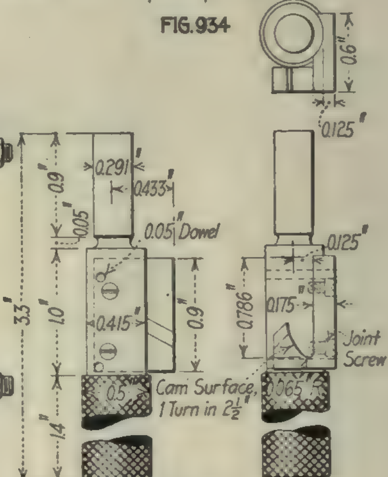


FIG. 937

OPERATION 9. COUNTERBORING, FIRING-PIN BODY SIZE

Transformation—Fig. 929. Machine Used—Ames 16-in. three-spindle upright. Number of Operators per Machine—One. Work-Holding Devices—Set on stud in block clamped to table, prevented from turning by stop A, Fig. 930; pilot of reamer enters block below work. Tool-Holding Devices—In drill chuck. Cutting Tools—Fig. 931. Number of Cuts—One. Cut Data—260 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 932. Production—120 per hr.

OPERATION 8. MILLING CAM

Transformation—Fig. 933. Machine Used—Ames 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Held on rotating fixture, Fig. 934; details in Fig. 935; work is held on stud A and clamped by screw B against block C; guided in rotation by cam D. Tool-Holding Devices—Taper shank. Cutting Tools—End mill,

OPERATION 10. TAPPING FIRING-PIN HOLE

Transformation—Fig. 943. Machine Used—Pratt & Whitney 14-in. tapping machine. Number of Operators per Machine—One. Work-Holding Devices—Fixture on tailstock, Fig. 944; work lies in holder A; notch prevents its pulling out on withdrawal of tap. Tool-Holding Devices—Tap screw chuck. Cutting Tools—Fig. 945. Number of Cuts—One. Cut Data—300 r.p.m. Coolant—Cutting oil. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 946, plug gage for thread. Production—200 per hr.

OPERATION 13. MILLING SEAR NOTCH TO FINISH

Transformation—Fig. 947. Machine Used—Pratt & Whitney Lincoln type No. 2. Number of Operators per Machine—One. Work-Holding Devices—Held upright on stud clamped on tang by jaws, Fig. 948; details in Fig. 949. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 950. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Compound,

¼-in. stream. Average Life of Tool Between Grindings—4,000 pieces. Gages—Fig. 951, height. Production—100 per hr.

OPERATION 15. POLISHING OUTER SURFACE EXCEPT END AND SEAR NOTCH

Number of Operators—One. Description of Operation—Polishing all outer surfaces except end and sear notch. Apparatus and Equipment Used—Polishing jack and wheel. Production—50 per hr.

F.) for 2½ hr.; quench in oil. Apparatus and Equipment Used—Cast-iron pots, oil-fired casehardening furnaces.

OPERATION 18. POLISHING SEAR NOTCH TO REMOVE ROUGHNESS DUE TO CASEHARDENING

Number of Operators—One. Description of Operation—Polishing sear notch to finish. Apparatus and Equipment Used—Polishing jack and wheel. Production—600 per hr.

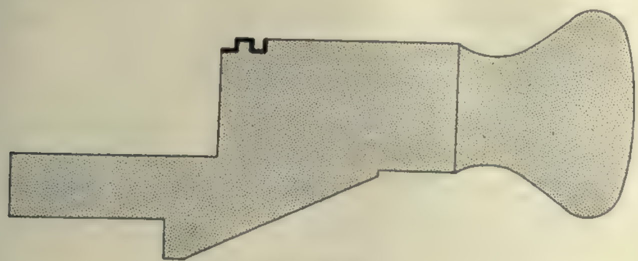


FIG.938

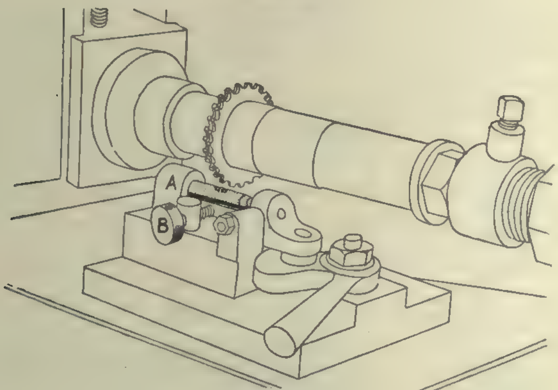
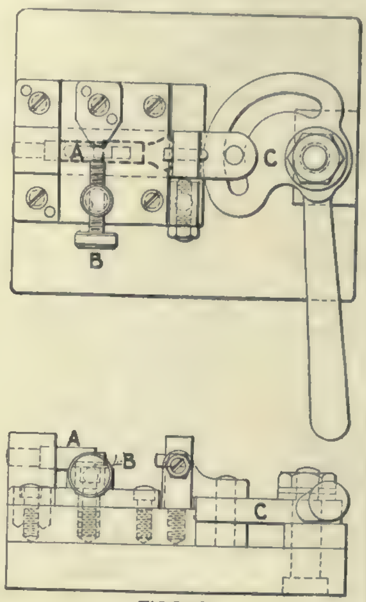


FIG.939



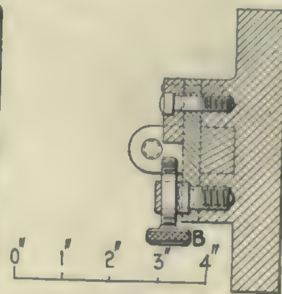


FIG.940

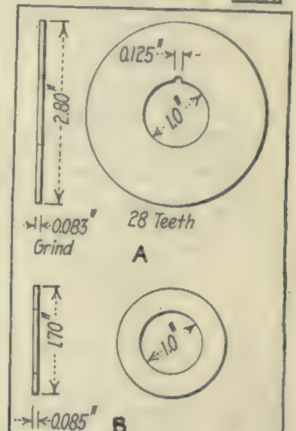


FIG.941

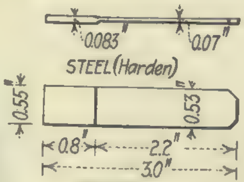


FIG.942-A

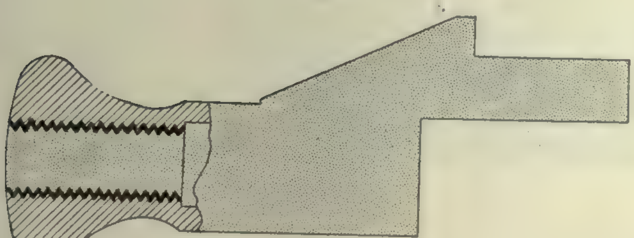


FIG.943

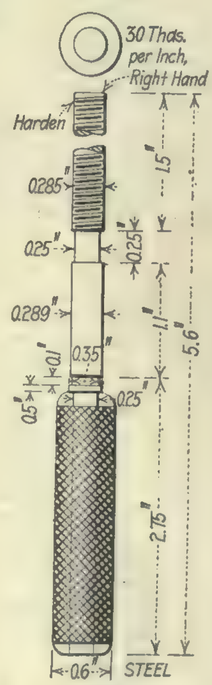


FIG.946

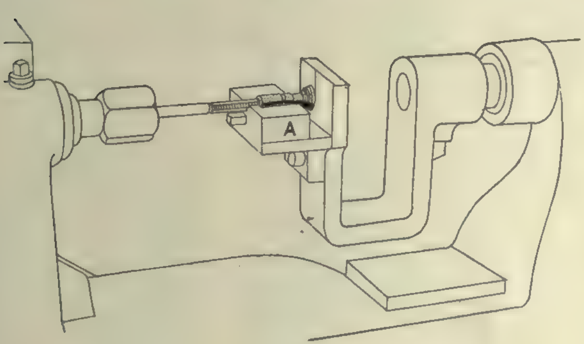


FIG.944

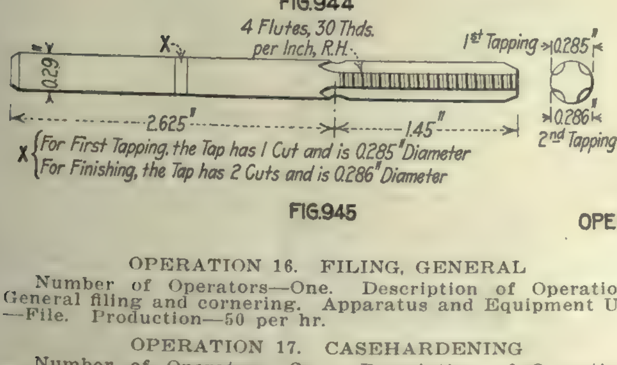


FIG.945

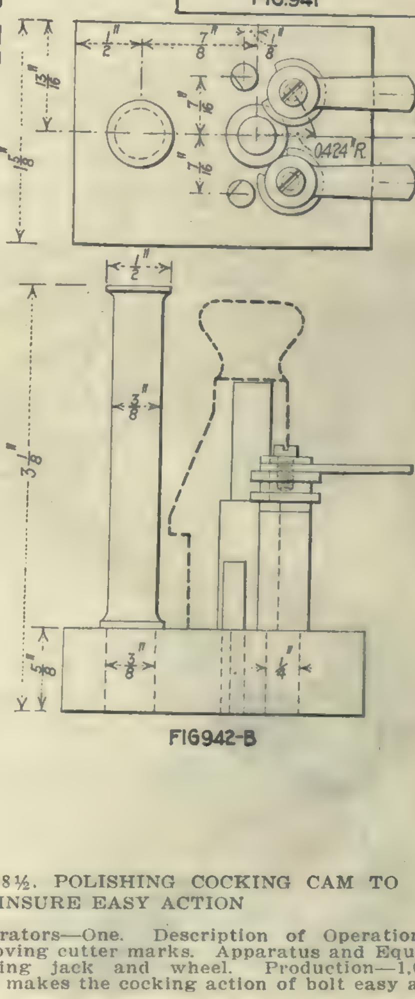


FIG.942-B

OPERATION 6

OPERATION 16. FILING, GENERAL

Number of Operators—One. Description of Operation—General filing and cornering. Apparatus and Equipment Used—File. Production—50 per hr.

OPERATION 17. CASEHARDENING

Number of Operators—One. Description of Operation—Pack in whole new bone, caseharden at 750 deg. C. (1,382 deg.

OPERATION 18½. POLISHING COCKING CAM TO INSURE EASY ACTION

Number of Operators—One. Description of Operation—Polishing cam, removing cutter marks. Apparatus and Equipment Used—Polishing jack and wheel. Production—1,000 per hr. Note—This makes the cocking action of bolt easy and smooth.

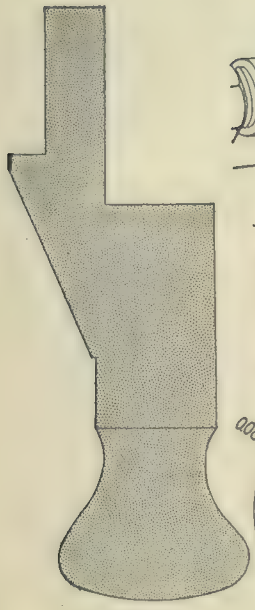


FIG. 947

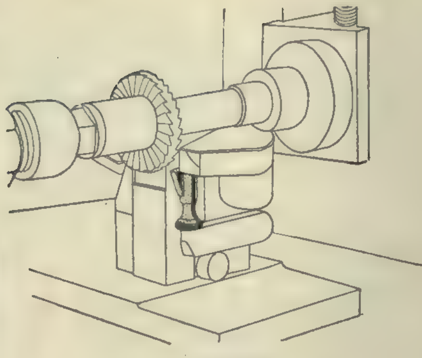


FIG. 948

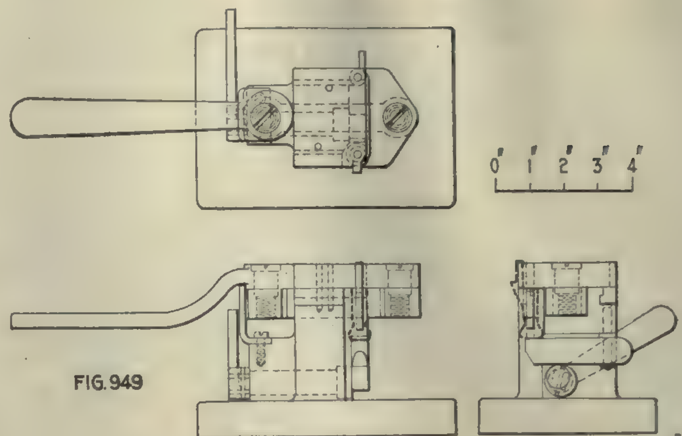


FIG. 949

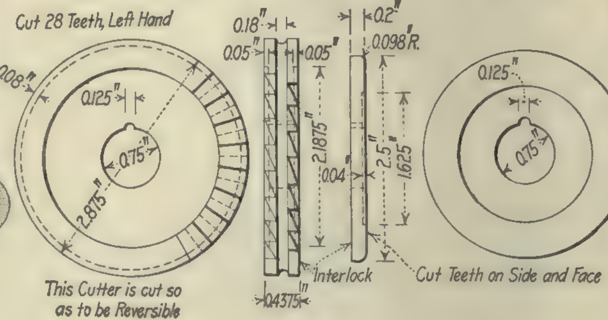


FIG. 950

OPERATION 13

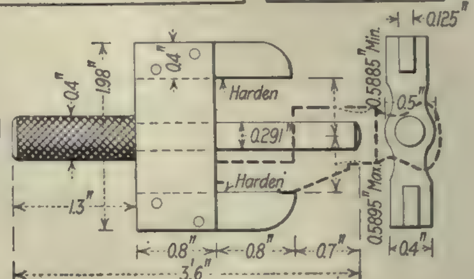


FIG. 951

OPERATION 19. FINISHING; HONING SURFACE UNDER SEAR NOTCH

Number of Operators—One. Description of Operation—Honing point of sear notch. Apparatus and Equipment Used—Oilstone in hand. Production—1,000 per hr.

Firing-Pin Sleeve

The firing-pin sleeve, as shown in detail in Fig. 952, holds the striker in position on the end of the firing-pin rod and is kept in place by the mainspring. It is made of Class D steel. It is entirely an automatic screw-machine job and is finished at one operation except for burring and bluing.

This sleeve is part of an ingenious method of holding the striker in place. The main or firing spring is first slipped over the firing pin rod, then the firing pin sleeve is put over the end of rod. The spring is compressed until the sleeve can slide back far enough to clear the groove in the end of the rod, the striker is slipped in place and the sleeve released. The main spring forces it over the end of the striker, effectually holding it in place, yet allowing it to be easily disassembled by merely compressing the main spring. This form of fastening may and should have other applications in various machine parts.

OPERATION 1. AUTOMATIC TURNING

Transformation—Fig. 953; machining diagram, Fig. 954. Machine Used—Cleveland 1-in. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Fig. 955; A, stop; B, large drill; C, smaller drill; D, counterbore; E, form cutter on cross-slide; F, cutoff on cross-slide. Cut Data—600 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tools Between Grindings—300 pieces. Gages—Fig. 956. Production—30 per hr.

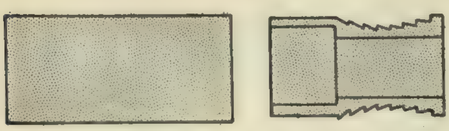


FIG. 953

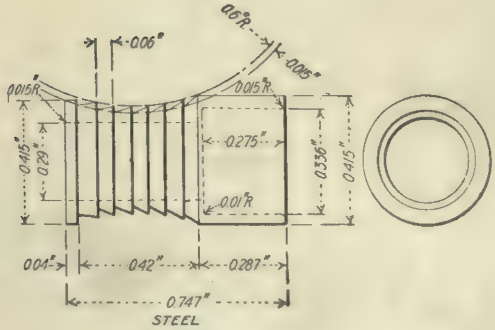


FIG. 952

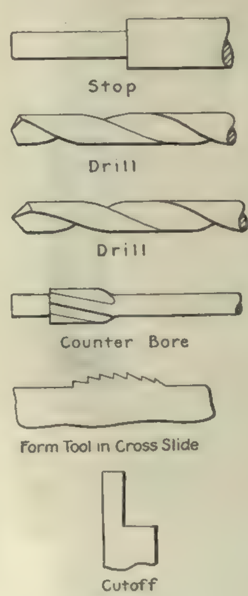


FIG. 954
OPERATION 1

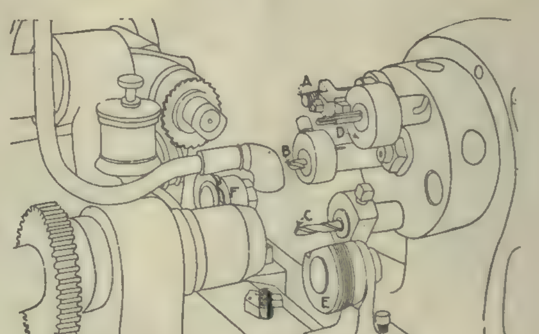


FIG. 955

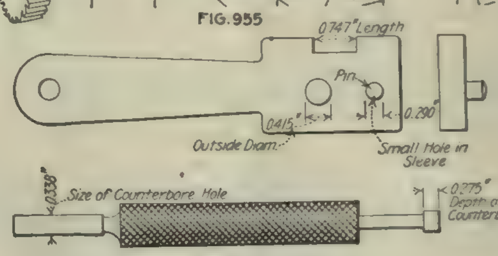


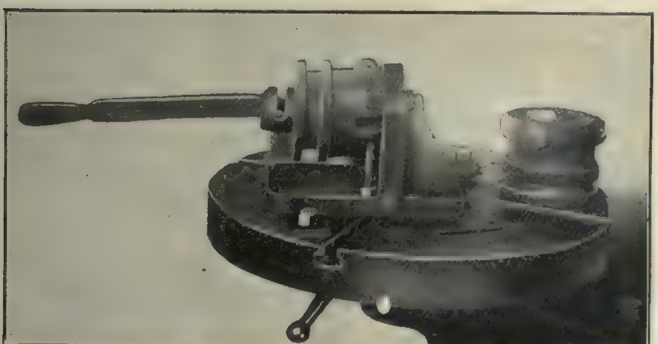
FIG. 956

Letters from Practical Men

Quick-Acting Drill Jig Clamp

Having a great number of sliding clutch sleeves to drill, the jig shown in the accompanying illustration was designed so as to enable these to be handled in a minimum of time. It consists of a heavy angle plate with a projecting stub arbor 3 in. in diameter, the same as the shaft used in the clutch. This was slotted at the end to take in the lever shown. This bent lever had a pin driven through it, this dropping into a slot perpendicular to the axis of the arbor. When it was desired to remove the casting this lever could be entirely lifted out and replaced again.

As shown, this casting had four holes through the two ears at the side. The indexing position was fixed by the vertical pin beneath the ears. When one hole was drilled,



A QUICK-ACTING JIG CLAMP

the lever was merely raised to about 45 deg., when the casting could be slid back enough to index, the lever pushing back again to position for drilling. This clamping arrangement proved quick and simple.

Lima, Ohio. D. O. BARRETT.

Two Types of Adjustable Dies

The covers shown in Fig. 1 were bent over on three sides and were pierced by a nest of holes, central and at a fixed distance from the open end. The width of the covers varied from 6¼ in. to 11¼ in. and the length could be any dimension from 15 in. upward. This decided that the open end had to be pressed against a stop at the required distance from the punches and the width of the die had to be adjustable. The problem was solved by a die with interchangeable stops, as shown in Fig. 2. The baseplate *A* was recessed for the female die *B* which was provided with a stop *D*. Strips *E* and *C*, made out of 1x⅝-in. material, were screwed against the baseplate and were tapped for ½-in. hexagonal stops *F*, as shown, of which there had to be four of each length required. As shown by those marked *G*, the ones not in use were screwed against the inside of the projections of the 1-in. strips and four stops on the outside governed the width of the cover to be punched.

Superficially there is not much against the outfit, but on investigation it was found: (1) The die is expensive as strips *E* and *C* have to be accurate and parallel. The stops have to be neatly shouldered, ground to length and hardened. (2) The changes are limited by the amount of stops. (3) The stops are easily mislaid or lost. (4) It requires time and tools to interchange the stops for

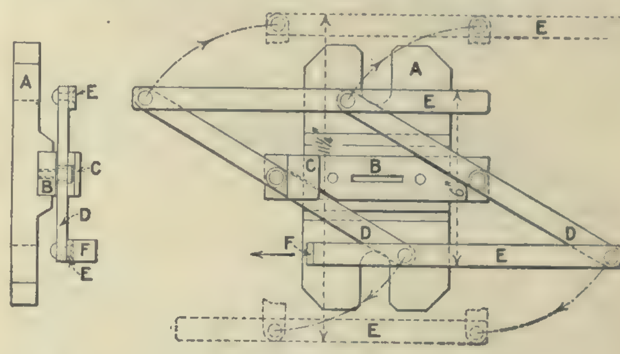


FIG. 3

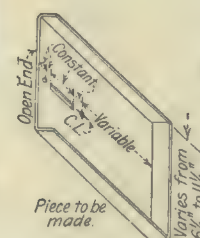


FIG. I

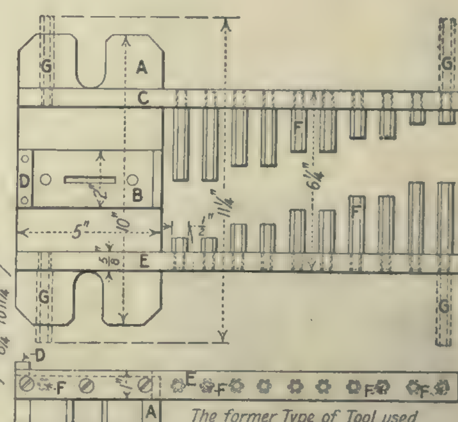


FIG. 2

FIGS. 1 TO 3. THE COVER AND THE TWO DIES
Fig. 1—Piece to be machined. Fig. 2—The former type of tool used. Fig. 3—The improved type of tool

different settings. (5) Absolute accuracy is not guaranteed as there has to be a slight play between the covers and stops and this might cause a slight twisting by the operator. Scale or dirt will do the same. (6) The output will be smaller, using four stops for guidance instead of two strips, where the operator has not to seek his way, when throwing a cover under press.

There is, however, a better way to do this work, as shown in Fig. 3. The die consists of a baseplate *A*, recessed for the die *B*, the latter being provided with a stop *C* at the required place. The die projects beyond the base and is partly halved at the ends as shown to accommodate the strips *D*. The strips swivel around pins at their center which are fastened to the die. At the ends these strips carry strips *E*, the four strips being connected by pins and the strips together forming a parallelogram. The lower strip *E* is bent up at the left,

the bent *F* serving to move the parallelogram in any required position, this enabling the operator to center instantly and accurately any cover thrown under press.

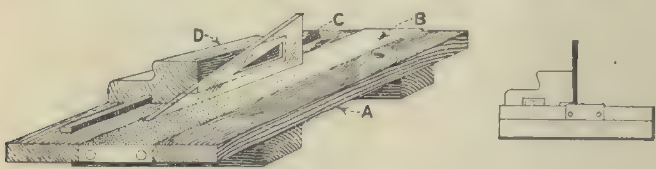
By providing the motion with a spring, which keeps the parallels widest as shown, the die will automatically become accurate, but slightly slower, as the motion has to be moved while the cover is kept ready in the other hand.

Brooklyn, N. Y. JAN SPAANDER.

Truing Worn Triangles

If there is a job that most draftsmen hate to tackle, it is truing up the edges of a worn triangle, whether it is of wood or transparent composition.

The rigging shown in the sketch has been devised to obtain an edge square with the faces and straight for



TRUING WORN TRIANGLES

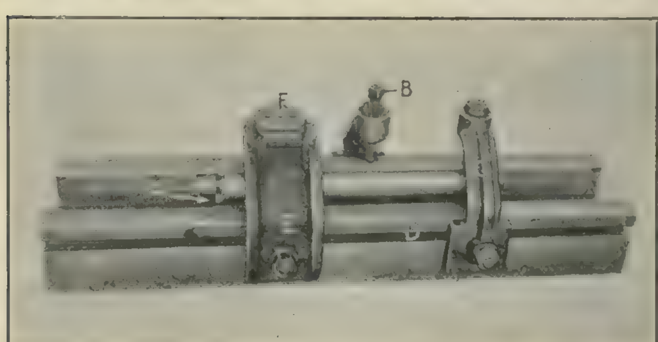
its whole length. On a board *A* approximately 8x8 in., of well-seasoned hardwood, strongly reinforced to prevent warping, are tacked a strip of smooth sandpaper *B* and a guiding rod *C*. The hardwood block *D* has its side perfectly square with the bottom and is shaped to fit the hand; the bottom is recessed to allow the triangle to travel over the sandpaper and is grooved with large clearance over the rod *C*. P. P. FENAUX.

Allston, Mass.

An Interesting Pin-Hole Jig

A simple universal jig for drilling pin-holes in shafts is shown in the illustration.

The shaft is pushed back against the stop pin *A* and clamped down by the setscrew *B*. The arms *C* may be slid along the T-slot *D* to any desired position. If necessary, more of these guide arms may be added, so that a



JIG WITH SHAFT IN POSITION

number of holes can be drilled in one shaft. The arm *E* may also be slid along the jig and as many holes as required drilled in the shaft through the guide holes in the bushing *F*.

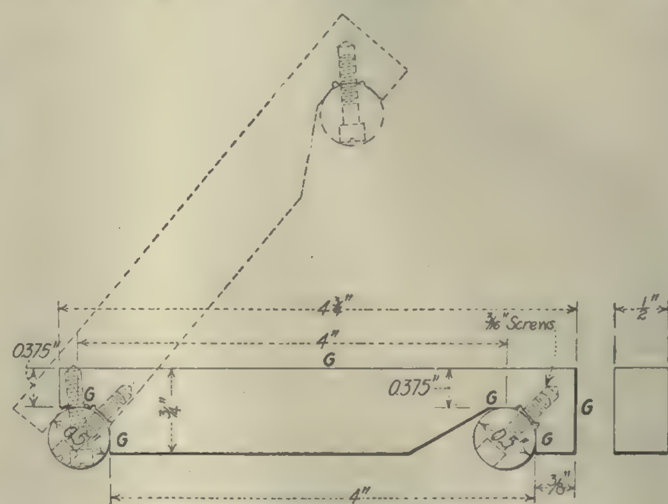
The bushings are removable so that others with different sizes of guide holes may be substituted.

New York City. A. TOWLER.

Sine Bar Simplified

There are on the market a great many different sine bars, made up by tool makers, but of all I have seen the one illustrated is as simple to make and use as any. This bar consists of a piece of tool steel $4\frac{3}{4}$x$\frac{3}{4}$x$\frac{1}{2}$ in., two rolls $\frac{1}{2}$ in. in diameter and two $\frac{3}{16}$-in. screws.

The notches for the rolls are so made that if the distance between the centers of the rolls is too great, one step can be ground; or if the distance is too small, the



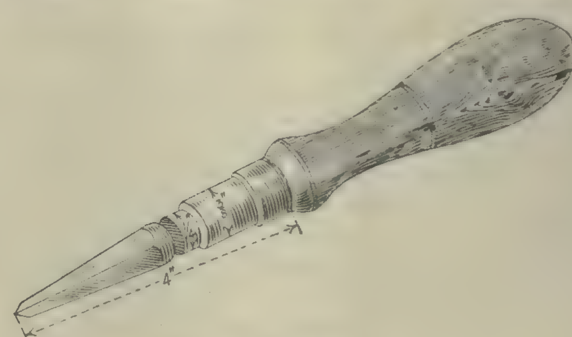
THE SIMPLE SINE BAR

other step can be ground. These steps can also be measured with a micrometer without using a roll, which has to be done when the grooves are cut at an angle of 45 deg. from a line vertical to the type surface of the bar. M. S. WRIGHT.

Hartford, Conn.

Handy Combination Holder for Small Tools

The accompanying illustration shows a convenient tool. By cutting off several pieces of drill rod one can make scrapers, die-sinking tools, screw drivers, and many other small tools. It does not require a large amount of room



THE ASSEMBLED TOOL

and is handy at all times. When changing from one tool to another simply unscrew the handle and insert the tool desired. In this way one handle will prove to be sufficient for the many tools that may be needed on a single job. ALBIN G. SWANSON.

Peoria, Ill.

Discussion of Previous Question

How Would You Produce This Casting?

The two ways that appeal to me as being the most practical for making the pattern and castings shown on page 318, Vol. 45, by Mr. Duggan are given herewith. The quicker and better of these methods is shown in Figs. 1 and 2. At first glance it would appear as if too much time would be lost on the corebox and cores, but in reality this is the quicker method and some time is saved on the pattern.

The pattern itself is shown in Fig. 1, and the corebox (in halves and doweled together) is shown in Fig. 2. It is, of course, necessary to carry the two inside bosses in the corebox as shown. These two parts—pattern and corebox—should not take a pattern maker more than 8 hr. to make, leaving 28 hr. for the foundry. To make the cores is fairly simple and could be undertaken by unskilled labor, while the molding should present no difficulties. For this method two boxes are required, the joint being made in the center as shown and the core registering half in each box.

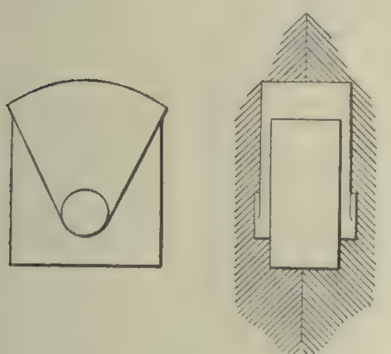


FIG. 1. THE PATTERN

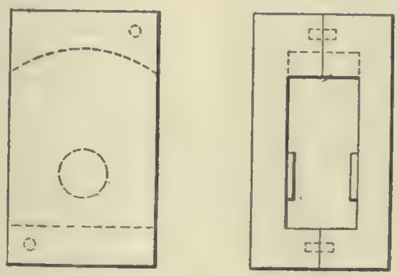


FIG. 2. THE COREBOX

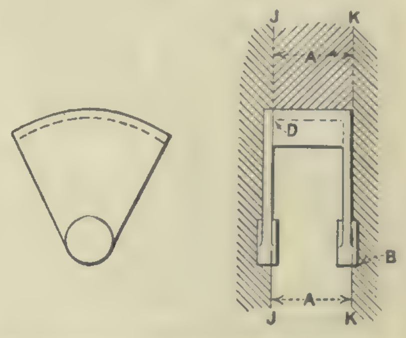


FIG. 3. METHOD USING THREE BOXES

Perhaps when Mr. Duggan inquired of the molder he was informed that he had boxes of just the correct width (*A*, Fig. 3). If so, a plain pattern could be made in two pieces and doweled together at *D;* but, owing to this point being so narrow, great care would have to be taken or variation between the bosses would creep into the castings. For this method three boxes must be employed and the joint lines made at *J* and *K,* as shown.

In molding in this way first ram up the center box, letting the boss *B* bed into the floor sand. Then ram up the left-hand box and finish off with the right-hand box, taking the remaining boss *B*. If I were making this pattern I should make this boss loose, so that it could be taken off and the center box rammed up into a board. In this manner a good joint can be made at *K* in quicker time. The boss can then be replaced for ramming up the last box.

The first method employed is by far the quicker and more accurate and is much to be preferred.

Surrey, England. P. JAMES.

Clearances of Pistons and Cylinders

Some time ago I noticed a query in your columns on the clearance required on various types of engines between piston heads and cylinder bushes. This query was never answered that I know of, and a few details of my observations may prove of interest.

The Canadian Pacific locomotives have from $\frac{1}{32}$- to about $\frac{1}{16}$-in. clearance between piston diameter and cylinder bore, and the piston rings are fitted so the ends will be $\frac{1}{8}$ in. apart. The amount cut out of a ring to give spring is about three times the difference between the diameter of the cylinder and of the piston ring. For example, a cylinder 22 in. in diameter has a ring $22\frac{1}{2}$ in. in diameter, which means that about $1\frac{1}{2}$ in. is cut out plus the $\frac{1}{8}$-in. distance apart of the ends.

Automobile engines should have the outer diameter of the piston tapered slightly from the head toward the crank end, as the head end is subjected to the greatest heat. It therefore expands much more rapidly than the other end and is liable to cut the cylinder and possibly stick.

A good rule is to make the head diameter equal to 0.998 times the cylinder diameter, and the crank end equal to 0.999 times the cylinder diameter. The length is usually about $1\frac{1}{2}$ times the stroke. The explosion temperature varies from 1,840 deg. F. to about 2,250 deg. F., and the center of the piston is about 340 deg. F. The higher temperatures are sufficient to effect changes in the structure and size of cast iron, the amount of change depending largely upon the analysis of the iron.

According to Kent, Whitham says in referring to steam practice that "in a horizontal engine the rings support the piston or at least a part of it." The pressure due to the weight of the piston upon an area equal to 0.7 the diameter of the cylinder times the breadth of the ring face should never exceed 200 lb. per sq.in. As an approximate formula breadth of ring face $= 0.15 \times$ diameter of cylinder.

I have seen piston heads on horizontal engines which had $\frac{3}{8}$-in. clearance on top, and yet they were fairly tight, due to the facts that the rings were good metal

and saturated steam was used. Present-day practice, using superheated steam, causes the cast iron in piston rings to lose its resiliency, which does not permit other bad conditions without excessive waste.

If a horizontal engine has a poorly fitted piston, a blow will soon develop on the top as the wear occurs on the bottom. For this reason a good fit should be made to secure longer service between repairs.

The clearance on gas engines varies from 0.004 to 0.008 in. on diameters from 6 to 15 in., and 0.003 in. on 5-in. diameters. Aside from the actual fit, the kind of service, grade of oil, etc., are factors in preventing compression losses. Graphite manufacturers claim that tests with their product show remarkable results along these lines. R. C. Gray.

Montreal, Canada.

Circle Punch Provided with a Disappearing Pilot

On page 1006, Vol. 45, Jan Spaander shows a circle punch with disappearing pilot. I have used such a punch for some 12 years, and the peculiar part of it all is that the one I have now is identical with Mr. Spaander's, with the exception of the knurling. Mine is knurled nearly the full length. Where I got the original idea from is more than I can remember.

The circle punch may be all right for the average run of drilling-machine work; but for tool and die work it is a failure, because the least bit of lost motion in the pilot will cause the circle to be eccentric with the original center-punch mark. J. R. Brown.

Janesville, Wis.

Why Blame Welding Apparatus?

I read with much interest the editorial discussing failures in welding by the oxyacetylene method, on page 653, Vol. 45. I am strongly in concord with your views, and I think every practical oxyacetylene welder must be in agreement. It is true, undoubtedly, that "the blame is too often placed on the apparatus," whereas inefficiency or inexperience of the operator is often the cause. Indeed, it may be safely said that oxyacetylene-welding methods are not generally understood, as making sound homogeneous welds in the different metals is the result of a knack that can be acquired only by exercise of considerable judgment and practice. Obviously, the success of oxyacetylene welding depends to a very great extent on the intelligence and ability of the operator.

To become proficient in this modern art, skill and training are essentials, together with a knowledge of how to apply the system as well as how to prepare the work to be welded. The operator should therefore be well versed in the fundamental principles of the process. He should know how to manipulate the welding flame at the right moment when fusion has proceeded so far that complete welding is assured; he should possess the dexterity that prevents the distortion of the metal under the torch; he should be skilled in the judicious use of the hammer at the right moment on the welded part of certain metals, whereby the strength of the weld is increased. Another important requirement is thoroughly knowing the characteristics of the materials used. This does not necessarily mean the study of their manufacture, but rather that knowledge which enables the operator to say which material is most suitable for the particular metal being welded.

I agree that this process of welding is unlike the ordinary work of the blacksmith and that it is possible to obtain a sound weld with practice of a short duration on certain metals, mainly because the weld can be built up from its foundation and in most cases can be readily seen, whereby its soundness and strength may be insured, but always provided it is properly and intelligently done.

Some makers of oxyacetylene-welding apparatus are willing to send experienced welders for a few days to their customers' workshops to teach the workman until he has acquired a fair knowledge of the process. Furthermore, the expert welder may be procured later to give assistance, should it be required, a charge being made according to length of service. Frequently, if workmen are left to their own resources, it will be observed that they develop into operators having only a limited acquaintance with the extent or the limitations of the process.

In the selection of workmen to become welding operators there is usually a discussion as to the class of man to choose for the work. Oftentimes, a laborer or a handy man is decided upon. This selection I do not approve of, because as in other skilled trades, it is best to use science in picking workmen to become welding operators. I have found it most satisfactory to choose the best mechanics of the various metal-working trades, such as good blacksmiths or sheet-metal workers, as these men invariably develop into competent welders after several months' training under an expert. By this system I have found that the work turned out is of first quality. Evidently, this is due to their previous knowledge of the characteristics of different metals.

The following is a case in point where unskilled labor was recommended by a firm manufacturing oxyacetylene-welding apparatus. Some time ago I contemplated welding the roof plates of modern passenger cars, of steel. Several manufacturers were consulted as to the most suitable apparatus and costs. The firm in question wrote: "Regarding the welding operator, it would be best if you would select a workman who has had no experience in welding before, as it is much easier to teach such a man the right way of doing the job than another who has perhaps some idea of welding and thinks himself an experienced welder, but only practices wrong methods." To a certain extent this may be true, as it may be said of other mechanical operations. Generally, however, this type of workman does not compare favorably with the mechanic who has had previous knowledge of metals and how to manipulate them. Indeed, this process of welding may be classed as a scientific art. Consequently, it is necessary to have a thorough knowledge of almost every kind of metal.

In conclusion it may be of interest to mention that, in the early days of oxyacetylene welding, it was used and advocated for repair work only and for small pieces at that. Now, this process is used for welding all sizes of repair jobs and manufactured articles, the method having been brought to such perfection that there are few metal-working industries in which oxyacetylene welding does not find advantageous applications.

Manchester, England. E. Andrews.

Which Is the Better Way To Impart Information?

On page 1041, Vol. 45, W. D. Forbes touches upon a problem that has troubled me a great many times; namely, what is the best way to impart information to others in such a way that it will be assimilated? It seems to me that the recipient of the information must be the determining factor in deciding which is the better method.

If the pupil has a trained mind capable of receiving, classifying and using information given in general terms, the sixty-word presentation is probably the best from the standpoint of economy of time. On the other hand, most recipients of the kind of information there presented are either boys or men in the school or shop, who have had no great amount of intellectual training. Upon these, it seems to me, a much greater and more enduring impression will be made by the concrete example given in the second presentation. It has been my experience, in teaching boys and men, both in school and shop, that a piece of information is much more readily received and remembered when given in the form of a well illustrated story than it is when the bare facts are presented in the briefest possible way.

An illustration of this has occurred many times in my own experience in teaching beginners how to lay out and make a square threading tool to meet given requirements. When the simple statement is made that, if a straight line equal in length to the circumference of the screw to be cut is laid off and at one end of this a perpendicular equal in length to the lead of the screw is drawn and the ends of these two lines are connected by a third straight line, this last line will give the proper slope when clearance has been added for the side of the tool, the method is seldom understood or remembered. If, however, I draw several diagrams by way of illustration and at the same time tell the story relating how I once saw old Tim spend two days by cut and try methods in making such a tool and then actually make one myself and demonstrate its use, showing how easily it can be done by the use of a little geometry, the interest of the pupil is awakened and the information is assimilated and remembered.

There seem to be three factors in presenting information: First, the spoken word; second, the written word; third, the performance of the necessary actions. If any one of these factors is absent, the impression made upon the learner is likely to be incomplete and therefore ineffective. A good story, well presented and illustrated, contains all the foregoing elements and is therefore among the best means of effectively imparting information. WILBERT S. DREW.

Olean, N. Y.

The Apprentice Question

John Silverman, on page 999, Vol. 45, solves the apprenticeship question by a mere calculation. If we elder readers did not know of the knocks Fate hands out once in a while, many a father might employ this method to terminate his son's education. Such calculations, if executed by hazard experts, hold absolutely true, if applied to the average of masses. But a boy, deciding upon the course to shape his destiny, is not interested in the average result. He is solely interested in his individual welfare. It is, I believe, not so much the way, which brings the results, but rather the stuff the boy is made of. Our future is so little influenced by our own actions that if a young man bears in mind that gathering knowledge is a splendid pastime, he will have a broader outlook on life than the fellow working persistently on a steady proposition. A young man should take that which is near, and the way to be followed depends on financial circumstances and environment.

Where rents are cheap, food is abundant and schools are fair, where father's job is steady and one factory with an interested employer offers variety of work, it unquestionably will pay to serve a term as apprentice. In a metropolis, however, where young men have an opportunity to knock about from factory to factory, where $15 a week is often a godsend to help mother out, where a small sum opens vistas of evening schools and even as much as a five-year course at night in a reputable college of engineering, a boy has no right to think of wasting his time on an apprenticeship.

I have watched, during the last three years, the growth of about a dozen boys here in the city, and the apprentices among them are all developing into full-fledged failures. Two of the dozen are screw-machine hands at $15 a week; and when they have finished their five years' evening course, of which two have been passed, I am sure they will know how to take care of themselves. They will prove that they are not lacking that much coveted rigid foundation which, according to Mr. Silverman, is the property of the apprentice only.

Whether it pays to serve as an apprentice or not is a question of environment and circumstances as well as the stuff the boy is made of. If, for instance, it is clear that a boy is fit to become a screw-machine hand and nothing else, why waste a thousand dollars on apprenticeship instead of tackling that job from the very beginning? JAN SPAANDER.

Brooklyn, N. Y.

Cutting Keyways in the Lathe

I would like to add to Mr. Parker's old lathe kink, "Cutting Keyways in the Lathe," on page 914, Vol. 45, that the cut should be taken toward the dead center to avoid any possible friction on the live center; also, a common lathe dog on the end of the shaft, strapped to the tailstock with a rawhide thong, the same as is used when working on a piece in the steadyrest, will give excellent results. I have cut short keyways on a shaft 9 ft. long in a 6-ft. lathe by this method—that is, removing the tailstock and substituting an extra steadyrest.

Bridgeport, Conn. R. C. WILSON.

Two Unusual Jig and Fixture Bushings

Mr. Johnson's criticism, on page 1048, Vol. 45, of the writer's lock pin for slip bushings is quite to the point. All such slip bushings of the writer's design are now made with an angular cut. However, the original design, which was sent to the *American Machinist*, was made with a slot with one vertical side to accommodate a special condition. W. BURR BENNETT.

Bridgeport, Conn.

Prescribing Face Powder for Blood Poisoning

By John R. Godfrey

SYNOPSIS—Showing the fallacy and uselessness of spending good money for refined analysis when the whole foundation is wrong. Showing, also, that unless we study the design of the article to be manufactured, we are wasting a lot of valuable time by only looking after surface details instead of getting at the real root of the matter.

The machine business is progressing, but there is a heap of work to be done yet before we want to parade it too prominently before the world at large as a really perfect specimen. And one of the things to look out for is the business doctor who works along the "quack" or "patent medicine" lines. Too many of them make some kind of showing on the outside, no matter how badly the digestive organs may need repair. It is very much like having your face treated by a beauty doctor when your liver is twisted and your heart is hitting on only three cylinders.

If you begin to talk about poor shop management in the presence of a dyed-in-the-wool business doctor, he immediately suggests his special nostrum as the only way to cure the disease. In many cases, however, the remedy would be about as useless as face powder to a patient who needed a heart stimulant. What is the use of making a minute study of every motion on laying out the holes in a pipe flange when the job ought to be done in a jig anyhow? If we get a man with enough practical knowledge to make a jig and pay him half as much as we do the high-browed gentleman with a title and a stop watch, we are dead sure to get results. The other way it is a gamble with the odds about 100 to 1 against you.

One of these professors of systematization was showing my friend Jackson some of his wonderful work in reducing the lost time in an old factory not a thousand miles from New York City. There were many very ingenious little devices such as special stools, benches with cleats to prevent work rolling, and all very conveniently placed. The operator was saved a lot of needless (but perhaps not altogether useless) motions; even a mirror saved him the necessity of turning to look at the clock or to watch the boss. But as Jackson pointed out, why bother with all this petty mummery when the whole method of doing the work was wrong from our modern point of view?

Buying New Machines with the Doctor's Fee

The work that was being done in an old bench lathe worth about 57c. for scrap could have been done on a modern vertical drilling machine in half the time with a few simple fixtures. In fact, the money that had been paid the wise guy for making the funny little work handlers would have come mighty near buying the right kind of machine. And this machine would have cut costs in half.

I will give the professor credit for one thing, however. He was honest enough to admit he did not know a blamed thing about machines, but he was a humdinger on motions. But here was a case where the right machine and a few fixtures would have eliminated the lost motions he was after, besides greatly reducing the costs. Does it not seem as if it is the motion-man's cue to keep off the stage until after the real man who knows the best machines and tools gets through playing his end of the game? Then, if there is any money left to play with, I suppose the professor might as well get his share—he has to live somehow.

There is another point in the manufacturing game which is too often overlooked—that the shop may be the last place to tackle to secure economical manufacture. It too often happens that the man who designed the piece was as innocent of production costs as the motion professor was of new machinery. And no design is likely to be right, from the manufacturing point of view, unless it has been thoroughly analyzed by a good production engineer, or better yet, two or three of them.

Curatives Versus Opiates

This is so obvious in several cases I have seen lately that I am inclined to believe it has a far wider bearing than we are apt to realize.

Of course, it may not be any of the shopman's business as to how much of a jackass the designer was. In the narrow sense his job is to make at the lowest possible cost any old thing that comes into the shop. But from the broader viewpoint, for the conservation of machine-shop energy and, quite incidentally of course, the fattening of the stockholders' dividends, this has a big bearing on the whole matter.

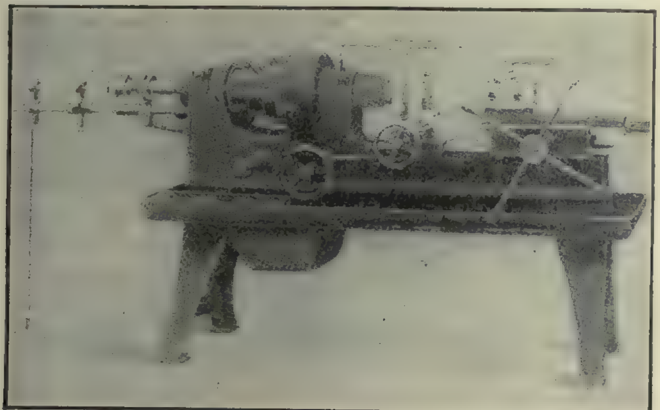
When we realize, however, that real economy means cutting out wastes of all kinds, that a poorly designed piece may cause continued waste of both material and labor every day for 10 or 20 years, or as long as the piece is manufactured, we see that unless the man who knows machine costs is on the job the so-called economies of the motion doctor may be insignificant. Every one of our modern activities, from lugging out ashes to listening in on the party telephone wire, is tied up in some way with our neighbors and through them to the whole community. The ashes may get on Jackson's lawn, hogging the telephone may keep Mrs. Brown from calling a dog doctor, and wasting unnecessary material may help raise its price to everyone who uses it. Waste affects us all, whether it occurs in Kalamazoo or Calcutta, and there is more of it tied up to the drafting room and the manager's office than most of them will admit.

So, although it may be entirely out of place for a meek and lowly mechanic to imagine he can make suggestions to a real designer ("designer" ought to be all "caps" to suit the aforesaid designer's notion of his own dignity), it is ten chances out of nine that he can save money for the firm by so doing. The sooner we realize that real economy means to get at the source of the trouble instead of trying to polish up the outside the better. Let us stop wasting money by studying a man's motions in chipping with a dull chisel—it is a heap more scientific to sharpen the chisel. And let us beware of the kind of business doctor who does not know whether the chisel is sharp or not.

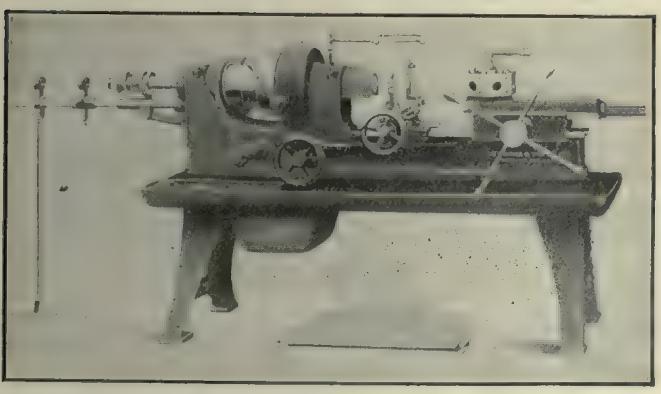
Editorials

A Flagrant Case—and an Apology

On page 966, Vol. 45, the *American Machinist* published an illustrated description of a hand screw machine, which was received from the D. & W. Machine Co., Inc. The Warner & Swasey Co. called attention to the first line of the description, which reads, "The illustration shows a hand turret screw machine recently developed by the D. & W. Machine Co., Inc., 149 Broadway, New York City," and to the practical identity of the illustration with one used by them since 1910 of one of their own machines. That the reader may see this practical identity, these two illustrations are reproduced



REPRODUCED FROM PHOTOGRAPH SUPPLIED IN NOVEMBER, 1916, BY D. & W. MACHINE CO., INC.



REPRODUCED FROM PHOTOGRAPH TAKEN IN 1910 OF A WARNER & SWASEY MACHINE

herewith. Unfortunately, the photograph used for the cut printed on page 966 is now unavailable, so that the first illustration is reproduced here from the halftone engraving as it was originally published. The view of the Warner & Swasey machine is from a print dated 1910. This view has been frequently used by that firm in its advertising literature.

No firm name appears on the machine of the first illustration, neither are oil guards shown. In the second illustration offered for comparison the name "The Warner & Swasey Co.," with the firm's address, is on the bed, and the oil guards are shown lying on the floor. Aside from these two points of difference the views are identical.

The *American Machinist* sincerely regrets that it credited to the D. & W. Machine Co., Inc., as "recently developed," a design that the Warner & Swasey Co. has had on the market for six years.

There has been much copying of machine tools during the last two years. These columns have carried references to it. In the haste to market some of these copies photographs of the phototypes have been used—another firm's property—and even the wording of advertising and descriptive literature has been followed.

One instance of this last-mentioned form of copying was condemned in these columns a few months ago on page 433, Vol. 44. The firm whose language was there followed was also the Warner & Swasey Co. In fact, several machines were shown during last year in our department "Shop Equipment News" that closely resembled products of that firm. Other well-known machine-tool builders can point to similar cases. Under our patent laws there is no redress unless there is infringement, and machine-tool building is an old art in the United States.

While there is no condemnation of the man or firm who copies unpatented mechanism and machines, we must utterly censure the one who sells his projected product on the literature of another. From every viewpoint of fair dealing and clean technical journalism the *American Machinist* regrets that it has been a party to such an act.

The Shop Physician

Several hundred physicians are now engaged in industrial practice. These men are conducting many all-day clinics in large manufacturing plants. Through an association of their own they are standardizing devices found useful in their practice and are exchanging information to increase their own knowledge and skill and to make their services still more valuable to the workers whom they serve. In some places they are doing work far beyond the usual activities of the physician. They are priests, confessors and advisors.

Needless to say, the duties and responsibilities of the industrial physician call for a very high grade of man. A cheap doctor gives a cheap result. A man who could not succeed in private practice has no place in industrial practice. To gain the confidence of the men and women whom he is to serve, he must be possessed of an attractive personality, must thoroughly know his work, must have acquired all needful skill, and beyond all these things must have a social vision.

It is extremely fortunate that there are men in industrial practice today who possess all these qualifications. Each medical department directed by such a one is a research laboratory, which in addition to doing immeasurable good, is collecting facts which finally must have a profound influence in future studies of industrial relations.

A physician to inspire confidence in those whom he meets in industrial practice must have the knowledge and skill to carry any one of his patients through the severest attack of illness, or himself perform any major operation. It is a bit of a privilege to consult such a man, and it is appreciated.

Dr. Otto P. Geier, who is in charge of the Employees' Service Department of the Cincinnati Milling Machine Co., in an address given before the Fifth Annual Safety Congress had the following to say about the industrial physician:

> Health is one of our most vital possessions. It is the nation's greatest asset. The effort to conserve it is in itself ennobling. The human relations department, therefore, had best begin its coöperative efforts along health lines. The all-day dispensary is a great melting pot for human experience. Here the virtues, as well as the weaknesses, of men are reflected. The right man in charge is priest and physician, confessor and advisor. How necessary, therefore, that one secure a man not only of high professional attainment, but one of broad social vision. A cheap doctor, like a cheap machine, will produce a cheap result, and no man will recognize that cheapness sooner than your workman.

The following from this same address outlines one of the industrial physician's problems:

> What is industry, in coöperation with its employees, going to do about alcoholism after it has counted the cost in lost time, lost production, lost patronage, to say nothing of the misery, want and crime that follow in its wake? Is society willing to continue to pay the price? Intemperance is the cross of the industrial physician. He copes with all other diseases with hope and vigor, but confronted with alcoholism in the worker he sits relatively limp and helpless. A man with a cancerous condition is fortunately short-lived, but the alcoholic seems at least to live indefinitely.

It is possible that the hand of the physician in industrial practice holds the key to the solution of many problems that have heretofore baffled factory managers. With what great care must he be selected!

A Business Necessity—Freedom To Coöperate for Foreign Trade

American manufacturers are today handicapped in their efforts for foreign trade by their own national legislation. The desirability of coöperating to sell in the markets of foreign countries is clearly recognized, but doubt as to the legality of such coöperation under our antitrust laws amounts virtually to a prohibition.

American manufacturers do not dare to combine for foreign business.

The necessity of modifying our antitrust laws to permit of this particular form of business coöperation has been emphasized for some three years. At the last session of Congress a bill, H. R. 17,350, known as the Webb Bill, was introduced and passed by the House, but not by the Senate. It defines "export trade" and permits the forming of associations organized solely for the purpose of engaging in that form of trade.

If this bill becomes law, American manufacturers can combine and coöperate by organizing companies for the express purpose of extending their foreign trade. There will then be complete freedom of coöperation.

There is no need of arguing the advisability of this piece of trade legislation. It has been indorsed both by the Federal Trade Commission and the Chamber of Commerce of the United States. One of the reasons why it should be passed at this session of Congress is the assured fact that for a time at least German buying after the war will be under Government control. There may also be coöperative buying for the principal countries of the allies. With the Webb Bill made law, American manufacturers can oppose controlled buying with coöperative selling.

A few of the advantages to be derived from coöperating for foreign trade are: A reduction in overhead sales charges, a reduction in the expense of technical representation abroad, the opportunity to offer a complete line of goods through one selling organization, the means to standardize products to fit the needs of foreign markets and the opportunity for the skillful handling and following up of advertising in distant markets.

There is no organized opposition to the Webb Bill. There is no hostility. If it fails to pass it will be because senators who are not familiar with the needs of foreign trade are perplexed by its provisions.

Only one serious objection has been offered to the bill, and that had its origin in a rather strained sense of fairness. It is that the United States should not prohibit trusts at home and then deliberately open the way for American trusts to do business with the rest of the world. The person who offers this suggestion forgets that foreign countries have ample means to protect their own manufacturers and traders.

Another comment has been made in mild opposition to the bill, but this is rather the expression of a fear than the stating of an objection. It is the fear that the getting together of American business men to coöperate for foreign trade may be an opening wedge for some kind of domestic regulation. It can be stated confidently that this fear is unfounded, for the desire of manufacturers to combine for foreign business is entirely apart from their aims and wishes in regard to domestic affairs.

The Webb Bill has been passed by the House with the addition of two unfortunate amendments. One prohibits the corporations organized for foreign trade from trading in the United States. The other prohibits these organizations from doing anything in restraint of foreign trade. It is evident that either of these nullifies the purpose of the bill. A corporation organized to carry on export trade must of necessity trade or buy goods in the United States, and in so far as it is a coöperative scheme of several manufacturers, it must operate in restraint of foreign trade as carried on by American manufacturers. It is probable that the keen lawyers composing the Interstate Commerce Committee of the Senate, where the Webb Bill is now being considered, will see the absurdity of these amendments and eliminate them.

While it is true that there is no opposition to the bill, it will not pass of itself. American manufacturers must not only do their part in urging the Interstate Commerce Committee of the Senate to report the bill favorably, but they must see to it that it has the proper support in the Senate. Action is all the more necessary because the time between today and March 4 is short, and there is an enormous amount of legislation pending.

Will you not do your share in helping the passage of the Webb Bill, which is working for the freedom of coöperation for foreign trade?

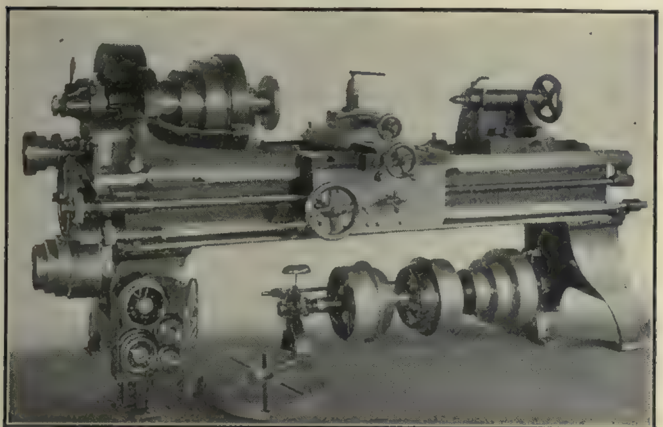
Business Ethics

Tell exactly what your machine is when you try to sell it, and make it exactly as you agreed to make it before you ship it.—J. B. Doan.

Shop Equipment News

Heavy-Duty Engine Lathe

The illustration shows one of a line of 14- and 18-in. heavy-duty engine lathes which have recently been placed upon the market by the Carl G. Westlund Co., Worcester,



18-IN. ENGINE LATHE

The 14-in. lathe: Cuts threads from 3 to 36; swing over bed, 16¼ in.; swing over carriage, 10½ in.; single back gear; 18-in. lathe: Cuts threads from 3 to 24; swing over bed, 20 in.; swing over carriage, 17 in.; double back gear; 3-step cone pulleys; front bearing on head spindle, 2¾ in. in diameter by 5 7/16 in.; rear bearing, 2⅛x4¾ in.; lead screw, 1 7/16-in. diameter, 4 pitch.

Mass. The lathes are made in various lengths and are equipped either with or without taper-turning attachments or power crossfeeds. Phosphor-bronze bearings are used for the head spindle.

Constant-Current Closed-Arc Welding System

The Arc Welding Machine Co., New York, N. Y., has put on the market a welding system known as the "Constant-Current Closed System," which operates arcs in series for welding purposes.

The generator, Fig. 1, consists of two units—the generator proper, which furnishes the energy for welding, and the regulator, which automatically maintains the current at a constant value. The regulator is excited from a separate source and by varying its excitation with a field rheostat the current may be set and automatically maintained. Each arc operated on the system is equipped with an automatic controller, shown in Fig. 2.

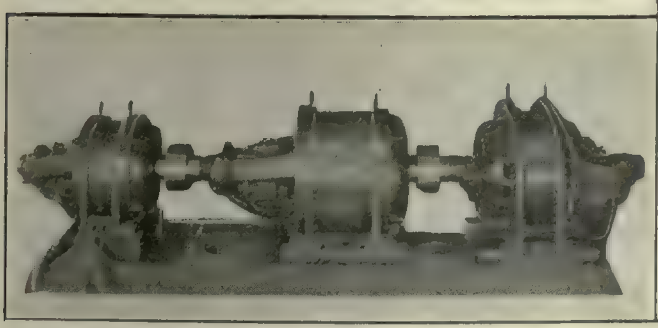


FIG. 1. THE GENERATOR

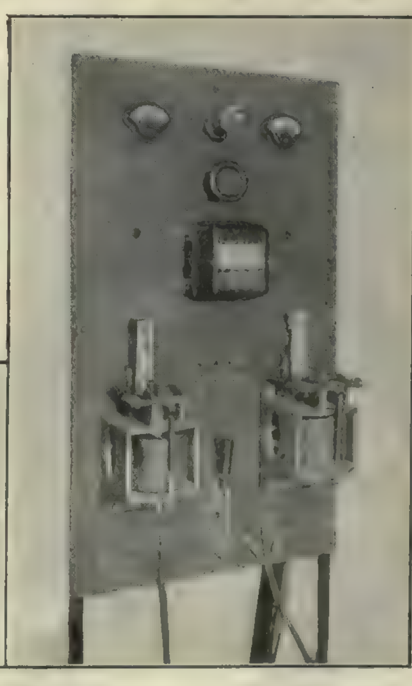
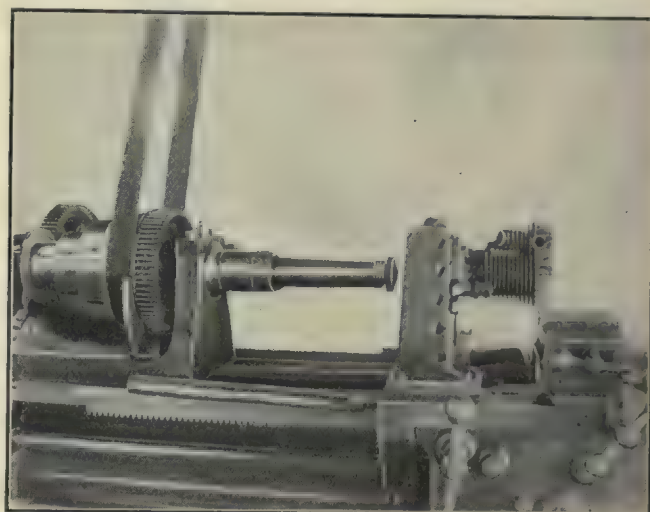


FIG. 2. AUTOMATIC CONTROLLER

Boring and Grinding Attachment for Engine Lathes

John Gibson, San Francisco, Calif., has recently placed on the market a machine known as the W. & B. combined boring and grinding attachment for engine lathes. It

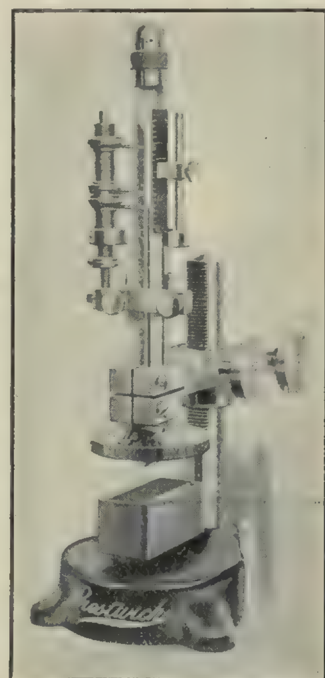


BORING AND GRINDING ATTACHMENT

consists of an attachment that is screwed to the lathe spindle and provided with a tool or grinding wheel the position of which with relation to the spindle axis is controlled by a micrometer adjustment. The machine is principally intended for reboring and regrinding gas-engine cylinders and may be used on any lathe having a swing of 16 in. or more. The machine will grind work from 3 to 6 inches in diameter and the face plate is arranged to take single or *en bloc* cylinder castings. The grinding spindle is mounted on roller bearings and an arrangement is provided to prevent end play.

Prestwich Fluid Gage

A fluid micrometer gage has recently been placed on the market by the Coats Machine Tool Co., Inc., 30 Church St., New York City. It consists of a fluid-containing chamber connected with a glass tube of fine bore. The diaphragm of the fluid-containing chamber has an anvil, which is opposite a second anvil on the rigid base of the machine. In using the machine the diaphragm is adjusted to an approximate position by means of a rack and pinion. After this is done the final adjustment is made by means of a micrometer screw in such a manner that a part of correct size brings the liquid in the small tube to the level of the indicating pointer, which is the center one in the illustration. When the work is placed between the two anvils, the diaphragm is displaced slightly, causing a greater displacement of the liquid in the tube. Pointers are provided by means of which plus and minus limits may be allowed for. It is claimed that the gage is very accurate, due to the elimination of errors by the human element.

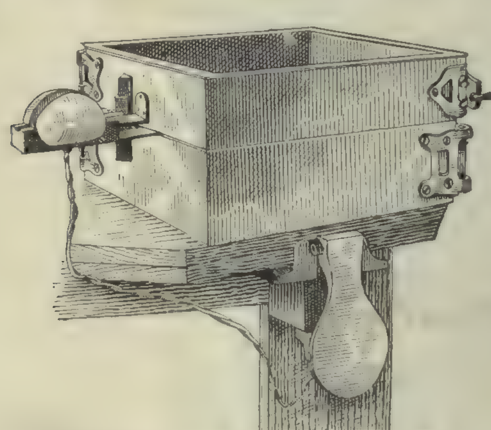


PRESTWICH FLUID GAGE

Electric Flask Vibrator

The illustration shows the Meico electric vibrator, which has been placed on the market by the Manitowoc Electric Implement Co., Manitowoc, Wis.

It consists of a small vibrator fastened to the side of the flask, by means of which the flask is vibrated while the pattern is being drawn. The vibrator is operated by electricity from an ordinary lamp socket and is controlled by a switch that is secured to the bench in such a position as to be easily reached by the knee of the molder.



ELECTRIC FLASK VIBRATOR

Machinery in a Biscuit Factory as Seen by a Machinist

By W. Osborne

When I started for that biscuit factory, I did not have any idea that I was going to see a lot of machinery in operation. The ones who had planned the trip were showing visitors to their city some of the things that were worth the time and effort of seeing. As some of my friends were going, I went too; and being a stranger to city ways, I selected as a mate a man who also lived at a distance. We knew that it is easy to go wrong in a strange city. Accordingly, we listened to the directions given by the chief guide, and at once decided that we should get lost if we tried to heed them. Disregarding instructions, we followed a tall and handsome man whom we had heard remarking that he lived in the city. Several others also followed him. I do not know how many of the principles of efficiency he used in his journey, but I do know that we were the first of the numerous groups that got to the biscuit factory.

We were furnished with a guide and taken up to the top of the building. The interesting thing on the roof was the immense sign that had not seemed impressive when seen from below. The laundry was full of machinery and was in full operation. The most familiar machine was the oil extractor that is used in the machine shops for taking the oil out of chips.

The size of the hospital might lead one to think that a biscuit factory is a dangerous place to work, were it not for the fact that there was not a patient in it. Near-by was a large lunchroom with lists of prices of the articles served. Stocks of the staples used in making biscuits were stored on this floor for future use.

This article is not intended for a description of the factory, but gives a glimpse that will show some of the work that such a place makes for a machine shop.

Material Starts at the Top Floor

The material, starting at the top, kept going down as it went through the various processes, and was loaded into cars on the ground floor. Tanks mounted on wheels received the ingredients. The tanks were moved to the different kinds of material, each of which was arranged to be put into the tank accurately and with little labor. At one place a pipe with several branches had a meter between the branches and the outlet, so that the liquid desired could be run in a measured stream into the tank. When everything desired was in the tank, it was run under a mixer; and the mixing was well done. Had there been a dumping attachment on the tank, that mixer would have done a good job on a batch of concrete. After this mixed batch was ripened properly, it was put into a real concrete mixer on another floor and worked like a nice big lot of taffy.

A man cut off a chunk of dough as large as he could lift, and put it into a hopper, where a pair of rolls forced it down and out. Here was a row of these machines with the dough being forced out in various forms. One was discharging narrow strips with a space between them. Cutters came down and cut these strips into pieces without hindering their movement on a traveler, without having the dough stick to the cutters and without the cutters cutting anything but the dough. A set of rollers on another machine was delivering the dough in a sheet.

Punches were cutting round rings all over this sheet as it traveled along. A contrivance was winding up the part of the sheet that was on the outside of these rings and taking it back to the hopper, while the pieces inside of the rings went on to be delivered to the pans. The punches made round rings, but the holes that traveled back to the hopper were elliptical.

A man standing at the end of the machine took the filled pan, placed it in the furnace behind him, removed a pan of baked cakes and set it in a rack. He then turned to the end of the machine and found another filled pan just ready to be taken up and placed in the oven. The pans in the oven were in motion, and the baking was done very uniformly and very quickly. One oven baked as rapidly as two men could put in and remove the pans. I did not time the number of pans per minute that were delivered from one machine, but I did notice that a young man was kept busy all the time wiping off the empty pans and sending them along on their rounds. Another man spent his time removing the baked cakes from the pans. The pans were oblong. They were grasped at one end, and the other end was given a smart rap on the top of a chute. This rap loosened the cakes from the pan, and they slid down the chute to join the ones that had gone before.

A Continuous Waffle Baker

Near-by was an arrangement that might be called a continuous waffle baker. It was a complete and self-contained affair. A person who is given to research and who loves to trace the various steps of progress in mechanical development could find in this machine something to think about. I am not able to say that it and the caterpillar tractor belong to the same family, but I do know that this baker made me think of a caterpillar tractor. The waffle irons were arranged like the drivers on one side of a caterpillar tractor and traveled through a continuous cycle.

At one end of the machine a man sat. It seemed that this man did not have anything to do but to open the irons, remove the baked cakes and shut the irons. It also seemed that he did not have any vacant spaces in his time. The bottom of each of these waffle irons—likely they were not called waffle irons in this cake factory—was fastened to an endless-chain arrangement so that the irons were level while going through the upper horizontal part of their travel. Starting empty and open from the man, the pan traveled under two pipes that delivered accurate batches of batter on it at just the right time and in the right place. It was then closed and locked, passed through the oven and around the far end, back along the floor to the front end. As it was rounding this end, it was opened and the baked cake removed.

In the time that it took for this iron to leave the operator (that may not be the proper word to use to designate the man, for he did not run the machine or look after the fire, so far as I could see, and I did not see how he had time to do anything else than what he was doing) and make the complete round, each of the other irons did the same thing. If this had been a tractor, I should be able to tell about its speed, horsepower, fuel consumption, pull on the drawbar, accessibility for repairs and a lot of other things. Being a baking machine, it was so foreign to my usual line of activities that many of the interesting points did not become apparent until it was too late to get the information. Now I wonder how the fire is regulated to time exactly with the speed of travel of the irons; how the valves are worked that control the delivery of the batter; how the pressure is kept uniform on the batter so that a certain amount is delivered in a given time; how the batter is made and kept at a uniform consistency; how much, in percentage, the cakes vary in weight; what the output of such a machine is; what the cost of running it is; how the burden is figured, and a lot of other things.

My friend laid his hand on my shoulder. "You didn't expect to see a miller taking a cut off the top of the cakes, did you?" he asked. "Come over here and you can see it."

Milling Cakes

I went along. Here was a miller without some of the common drawbacks. The top of the table moved constantly forward—some more of the caterpillar-tractor idea—under the cutter. The cakes were laid on the table and did not require any clamps to hold them there. The cutter was a multiple-tooth affair that looked like a revolving wire brush. Near-by was a miller of another type. A pile of cakes placed on a table passed along under an arbor that carried a number of slitting saws. These saws cut the pile into slabs. The table moved forward, stopped, revolved a quarter-turn, passed along to more slitting saws, and out came nice accurate rectangular products of machine work.

I might try to tell about the other interesting machines like the ones that put the filling between the sheets or the ones that put two kinds of gratification between the little round cakes, but anyone can see that I am trying to describe machinery that I do not know anything about. It will show that there is a lot of machinery used in a biscuit factory.

Our guide had quite a large party in charge. A number of them were ladies and their escorts. My friend and I modestly kept in the rear and saw the things that interested us, but we did not have the advantage of the explanations given by the guide. We did, though, have a good illustration of the fact that this factory was a large place and that we were only touching the high spots in going through it, for we got interested a little too much at one time; and when we turned around, our party had vanished. An obliging workman indicated the direction, and we started to find them. We proved to be poor trailers, for we got hopelessly lost and it took a number of obliging persons some time to find our party and direct us to it.

When I saw the Loose-Wiles Biscuit Co. as one of the places named for excursions by members and visitors of the A. S. M. E., I thought of it as being a place provided to interest the ladies particularly. Now, whenever I eat any of the fancy little cakes, I will know that I am eating largely of the product of the machine shop and of the work of the mechanical engineer.

Safe and Noiseless Operation of Cut Gears—Erratum

Formula (2), published on page 1030, Vol. 45, should read $P = \frac{MK^2}{R^2} \frac{V}{2t}$ instead of $P = \frac{MK^2}{R^2} \frac{2t}{V}$, as printed.

The "Coincider" Who Always Agrees with You

By J. P. Brophy

Did you ever notice the man in your employ, perhaps of considerable consequence in some one direction, who never differs from you on any question? No matter how nonsensical and ridiculous your argument is, he still agrees with you.

The coincider is always a good fellow; he never says much. You have a notion that a certain change in something you are manufacturing would improve it, and it may be that your opinions are formed without looking into the matter deeply enough and without giving it the consideration it deserves. The coincider, whether he be your assistant, foreman or subordinate employee, is silent and simply acquiesces, regardless of whether he thinks you are doing the right thing or not.

This man would not think of opposing you, although in his mind he feels your ideas are not practical. I consider such a man dangerous. Give me the man who has an opinion when one is expected. He will express himself, if satisfied you are wrong, no matter how enthusiastic you may be over your idea; and he is not afraid to differ with you, and to let you know that he differs with you.

A man who holds a job that carries with it responsibility and who always evades giving his views when called upon to do so, but coincides with yours, is not dependable. If he pretends to understand you and does not, then when mistakes are made he will escape the blame. If it is something for which he will receive all the credit, he is very talkative and wants everyone to know what a smart fellow he is.

This man is a hindrance in many respects. You are paying him for the delivery of his best services, but he escapes responsibility because he is a good fellow and agrees with you in all your arguments.

There are two kinds of "coinciders": One is not smart enough to know a good thing when he sees or hears it and is foxy enough to say nothing except when he is forced to give an opinion. The other is a wise proposition and a silent schemer. If he knew the drawings of a piece of machinery were wrong and could show you just where the mistake was, he would most likely smile a mild approval and perhaps say, "As far as I can see, this will work out all right." He just wants you to think he is right with you. Such a man is a deceiver. He is liable to do considerable harm if you are not wise to his way of doing business.

This kind of man, when his opinion is asked, lacks the courage to condemn if he does not approve, or makes a pretense that he knows what you are talking about when he does not. Just size him up for what he is worth and treat him accordingly.

Any individual who wants to reach your heart in this way can be properly called a damaging coincider—one who generally contrives to escape all responsibility.

New Publications

Automobile Welding with the Oxyacetylene Flame—By M. Keith Dunham. One hundred and sixty-seven 6¼x4-in. pages; 66 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $1.

This work is intended as a book of instruction and help to those who find it either advisable or necessary to do oxyacetylene welding. The book is divided into eight chapters under the following subjects: Shop Equipment and Initial Procedure; Cast Iron; Aluminum; Steel; Malleable Iron, Copper, Brass and Bronze; Carbon Burning and Other Uses of Oxygen and Acetylene; How To Figure Cost of Welding. Each subject is illustrated, and the text is presented in a form that should prove of help to anyone who desires to know how to prepare and make a successful weld.

The various things to be avoided when either preparing or making a weld are noted, so that much of the doubt felt by many welders may be removed and successful operations performed.

Applied Electricity for Practical Men—By Arthur J. Rowland. Published by McGraw-Hill Book Co., New York City. Three hundred and seventy-five 5x7½-in. pages; 323 illustrations; indexed; cloth bound. Price, $2.

Many elementary books have been written on electricity. They appear to be divided into two classes. One attempts to cover the whole field of electrical science with the result that it must be superficial, and the other deals with the theoretical principles only and does not attempt to apply the principles to apparatus. This book, however, is written wholly from the standpoint of the one who constructs and operates electrical circuits and machinery, and is the result of the author's 20 years' experience in teaching applied electricity to practical electrical workers who expected to make direct application of the knowledge gained in the lecture room and laboratories.

The work is divided into 18 chapters. The first four treat of the fundamental principles of the electric circuit, electromotive force and Ohm's law, magnets and magnetic flux, and the calculation of combined resistances. Three chapters are devoted to the study of direct-current machinery and take up the general characteristics, construction and operation of the direct-current generator, the drum armature and multipolar machines, and the general treatment of armature winding, and different types of direct-current motor starters and controllers. The principles of alternating current and polyphase circuits are treated in two chapters. The four chapters on alternating-current machinery are devoted to a study of the construction and operation of alternators, synchronous converters, the direct-current three-wire generator, transformers both of the constant-potential and constant-current types, the different types of alternating-current motors including the series, single-phase and polyphase induction, and synchronous motors, considerable space being given to the principles of operation, methods of starting and speed regulation of the various types of alternating-current motors. The chapter on storage batteries gives consideration to the different types of batteries, their care and methods of charging, including the mercury-arc rectifier, vibrating-contact rectifiers and the aluminum valve. Three chapters are devoted to direct-current systems of distribution, electric lighting and wiring. Many problems are given at the end of each chapter to be worked out by the student, for the book is intended to be used in trade and industrial schools as well as by electrical workers.

Business Items

The Link-Belt Co., Indianapolis, has recently blown in the fifth furnace at the Belmont plant, adding materially to the capacity for producing malleable link-belt. Extensive building operations at the Belmont works have been completed and the manufacturing activities reorganized.

The Pheoll Manufacturing Co., Chicago, Ill., has recently acquired a tract of land about 358x335 ft., at the corner of 12th St. and Walker Ave. A factory will be erected on the site at once. The product of this company is machine screws, stamped and drawn work, automatic screw-machine products, etc.

The Name of the Celfor Tool Co., Buchanan, Mich., has been changed to Clark Equipment Co. No changes in the policies or personnel of the organization will be made other than in position of M. L. Hanlin from general manager to vice-president in charge of the twist drill division. Eugene B. Clark continues as president.

The W. & S. Manufacturing Co., manufacturer of metal stampings, has incorporated under the name of the Worcester Stamped Metal Co., with a capital stock of $150,000. The officers are: President, Harry R. Sinclair; treasurer, Frank E. Billings; clerk, B. M. Whittle. The present company is an outgrowth of the old firm of Wilson & Smith, who have specialized in stamped metal parts of all kinds.

Engineering Laboratories for the Haileybury School of Mines, Ontario, are nearing completion, and the school is now procuring machinery and equipment for them. The laboratories will comprise a complete machine shop, carpenter shop, blacksmith shop, concentrator, cyanide mill, flotation plant and assay office. The school has the coöperation of the mines of the Cobalt district and of manufacturers of mining and other machinery and is always pleased to make arrangements with manufacturers to have their machinery represented in the school.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Operations on Sugar-Mill Rolls

By Frank A. Stanley

SYNOPSIS—Lathes and tools used in turning and grooving sugar-mill rolls. Details of a new system of grooving.

The illustrations in this article show some of the operations on sugar-mill rolls as made by the Honolulu Iron Works Co., Honolulu, Hawaii. The mill rolls for crushing sugar cane are usually made of gray iron or semi-steel. They are big, heavy affairs, requiring large lathes to machine them and a good sized hoisting equipment to handle them. An idea of the proportions of some of these rolls can be gathered from Figs. 1 and 2, the first of these showing a roll in the lathe ready for grooving, while the other view shows a large number of rolls of various sizes in the yards between the shop buildings.

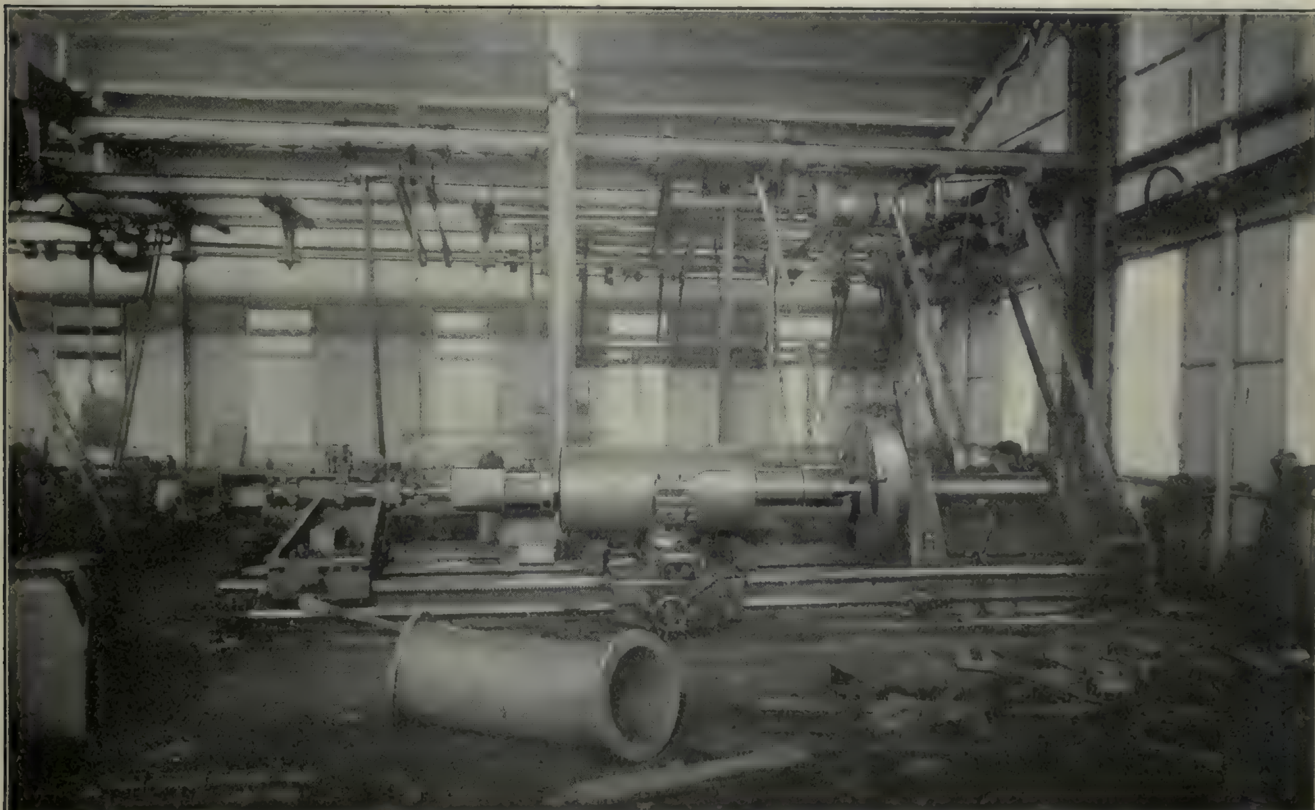


FIG. 1. SUGAR-MILL ROLL SWUNG IN BIG LATHE

The Detrick & Harvey lathe in Fig. 1 swings 56 in. and is provided with two carriages, one in the front and one at the rear, each operated independently, so that two tools or two sets of tools may be applied to the work at opposite sides.

The view in Fig. 1 is from the rear of this lathe, and it will be seen that the carriage at this side is designed for the same facility and control as the regular front carriage. The feed-guide mechanism is operated from special gearing at the head end of the lathe and controlled by the vertical lever below and back of the spindle. The regular cross-slide on the carriage is provided with a swivel head which carries a slide for the tool post, and in this tool holder the cutting tools are securely clamped by the nuts on the four studs. The drive from the spindle gearing is through suitable spur gears to an internal gear ring formed at the back of the heavy face-plate and chuck.

This face-plate is shown more clearly in Fig. 3, where are shown four jaws with their adjusting screws in the face of the chuck. These jaws are set down on the square on the neck of the roll to drive it, and as will be seen, when once adjusted they are secured to the face of the chuck by a pair of bolts and nuts at the sides of the jaws.

A big steadyrest used for supporting the roll for one of its journals during the grooving operations is seen in Fig. 4. The steadyrest jaws here are big cylindrical pieces set up in contact position with the journal, with adjusting screws at the end operated by a socket wrench.

Fig. 5, which represents the grooving operation, also shows the general design of the carriage, tool slide, feed mechanism, and so on.

The process of grooving is carried on with two workmen operating the carriages and tool slides on opposite sides of the roll.

Groove Details

It is important that the feed roll in cane-crushing mills have such a surface as to shape and texture that the cane will be gripped between the feed and the top roll without slipping. Naturally, on this account, a smooth surface is not so satisfactory as a rough one, and it is desirable that the roll material should be such as to retain this rough-

ness of surface during working operations. Ordinarily the rough surface gradually wears away into a smooth condition, and this is likely to cause the rolls to fail in their grip on the cane, permitting slipping of the material and imperfect crushing, so that there is a decrease in the amount of juice pressed from the cane during its passage through the various sets of rolls. This undesirable condition has led sugar-mill engineers to a study of modification in the shape of roll grooves, so that effective feeding of the cane might be secured even though the roll surface itself became smooth after a certain period of operation.

FIG. 2. SUGAR-MILL ROLLS IN SHOP YARD

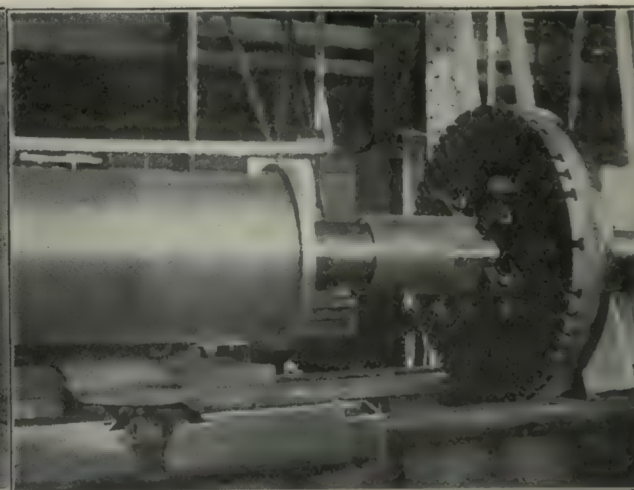


FIG. 3. METHOD OF DRIVING ROLL IN LATHE

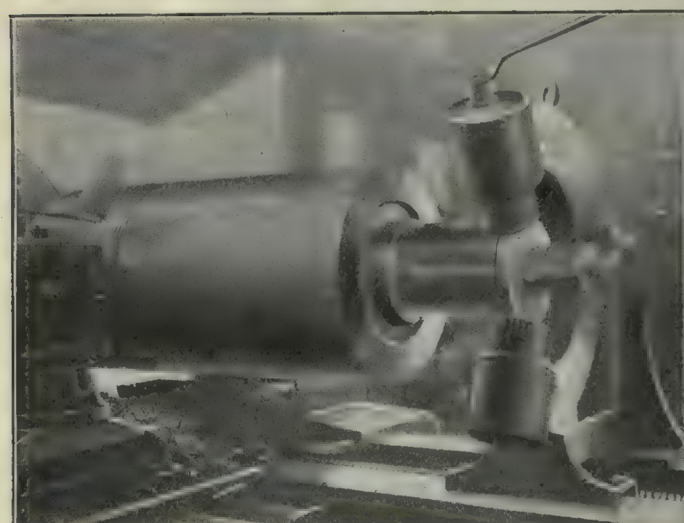


FIG. 4. STEADYREST FOR ROLL NECK

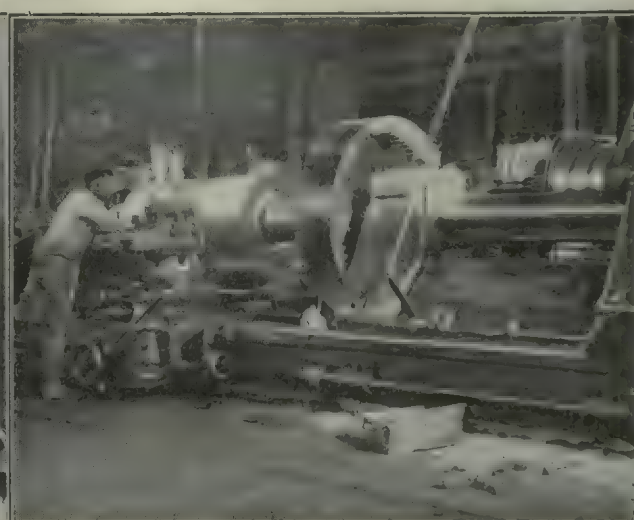


FIG. 5. THE GROOVING OPERATION

Improved Mill-Roll Grooving

Considering now Fig. 6, an obtuse-angle groove is shown. Here *bagasse* (crushed cane) and the juice are mixed in the press and after crushing fall to the bottom of the groove. The tendency of the liquor is, of course, to lubricate the grooved sides and cause slippage. If an acute-angle groove of say 30 deg. is used, as shown there is a wedging action set up, which causes the *bagasse* to be crowded against the sides of the groove, and instead of being forced to the bottom as with the obtuse-angle groove, it leaves an unoccupied lower space, as indicated, for the juice to run off, so that slippage is prevented and the liquor is carried away from the region of the greatest pressure.

The conditions obtaining with this sharp V-groove, as shown in Fig. 6, make it feasible to use in the roll construction any strong close-grained material, such as cast steel, as the surface texture of the roll, and material is no longer a factor affecting the feeding process.

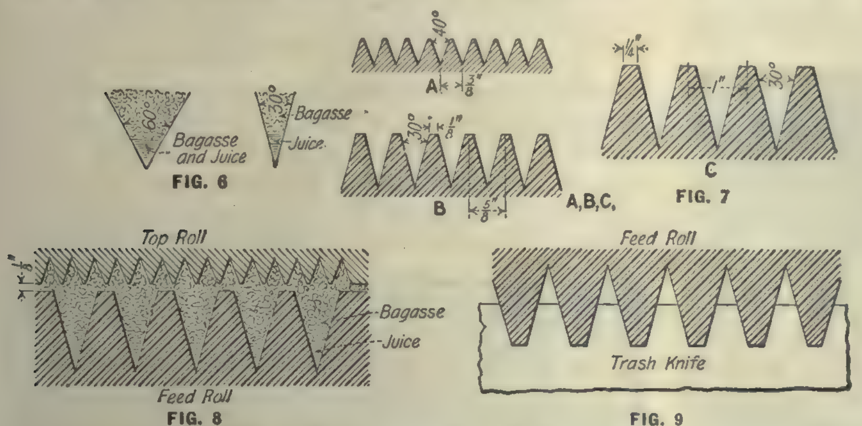
Rolls of cast steel with a 30-deg. groove angle have quite recently been designed and put into service by R. Renton Hind, consulting engineer of the Honolulu Iron Works Co., and the system is known as the Hind-Renton system of grooving.

This angle of groove is, however, the whole secret of satisfactory operation of a feed roll made of cast steel. It makes possible, in the first place, a roll which will operate much longer before requiring redressing, which gives a much longer ultimate life because of less rapid wear, and what is still more important to a sugar manufacturer, it increases, as found by actual tests, the efficiency of the mill by at least 1½ per cent., as measured by the amount of juice from a given weight of cane.

The pitch of the grooves, the width between the tops of the groove and the angle referred to, are all specified in the drawing, Fig. 7, which shows the grooving for the top and discharge rolls, and for feed rolls in the Hind-

Renton system. Fig. 8 shows the relative position of top and feed rolls, illustrating the manner in which the *bagasse* wedges into the sharp V-grooves in the feed roll, leaving the bottoms of the V clear for the juice to pass out, while Fig. 9 illustrates diagrammatically the manner in which the trash knife extends halfway into the groove. This knife, like the feed roll itself, is made of cast steel.

It is interesting to note here the relative wear of this new form of roll as compared with that of the customary



FIGS. 6 TO 9. DETAILS OF THE ROLLS

Fig. 6—Detail of roll grooving. Fig. 7—30-deg. bottom-roll and 40-deg. top-roll grooving. Fig. 8—Relative position of top and feed rolls. Fig. 9—Position of trash knife

iron roll. One of these cast-steel rolls installed in a big mill in Honolulu is in regular operation with a group of iron rolls, and it has been found that the steel roll after a long period of service required a reduction in diameter of $^1/_{64}$ in. only, while the other rolls had to be reduced $\frac{3}{8}$ in. in diameter. This $\frac{3}{8}$-in. reduction represents normal wear of the ordinary roll in a year's time and means that the roll would have to be redressed by turning off twice a year.

It should be noticed in this connection that sugar-mill rolls are trued up by turning off and not by grinding.

In cutting the grooves in these rolls, seen in Fig. 7, a square-nosed tool is first run in approximately to depth, and a series of rectangular grooves are thus formed by feeding the carriage to advance the tool for each cut to suit the pitch of the grooves. A side cutting tool is then used with the cross-slide swiveled to the necessary angle, and the finishing of the groove is accomplished by operating the cross-slide screw to feed the tool along the side of the groove at the angle specified. The two sides of the groove are thus formed to the exact angle required. As already noted, it is possible for two men to work on the roll at the same time, one controlling the movements of the front cross-slide, the other working with the slide on the rear carriage.

The journals of these rolls are of large diameter, and in the mills they are supported in big boxes fitted in seats planed out in the mill housings. The boxes are commonly made in halves and after planing are placed in a suitable holding fixture, where both members are bored on a horizontal machine at one setting.

In connection with the handling of the rolls themselves between the shop and mill, it should be pointed out that it is customary to lag them heavily to prevent injury to the crushing surfaces and bearings. Frequently the rolls have to be hauled by teams to the mills, which in many instances are at a distance from the railroad.

Theoretical and Practical—in Practice

By W. Osborne

Visitors should feel at home at once in getting around in New York City, because it is such an easy city to understand. When one understands it, all one has to do to get to any desired place is to head in the right direction and keep going. That is the theory of getting about, and you can see that there cannot be any argument against it. It is, or should be, as convincing as the reasonings in support of theories of machine-shop management or cost accounting. I was downtown alone in New York City one evening recently and wished to get up to about Thirty-Sixth St. and Broadway. A subway station was at hand, and I wanted to go uptown. The signs said up; the man at the ticket box said up; but that train seemed to come from the wrong direction. Not having any time for argument, I took it and saw by watching the station signs that we were going uptown. On getting off I carefully noted the direction in which the train was going. After the usual maneuvering I finally reached the street. Then, after walking a short distance, I stopped. Of course, I knew (?) that I was going in the right direction, but why did the street run down such a grade? I asked a busy, hurrying individual the direction of uptown. He waved a hand up the grade. If he meant that for an answer, I knew (?) that he was wrong. I asked a number of practical persons and was surprised at their answers. I put the question to a newsboy, without stopping to consider that he was likely to be uneducated. He asked me to tell him where I was trying to go; and when I did so, he gave me clear directions. "Go up grade so many blocks, turn to your left and keep going." After I left him, I got so busy trying to understand why theory and practice did not agree that I lost my bearings again; and if I had not abandoned all my theories and just followed his practical directions, I do not know where I should have landed.

My theory of travel is all right, except that it takes room in my head that should have been filled with practical knowledge of how to get around. I am afraid that some of my friends, as well as myself, are running some lines of shop business in about the same way.

In less than forty minutes I could have walked the distance between the point where I started and the point where I wanted to go, but in going there many things interfered all along the line. Lines of travel did not lead direct. Trains were missed. Crossings were blocked. The wind blew against me. Street signs were not at all street intersections. Building operations obstructed. Others used part of the sidewalks. These are some of the things that interfered with the perfect working of my theory of travel. When I try to put into practice some new theory of shop management, I am sure to find the same kind of departure from perfection, with the added trouble that after spending a lot of effort and time I do not get to the point for which I set out.

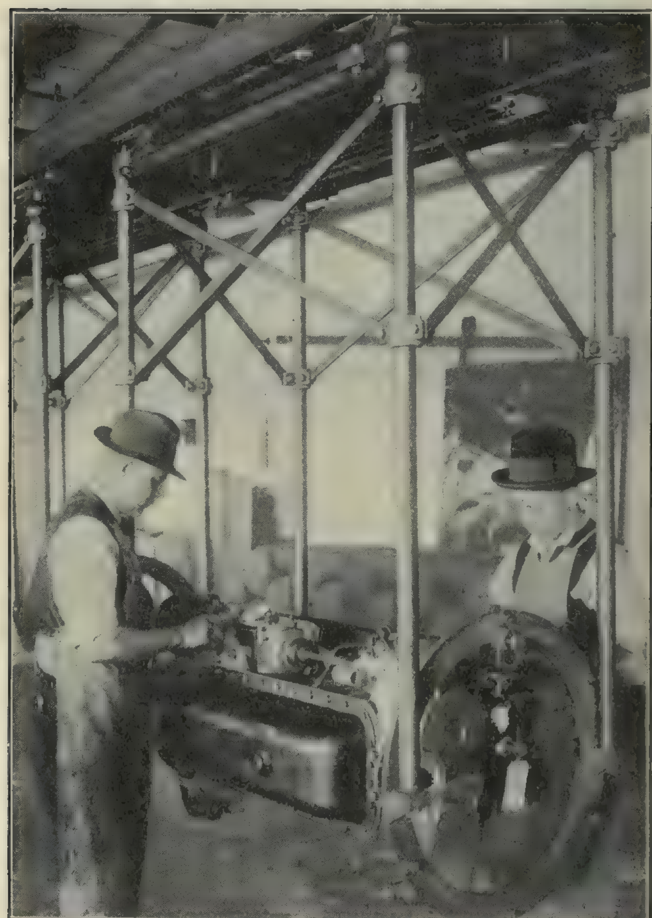
Perhaps some people will not see any connection between this and machine-shop practice.

Continuous Assembling Frame

Editorial Correspondence

Economical assembling of a motor or any other piece of machinery is largely a matter of get-at-ability. This quality has probably been developed more completely in automobile shops than in any other, because of the extremely large numbers turned out, but a little more attention to this feature would help in many other manufacturing establishments.

The illustration shows the assembling frame—it can



ASSEMBLING FRAME IN HUDSON SHOP

hardly be called a stand—used in the Hudson factory. It consists primarily of a four-wheeled truck running on an overhead track. Below the truck is the framework shown, consisting of four pipes with suitable connections, braced by crossed bars and fitted at the lower end with a trunnion or turning device so as to allow the motor to be swung in any position desired. In this way the assemblers can get at any part of the motor by turning it into the position that will be most convenient, an index pin holding it at the various points.

This work is a part of the continuous assembling scheme as the motor is moved along to different points to have different auxiliaries and attachments put in place. At the end of the line—if a closed circuit can be said to have an end—the motor is inspected. If all fittings are in place, it is O. K.'d and removed for testing. Should anything be missing, a tag indicates the missing part. If small repairs are necessary, the motor is removed to a stand and given to a repairman, who does the work required. If, however, it has been necessary to omit assembling operations which have in their turn prevented the succeeding operations being accomplished, the motor is sent around the circuit and goes through the assembly line for a second time.

This form of assembling frame is decidedly convenient and may suggest improvements in methods in shops building other kinds of machinery.

An Hawaiian Welding Plant

Editorial Correspondence

The accompanying illustrations are reproduced from photographs taken in the plant of the Honolulu Welding and Machine Co., Honolulu, Hawaii. Like most of the shops in the Islands, this jobbing and repair shop has a wide variety of work to attend to, including repair jobs for boats, locomotives, automobiles, plantation equipment,

FIG. 1. GAS-WELDING OUTFIT

FIG. 2. WELDING A PLANTATION-LOCOMOTIVE FRAME

etc. It does a great deal of oxyacetylene welding, making use of the Davis-Bournonville torch.

In Fig. 1 are shown gas tanks of 100-cu.ft. capacity for pressures up to 300 lb. per sq.in. These are charged by the two-stage compressor shown at the left of the view. It is cheaper to obtain the gas from San Francisco, but the shop is fully equipped for its manufacture and makes it on the premises with the equipment illustrated.

In Fig. 2 is represented a repair job consisting of the welding of a broken section on a locomotive frame. This is a steel forging, which broke in the offset. It is for a plantation narrow-gage locomotive weighing approximately 10 tons. In the welding operation a 45-deg. angle torch is used, and the weld is made with Norway iron.

The Five Metric Myths

By F. A. Halsey*

SYNOPSIS—The case for the metric system is based on beliefs that came from no-one-knows-where, which are passed on and accepted without proof or investigation. The author states these beliefs and then presents arguments and facts to show their falsity.

Human history supplies no better example of the growth of myth and legend than the development of the case for the metric system, while the acceptance of these myths, without investigation or question, forms a discreditable chapter in the history of modern science. The latest illustration in point is found in the article "A Metrical Tragedy," published in the December, 1915, impression of the *Scientific Monthly*, from the pen of Dr. Joseph V. Collins, who does not pretend to have verified his statements of fact by investigation, but like others simply accepts and repeats statements that he has seen in print many times. The case for the metric system as it stands today is based on the following myths:

1. The system is in universal use except in the United States, the British Empire and Russia, and frequently Russia is placed in the metric column.
2. The adoption of the system is easy and the transition period short.
3. The system leads to an important saving of time in calculations.
4. The system leads to an important saving of time in primary education.
5. The adoption of the system is important in the interest of foreign trade.

It is the object of this article to show these myths to be such.

Myth No. 1: The System Is in Universal Use Except in United States, British Empire and Russia

This myth is an outgrowth of Myth No. 2. The metric party begin by assuming the adoption of the system to be easy. They then find that many countries have passed laws favorable to the system, and they conclude, by easy deduction and because of the assumption, that those countries have really and effectively adopted the system in everyday life. It will be seen at once that the demonstration lacks Euclidean rigor, and under searching investigation it has been turned to ridicule.

Under this investigation the imposing list of countries in which the system is really used in trade and commerce has dwindled to a few in western Europe, where the use of the system is compulsory and the people have no choice.[1] The other countries of the list have passed laws of two general kinds, one of which (like those of the United States and Great Britain) merely legalizes the system[2]—that is, makes its use permissive and contracts based on it enforcible—while the other adopts it as an official government system for the collection of customs duties and other purposes, but without compulsion on the people. Neither has resulted in any appreciable adoption of the system in trade and commerce, while in no country whatever have compulsory laws of the most sumptuary character succeeded in eradicating old units.

Government adoption in the belief that the people will first learn and then adopt the system was the plan of the last Congressional metric bill, and it was expected by the metric party to bring about the general use of the system in two or three years—some thought much less. This plan is known to have been tried fourteen times in as many countries and during long periods of time. It has always failed to bring about appreciable use of the system in trade and commerce or do more than superimpose a special government system on the existing commercial system. This is the present condition in most of Spanish America.

The people everywhere show substantially unanimous preference for their old nondecimal units, even after, in some countries, several generations of use of the new and in spite of the imposition of legal penalties. This preference can be explained in two ways and in two only: Either the old units are preferred because they have been found better for their purpose than the new, after long trial of the latter, or the change from the old to the new system is so difficult that even compulsory laws are not able to bring it about. It is for the metric party to choose between the horns of this dilemma, either of which is fatal to their case.

The broad fact stands out that in no country whatever—France included—have the people adopted the system in trade and commerce because of its supposed advantages. Wherever and to whatever extent it is used in trade and commerce, its use is due to compulsion. Were the advantages claimed for it real, compulsion would long ago have become unnecessary. The adoption of improvements is always because of their merits; and were the metric system an improvement, it would be adopted for that reason.

S. S. Dale, editor of *Textiles*, Boston, Mass., and myself have demonstrated these facts by evidence piled on evidence. This evidence is far too voluminous to be repeated here; but that is unnecessary, as it is on record in the "Transactions" of the American Society of Mechanical Engineers, Vols. 24 and 28. It gives first-hand information from and settles the case for the following countries: Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Cuba, Ecuador, France, Germany, Greece, Guatemala, Honduras, Italy, Japan, Java, Mexico, Nicaragua, Norway, Sweden, Ottoman Empire, Panama, Peru, Philippines, Portugal and dependencies, Roumania, Salvador, Santo Domingo, Spain, Switzerland, Uruguay. A de-

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[1]I give the facts as they were when my investigation was completed. In the meantime I cannot claim to have kept track of the laws of all the earth, and some countries may have changed their laws. This, however, would not imply that they have changed their practice.

[2]These countries belong in the metric column just as much and just as little as the United States and Great Britain do. As a matter of fact, in metric literature intended for circulation in Spanish America the United States—because of this permissive law—has been repeatedly classed as a metric country! Strange, how little is required to make a country "metric" when it is far removed and the facts difficult to discover!

tached but conclusive piece of evidence is found in a nine-page official table of "Nonmetric Units Used in Metric Countries," compiled by the United States Government because required in the custom houses for the assessment of duties on imports which come to us invoiced in the units of the countries of their origin. This table may be found in my book, "The Metric Fallacy."[3]

The simple fact is that no nation has made serious progress toward the adoption of the system in trade and commerce except by the force of compulsory law, and no nation has discarded its old units by compulsion.

These are the simple facts placed against simple assumptions. That the assumptions are widely current and generally accepted does not make them true. Their acceptance is nothing more than a manifestation of credulity—willingness of the metric party to believe and to accept anything whatever favorable to their system. The metric system is the great delusion of our time.

Myth No. 2: The Adoption of the System Is Easy and the Transition Period Short

In April, 1906, the French Minister of Commerce, Industry and Labor, Gaston Doumergue, addressed an official circular letter to the presidents of local French chambers of commerce, of which the full text may be found in the "Transactions" of the American Society of Mechanical Engineers, Vol. 28, and from which the following are extracts:

> My department at different times has been called upon to give to the Department of Weights and Measures instructions for accomplishing the total suppression of the measures and weights prohibited by the old law of July 4, 1837, by the seizure of the prohibited articles. The department in spite of all such efforts has not succeeded in attaining the desired result. The situation appears to be due to the persistence with which certain trades continue to use the prohibited weights and measures.
>
> I have learned that in certain industries the advertisements, prospectuses, catalogs, etc., used by the merchants among themselves and also for sending to their customers contain the illegal expressions. The merchants will invoke, without doubt, the necessity under which they find themselves not to change the existing order of things for fear that thereby they may lose orders for their goods. They thus continue to designate in "lignes" and inches all the articles they sell.
>
> I do not consider it worth while to enumerate here the industries and professions which have continued to employ the prescribed standards, but they are still numerous and most of them known to members of your organization.

The letter concludes with an appeal to the chambers of commerce to use their influence to bring about a renunciation of this illegal practice. Along with this should go the following from the reply of the Chamber of Commerce at Amiens:

> The Chamber considers that, in view of the customs adopted by certain traders, it seems difficult if not impossible to arrive at a complete suppression of the actual conditions; that, moreover, such a radical and immediate suppression would cause profound disturbance in many industries, notably textile manufacturing.

"Such a radical and immediate suppression would cause profound disturbance in many industries"—and this at the end of 112 years of effort and of 70 years of compulsory law!

Note especially that it is in manufacturing industry that the old units are anchored. Reflect that, when the system was adopted in France, modern organized manufacture had scarcely begun; and remembering that 112 years have been found to be insufficient to complete the change under those conditions, ask yourself how many years will be required for the change begun under the present conditions of organized manufacture. The ratio of difficulty is at least equal to the ratio of increase of manufacture.

The Chamber of Commerce at Amiens refers specifically to the textile industry. The largest single industry in France is the manufacture of silk fabrics; and it is a simple fact that, in spite of special compulsory laws,[4] that industry makes no use of the metric system as a mill system except as to the units used in selling its products, for which the law effectively compels their use. The factory operations are conducted with the *aune* as the long and the French *inch* as the short unit of length and the *denier* as the unit of weight. Similarly in Germany, the cotton-mill industry is based on the English *yard* and *pound* and the woolen-mill industry largely on the old German *ells* and *pounds.*

With the case for France officially acknowledged (and proven equally well from other sources) it would be clearly redundant to expand this article beyond reasonable length by presenting the overwhelming accumulated evidence from the countries previously listed, great as are the temptation and the opportunity to do so. The period of transition is claimed to be short; but there is no evidence to support the claim, and it has no weight in view of the fact that no nation in the world has passed even approximately through it.

Myth No. 3: The System Leads to an Important Saving of Time in Calculations

Of all these myths none is more completely accepted as gospel truth than this. It is based on the "inter-relation and correlation of the units," of which so much is made and which, while very pretty theoretically, have no application to the commercial, industrial and technical uses of weight and measure. To illustrate the supposed superior simplicity in the calculations of everyday life, the metric party give hypothetical problems to solve. They assume, for example, a distance of so many miles, furlongs, rods, yards, feet and inches, show the number of figures required to reduce this expression to inches and then give corresponding problems in which distances are expressed in kilometers, hektometers, dekameters, meters, decimeters, centimeters and millimeters and show that the expression can be reduced to millimeters by the simple process of properly locating the decimal point. Similarly, they show the amount of work involved in reducing an immense number of inches to miles, furlongs, rods, etc.; and alongside they place an exhibit showing that millimeters may be reduced to kilometers, hektometers, etc., by merely changing the decimal point.

The trouble with these problems is that they are purely hypothetical. No one has them to do—no reader of these pages has occasion to solve such problems outside of the schoolroom or laboratory. With the exception of feet and inches, which are used in combination, although the tendency is against the practice, quantities are commonly expressed in a single unit. Thus the flow of aqueducts and the capacity of pumping engines and of city reservoirs are given in gallons and the strength of materials

[3]Bound up with "The Metric Failure in the Textile Industry," by Mr. Dale. This book records many discoveries not included in the foregoing citations and in particular the almost unbelievable confusion of measurements and calculations of the Continental European textile industries. This confusion is the result of a mixture of systems of which I shall have more to say later.

[4]The effect of these laws has been to compel the marking of equivalent metric sizes on the tickets along with the denier-aune sizes which continue to be used by the trade.

in pounds per square inch. Similarly, when we buy small quantities of things at the drug store, we do it by the ounce and its fractions, while if we buy larger quantities at the grocery, we do it by the pound and its fractions—pounds and ounces being practically never mixed. Again, we buy milk by the quart, gasoline by the gallon, grain by the bushel and cement by the barrel, but no reader of these pages ever sees the units used conjointly. The civil engineer uses the mile as his long, and the foot as his short, unit of length—these units being divided decimally for the purposes of measurement and calculation—but he seldom or never uses the two in combination. His unit of excavation is the cubic yard, but like the others it stands alone. Reduction, ascending and descending, among these units is one of the rarest of problems, and the ratios between them are about the least important things that ever provoked a heated discussion.

Not only is this the method by which these units are used, but it is the manner in which they were intended to be used. Units of different sizes—English and metric alike—are provided in order that those suitable for various purposes may be available. The quart being suitable for the amount of milk commonly purchased, the quart is used for that purpose, while the gallon being suitable for the amount of gasoline commonly purchased, the gallon is used for that purpose. For the same reason the ounce is used for the purchase of drugs, the pound for groceries and the ton for coal. The use of a mixture of units for the same purpose is uncalled for and unnatural, and its appearance in the problems referred to is simply a case of manufacturing evidence to suit the case that it is desired to prove.

This use of units nullifies the argument for simplicity of calculations, and it reduces to insignificance the importance of the ratios between units. For purposes of calculation our units may be divided decimally,[5] as they usually are when they fall into perfect harmony with decimal arithmetic. When units are used in this way, no discoverable difference in the time required for calculations in the English and the metric systems has ever been shown, because none exists. The engineer calculates stresses or pressures in pounds per square inch with absolutely the same simplicity of calculation that he does in kilograms per square centimeter. So, also, the dimensions of structural members are calculated in inches with the same degree of simplicity as in millimeters, and hydraulic calculations in gallons are as simple as in liters.

Regardless of endless iteration and reiteration to the contrary, these statements are facts. The claimed simplicity of calculations is the outgrowth of the "inter-relation and correlation of the units." When we confine ourselves to a single unit, there is neither inter-relation nor correlation, and the supposed advantage vanishes.

When calculating weights, we multiply the volume by the specific gravity in the metric system and by the weight per unit of volume in the English system, consulting a table for the required constant in either case. There is not a shadow of advantage in either procedure, except when calculating the weight of a tank of water; and in the one field of human endeavor in which this might be of appreciable value (naval architecture) it vanishes in the increased gravity of sea water.[6]

In commercial transactions no one has shown and no one can show the slightest advantage in the purchase of dry goods by the meter as against the yard, groceries by the kilogram as against the pound or milk by the liter as against the quart. The claim which one often sees that the metric system would be a protection against short weight is of course absurd. There is nothing to prevent the making and using of short metric with the same facility as short English measures.

Equally absurd are the claims that "calculations in the metric system are two or three times as accurate as in the English system" and that "calculations always come out in even figures in the metric system."[7] After completing his calculations the English designer adjusts his result to the nearest eighth or sixteenth and the metric designer to the nearest tenth, and between these procedures there is not the suspicion of a choice.

While I am disposing of these minor fallacies, how about the adoption of standard meridian time, so often cited to illustrate the ease of these changes? That action involved no change in any unit of measurement; no scrapping of measuring instruments, gages, factory and commercial equipment; no change in concepts of value; in expressions for the time of events or for the value of intervals of time. It involved no physical change of any kind, except the setting of the clock to agree with the new noon hour. And we are asked to consider this a precedent for doing all the things that were here not done. Shallow thinking can go no farther.

Myth No. 4: The System Leads to an Important Saving of Time in Primary Education

The alleged saving of time by adoption of the metric system is commonly stated to be from one to two years of each school child's life. Dr. Collins gives as a "conservative expert estimate" two-thirds of a year. The statement, using various intervals of time, is a stock one in metric literature, but its source is never given. No one tells us when, where or by whom the estimate was made, but each metric author repeats it, without question, from some previous writer and passes it on to the next. An inquiry into its truth shows it to be the grossest of exaggerations.

When preparing my Cornell University lecture on this subject, I gave the results of an investigation based on an official pamphlet—the "Course of Study for the Elementary Schools of New York [City] as Adopted by the Board of Education"—and these results I shall repeat

[5]The metric party labor under a strange hallucination that they possess a monopoly of decimal arithmetic, and they hail every use of decimals as a concession to their claims. Decimal fractions are of course centuries older than the metric system. So far from inventing decimals, the fathers of the metric system merely attempted to discard other fractions. Metric partisans might as reasonably claim exclusive use of the Arabic notation or of the Roman alphabet.

[6]While there is no advantage in either procedure, nevertheless of the units most used for the purpose (the inch and the millimeter) the English unit is the larger and expresses the same dimensions in fewer figures. Above about 4 in. the millimeter always requires at least three figures; and above about 40 in. at least four. This results, in the average case of calculation, in fewer figures with the English system. While this is a fact, it is too trifling a matter to deserve mention here except to counter the grandiose and ridiculous metric claims. The subject is, moreover, of little more than academic interest, as the procedure described is in practice used relatively but little. The leading calculators of weights are engineers, architects and shipbuilders. In the case of castings the procedure described is followed, with such balance of advantage as there is on the English side. The weights of the other materials used are tabulated with great completeness in pounds per hundred and per foot of length or area. Actual calculations of the weights of structures are made by the use of these tables, and the labor involved is determined not by the system of measurements used, but by the completeness of the tables available.

[7]The quotations are from the article by Dr. Collins, to which this is, primarily, a reply.

here. This pamphlet contains a tabulated statement of the schedule of the schools of New York. Each column of this table relates to a year and each line to a subject of study, the entries opposite each subject being the number of minutes per week devoted to that subject during that year. The footings of the columns are in all cases 1,500, which is the number of minutes comprised in the school sessions of a week—that is, 5 days of 5 hours of 60 minutes each. The figures for mathematics are as follows:

	Year 1	2	3	4	5	6	7	8
Minutes per week....	120	150	150	150	150	200	200	160

The seventh year is devoted to algebra and geometry and does not enter the present calculation. Part of the eighth year is also given to these subjects; but as the amount is not stated, I will give good measure and charge all of that year to arithmetic. The school year comprises 40 weeks, and $40 \times \frac{120}{1,500} = 3.2$ weeks is the equivalent time spent on arithmetic during the first year. In the same way we may obtain the time to be charged to this subject for the other years and add them up thus:

Year		Weeks
1	$\frac{120}{1,500} \times 40 =$	3.2
2	$\frac{150}{1,500} \times 40 =$	4.0
3	$\frac{150}{1,500} \times 40 =$	4.0
4	$\frac{150}{1,500} \times 40 =$	4.0
5	$\frac{150}{1,500} \times 40 =$	4.0
6	$\frac{200}{1,500} \times 40 =$	5.33
7	Algebra and geometry	
8	$\frac{160}{1,500} \times 40 =$	4.27
Total		28.8

28.8 weeks = 6.63 months.

My readers cannot fail to admit that the attempt to save eight months' time by the omission of part of less than seven months' work is fraught with difficulties; and, mark, this is no one's estimate, but the actual practice of the largest unified system of schools on earth. No one living can obtain a different result from the same data.

This pamphlet gives no clew to the amount of time spent on denominate numbers and weights and measures and, to determine this, I have counted the number of pages devoted to this subject in the school arithmetic[8] used by my own daughters and find that these pages comprise almost exactly 20 per cent. of the entire book. Assuming that the time spent upon a division of a subject is proportional to the space occupied by it in the textbook—and this assumption cannot be far wrong[9]—we find that the time devoted to denominate numbers and weights and measures is $28.8 \times 0.20 = 5.76$ weeks, and even my pro-metric readers will observe that the difficulties in the way of saving eight months' time are rapidly thickening.

[8]"Wentworth's Practical Arithmetic." A collection of miscellaneous examples and an appendix containing the various rules for partial payments, etc., which few study nowadays, are omitted from consideration. To include these would strengthen my case.

[9]This subject certainly consumes far less time per page than the multiplication table or the subjects of square and cube roots.

But this is not all. Had we the metric system and had our present system vanished into oblivion, we would still have with us the year divided into months, weeks and days, the day divided into hours, minutes and seconds and the circle divided into degrees, minutes and seconds. We should still have the subjects of interest and discount involving the divisions of the year, longitude and time connecting the divisions of the circle with those of the clock dial; and had the last Congressional bill as drawn by the metric party been passed, we would have our old land measure, for the survey of the public lands was expressly exempted from the provisions of the bill.

Moreover, some of us must learn trigonometry, while surveyors, draftsmen and mechanics must continue to deal with angles and with the units by which they are measured, and with these units all must be acquainted. Clearly, these subjects must still be taught and with them denominate numbers of which they are examples—not, of course, with the same fullness of illustration, but otherwise very much as now. Clearly, also, the time required for these subjects must be subtracted from the previously mentioned 5.76 weeks to get the net amount. I shall make no effort to determine the remaining modicum of saving, for certainly the case has been made sufficiently ridiculous already.

During the transition period both systems must be taught and there would be no gain. If, as all know, the metric system is not now taught effectively, more time must be given to it and the net result would be a loss.

Myth No. 5: Adoption of the System Is Important in the Interest of Foreign Trade

Twenty years ago there began one of the most striking of our export trade developments—the export of machine tools to European countries, France and Germany being our leading customers. This great movement continued down to the opening of the present war, which stopped it to Germany, but accelerated it to France. However, this influence being abnormal, it should be ignored.

Machine tools are the embodiment of accurate measurements, and more to the point, on them all other machines of whatever kind and purpose are made and the dimensions of their parts determined. Here, if anywhere, the need of the adoption of the metric system should be paramount, but what are the facts? Certain of these machines, notably lathes and millers, contain measuring and adjusting screws (lathes two and millers three) and these in some (but by no means all) cases have been called for to metric pitches. The pitches of such screws comprise all of the thousands of dimensions of these machines that have needed change. Apart from them, these machines have proved just *as acceptable to French and German as to American and English customers.*

These facts are officially certified in a series of resolutions of the National Association of Machine Tool Builders which contain the following:

> The sale of many million dollars' worth of machine tools has been made abroad by members of this association, especially to France and Germany, without requirement or request by the purchasers for changes in general construction to conform to metric measurements, the only changes being in adjusting and measuring screws, the great majority of machines needing no changes whatever.

If confirmation of this is needed, it is found in the following from Laurence V. Benét, engineer of Hotchkiss & Cie., the great French ordnance makers:

We are using a very large amount of American machinery in our works, and the fact that this was all built to English dimensions has given no difficulty. . . . All of the newer and most uptodate establishments in France, including all of the Government establishments, are largely equipped with American machinery, and I know of no case where the fact of the machines being built to English measures affected their salability.

In the machine shops of South America—of which there are more than most people realize—39.3 per cent. of the machine tools are American, 43.2 per cent. are British and the remaining 17.5 per cent. are German, Belgian and French. We are always told that South America is metric. South American shops have the world from which to buy, and they choose machine tools made to English over those made to metric measures in the ratio of nearly 5 to 1.

Another illustration, known to all, is found in the vast export trade in American automobiles, which go to, and are equally acceptable in, all countries, metric and nonmetric alike. No one knows, asks or cares to what system of measurements their parts are made, and the same is true of steam engines, mining, agricultural and other lines of machinery.

The matter is as broad as it is long. If our goods are not acceptable in metric countries because of the units used in making them, metric goods should for the same reason be unacceptable here. We import vast quantities of such goods, but no reader of these pages ever heard the question raised. We buy these goods without thought or question regarding the system of measurements used in their construction.

There is a certain amount of information, as distinguished from construction, that should be given to a foreign buyer in his own units of measurement, be they metric or nonmetric. Of machine tools, for example, the capacity or dimensions of the largest piece of work to which they are adapted, the dimensions of the space occupied and the weight should be given in the customer's units. We print our catalogs for foreign buyers in their own languages, and it would be of large advantage to ourselves if we could conduct correspondence in those languages. This most of us cannot do, but we can give commercial and general information and invoice goods in foreign weights and measures. This it is the most common of commonsense to do, and this is all there is of the foreign-trade myth.

To say that this involves the adoption of the metric system is equivalent to saying that the printing of catalogs for, or the writing of letters to, Spanish America in the Spanish language involves the adoption of that language. To say that the steel mills of Pennsylvania shall change their entire mill practice and procedure, as I shall describe at great length later on, in order to invoice shipments in metric instead of English tons is preposterous.

Here again we place fact against imagination, and again imagination goes to the wall.

And now is the title of this paper justified? Am I right in saying that the acceptance of these myths without question or investigation is a disgrace to science? But will this showing of the hollowness of the metric claims influence the metric party? I wot not, for belief in the system is not in reality based on these claims. It long since passed that stage and became what it now is, a sort of religion, with corresponding intensity of conviction and superiority to mere argument. Under these conditions it is useless to expect a dyed-in-the-wool metricite to be influenced by the demolition of his case.

It is something (I think it a good deal) to show that the claims for the metric system have no basis of fact, but being a negative argument, it is not enough. There remain the reasons for the united opposition of manufacturing interests, and these I shall endeavor to explain in a succeeding article. Respect for limitations of space will, however, compel me to omit discussion of the pecuniary cost, of the consequences of our unfortunate system of decimal arithmetic, of the superiority of binary over decimal divisions for purposes of manufacture and of the dominance of measures of length over those of weight and capacity.

Critical Speeds of Rotors Resting on Two Bearings

By Walter Rautenstrauch*

SYNOPSIS—In this article are analyzed the case of a rotor resting on two bearings and the formulas used to obtain the critical speeds. Not only are the formulas given, but the graphical methods are shown to obtain the bending and deflection moments.

The rotors of steam turbines are usually investigated for critical speed in order to insure the safe operation of the unit. The construction of these rotors is generally such that the usual formulas for the critical speeds of loaded shafts are not directly applicable. This will be apparent from an inspection of Figs. 1 to 7. Fig. 1 shows a rotor having a shafting of varying cross-section and multiple loads, but since the major part of the shaft is 15 in. in diameter it is evident that the deflection of this shaft will very closely approximate the deflection of a shaft 15 in. in diameter throughout the entire length. This case can therefore be solved by the use of Dunkerley's semi-empirical equation

$$\frac{1}{N^2} = \frac{1}{N_1^2} + \frac{1}{N_2^2} + \frac{1}{N_3^2} + \cdots + \frac{1}{N_n^2} \qquad (1)$$

where

N = critical speed of shaft with multiple load, and N_1, N_2, etc. = critical speed of shaft with each single load alone.

The same is true with regard to Fig. 2. In this case the mean diameter of the shaft should be used. Usually the running speeds of the turbines are so far removed from the critical speeds of the rotors that approximate solutions are sufficient to disclose the margin of safety had. Some judgment must be exercised in approximating

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the several factors used in the computations. For example, the De Laval rotor shown in Fig. 3 closely approximates the case of a shaft of uniform section throughout its length carrying a single load. The shaft, however, is continuous over several bearings and furthermore the disk and couplings are very stiff so that the deflection is less than for a continuous small shaft. Accordingly, there will be found extremes between which the critical speed will lie. In the first place it may be assumed that the case is one of a shaft 22 in. long and $1\frac{3}{16}$ in. in diameter carrying a load of 210 lb. (weight of disk and blades) at a point 14 in. from one bearing. It may be further assumed that the ends of the shaft are simply supported. The assumption of these conditions will give the lowest critical speed which is found to be as follows:

$$n = \frac{1}{2\pi}\sqrt{\frac{3\,gEIl}{Wa^2b^2}}\ rev.\ per\ sec. \qquad (2)$$

Let

$E = 30{,}000{,}000$ lb. per sq.in.;
$I = 0.094$ in.^{4};
$g = 32.2\text{x}12$ in. per sec.^{2};
$l = 22$ in.;
$a = 14$ in.;
$b = 8$ in.;
$W = 210$ lb.

Then

$$n = \frac{1}{6.28}\sqrt{\frac{3 \times 32.2 \times 12 \times 30 \times 10^6 \times 0.094 \times 22}{210 \times 14^2 \times 8^2}}$$

$= 26.9$ per sec.;
$N = 1{,}614$ per min.

Now let it be assumed that the stiffness of the disk and couplings affects the shaft deflection such that an equivalent length of $16\frac{1}{2}$ in. is had and (a) $= 11\frac{1}{4}$ in., (b) $= 5\frac{1}{4}$ in., also that the one end of the shaft is fixed and the other end is free. Accordingly, it is found that

$$n = 10.86\sqrt{\frac{EIl^3}{W[a^3b^2(3a+4b)]}} \qquad (3)$$

$n = 67.9$ per sec.;
$N = 4{,}075$ per min.

If the assumption be made that the bearings are fixing the direction of the shaft while the equivalent length of shaft is $16\frac{1}{2}$ in., it is found that

$$n = 5.04\sqrt{\frac{EIl^3}{Wa^3b^3}} \qquad (4)$$

$n = 98.8$ per sec.;
$N = 5{,}928$ per min.

The running speed of this turbine is 10,000 r.p.m., which is well above the lowest critical speed under any of the conditions assumed. The next critical speed under each of these conditions will be $4 \times 1{,}614 = 6{,}456$ r.p.m. for the first case; $3.24 \times 4{,}075 = 13{,}285$ r.p.m. for the second case, and $2.75 \times 5{,}928 = 16{,}302$ r.p.m. for the third case.

It will appear therefore that the nominal running speed of the shaft does not lie dangerously near either the first or second probable critical speeds. In bringing the turbine up to speed the first critical speed is passed through, but since the time element during which the critical speed obtains is very small, no serious consequences result.

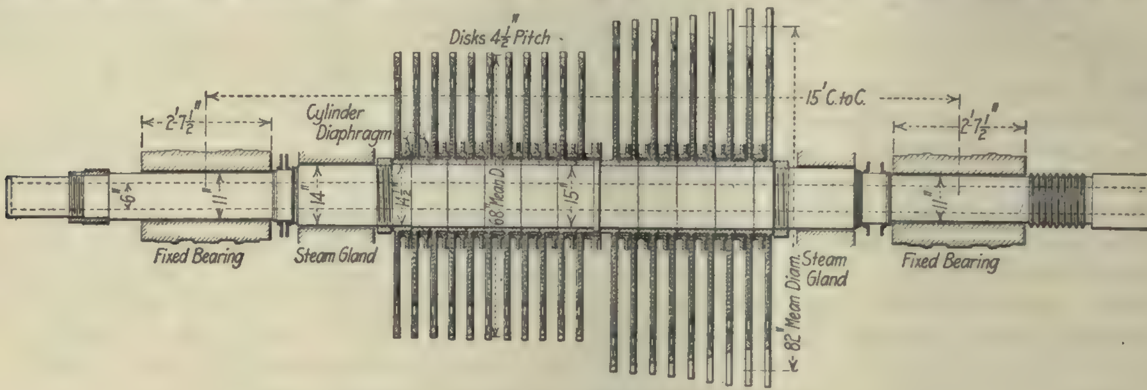


FIG. 1. ROTOR FOR ZOELLY TURBINE

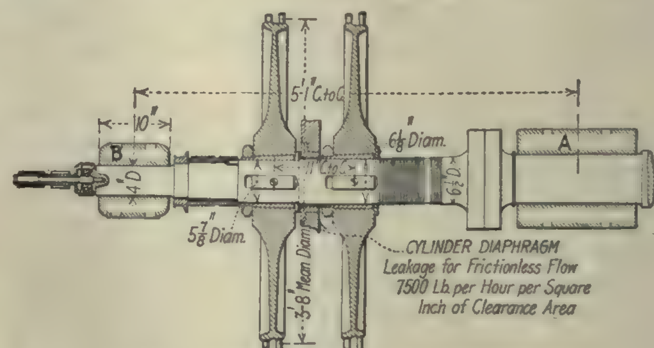


FIG. 2. ROTOR FOR A. E. G. TURBINE

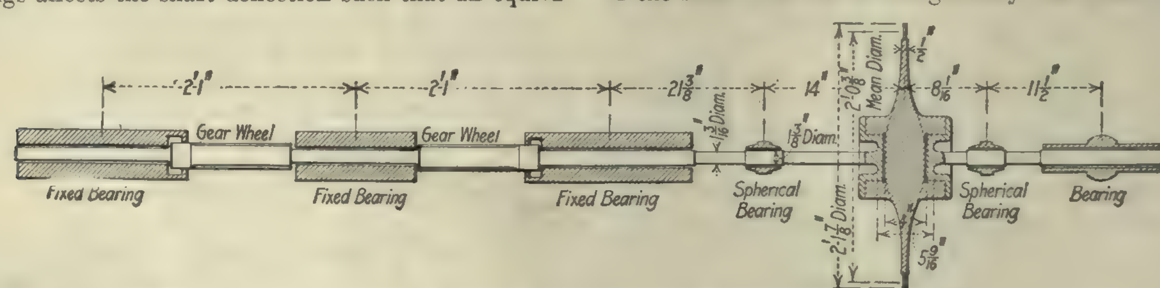


FIG. 3. ROTOR FOR DE LAVAL TURBINE

When the rotor is made up of a drum or a combination of drum and disk, as shown in Figs. 4, 5, 6 and 7, it is necessary to account for the variable cross-section of the rotor in determining the probable critical speed, and this is most readily accomplished by graphical methods.

The successful solution of this problem requires a careful regard for the units and scale factors of the diagrams used, and therefore it will be well to consider at this time the general problem of loading and deflection of beams and their representation by graphics.

Let Fig. 8 (a) represent a beam freely supported at the ends having a length l and loaded with a variable unit

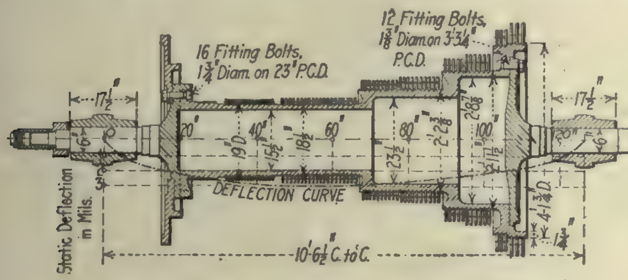


FIG. 4. REACTION TURBINE ROTOR

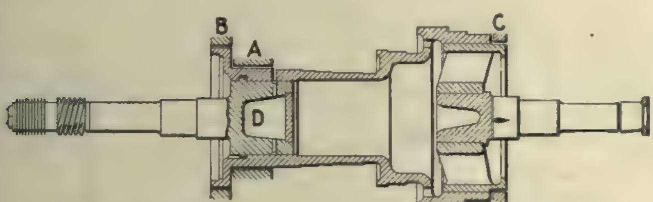
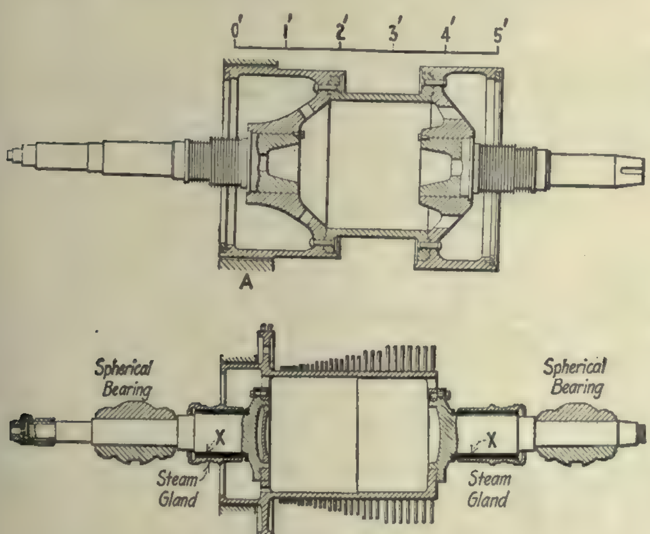


FIG. 5. DRUM TYPE ROTOR WITH TWO BEARINGS



FIGS. 6 AND 7. TWO CASES OF ROTORS SUPPORTED ON TWO BEARINGS

load throughout its length. Let the load per inch length at a distance x from the supports be W_x and let the ordinates of the load curve be drawn to the scale 1 in. = p lbs. per inch length of beam. If the scale to which l is drawn is 1 in. = q in., then 1 sq.in. of the loading diagram is to be read to the scale 1 sq.in. = pq lb. The shear diagram shown in Fig. 8 (b) measures the vertical shear throughout the length of the beam. Thus at a distance x from s the shear $J_x = \int_o^x wdx - R_s$ where R_s is the reaction at the support s.

If the scale to which the ordinates of the shear diagram are laid down is 1 in. = n sq.in. of the loading diagram (Fig. 8 [a]) then the area bounded by the shear diagram is to be read to the scale 1 sq.in. = npq^2 in.-lb. and the ordinates in the shear diagram are to be read to the scale 1 in. = npq lb. The resulting bending moment is shown in Fig. 8 (c). The bending moment at a distance x from the support s is M_x. If m sq.in. in the shear diagram equal 1 in. of bending-moment ordinate, then the scale to which the bending-moment diagram is to be read is 1 in. = $mnpq^2$ in.-lb. and 1 sq.in. of area in the bending-moment diagram is to be read to the scale 1 sq.in. = $mnpq^3$ in.-lb.

The slope of the beam under this load is shown in Fig. 8 (d). The slope at distance x from s is $i_x = i_s + \frac{EI}{1}\int_o^x Mdx$ where i_s is the slope at the supports. If o sq.in. in the moment diagram represent 1 in. ordinate in the slope diagram, then the scale to which the slope ordinates are to be read becomes 1 in. $= \frac{omnpq^3}{EI}$ radians, and therefore 1 sq.in. area in the slope diagram is to be read to the scale

$$1\ sq.in. = \frac{omnpq^4}{EI}\ inches$$

The deflection of the beam throughout its length is shown in Fig. 8 (e). At a distance x from s the deflection is Y_x. If r sq.in. in the slope diagram represent 1 in. ordinate in the deflection diagram, it will appear that the ordinates in the deflection diagram are to be read to the scale 1 in. $= \frac{romnpq^4}{EI}$ inches.

The above example will serve to fix in mind the scale to which the deflection curve is to be read. In laying out a deflection curve it will only be necessary, however, to lay out the loading and bending-moment diagrams from which it is possible to construct the curve of deflection. The following example will make this method clear.

In Fig. 9 is shown a beam l in. long acted upon by an irregularly distributed load. The beam is of uniform cross-section throughout its length, hence I is constant. Let the ordinates in the load diagram be drawn to the scale 1 in. = p lb. per in. run and the length be represented by the scale 1 in. = q in. Then 1 sq.in. of ordinate in the loading diagram represents pq lb. Divide the load diagram into sections (a), (b), (c), (d), etc., as shown, and measure the area of each section by planimeter. Begin the construction of the first vector polygon by laying down a vertical line and laying off the distances (a), (b), (c), (d) successively to represent the areas (a), (b), (c), (d), etc., in the load diagram.

Let the scale to which (a), (b), (c), (d), etc., in the first vector polygon are laid down equal 1 in. = m sq.in. of area in the load diagram. Select a point o to the left of the load line by a distance h and construct the vectors 1, 2, 3, 4, etc., as shown in the first vector polygon. Draw the mean lines (dotted) through the sections (a), (b), (c), (d), etc., of the load diagram, and selecting any point on TU draw the bending-moment diagram by constructing the elements 1, 2, 3, 4, etc., of the bending-moment curve parallel to the vectors 1, 2, 3, 4, etc., of the first vector polygon and terminating in the mean lines through (a), (b), (c), (d), etc., of the load diagram. The ordinates of the bending-moment diagram are to be

read to the scale 1 in. = $mpqh$ in.-lb. and 1 sq.in. of area in the bending-moment diagram will represent mpq^2h in.-lb.

The areas A, B, C, D, etc., in the bending-moment diagram lying under the segments 1, 2, 3, 4 of the bending-moment curve are to be found and laid off as a load line in the second vector polygon, as shown in Fig. 9. Let the scale to which the areas A, B, C, D are laid down in the second vector polygon be n sq.in. area in the bending-moment diagram equal 1 in. Select a pole o' a distance h' from the load line and construct the vectors 1′, 2′, 3′, 4′, etc. Select any point in the line TU and construct the elements 1′, 2′, 3′, 4′ of the deflection curve parallel to the vectors 1′, 2′, 3′, 4′, etc., of the second vector polygon. The scale to which the deflection ordinates are to be read will be 1 in. = $\frac{nmpq^3hh'}{EI}$ where I represents the moment of inertia of the beam.

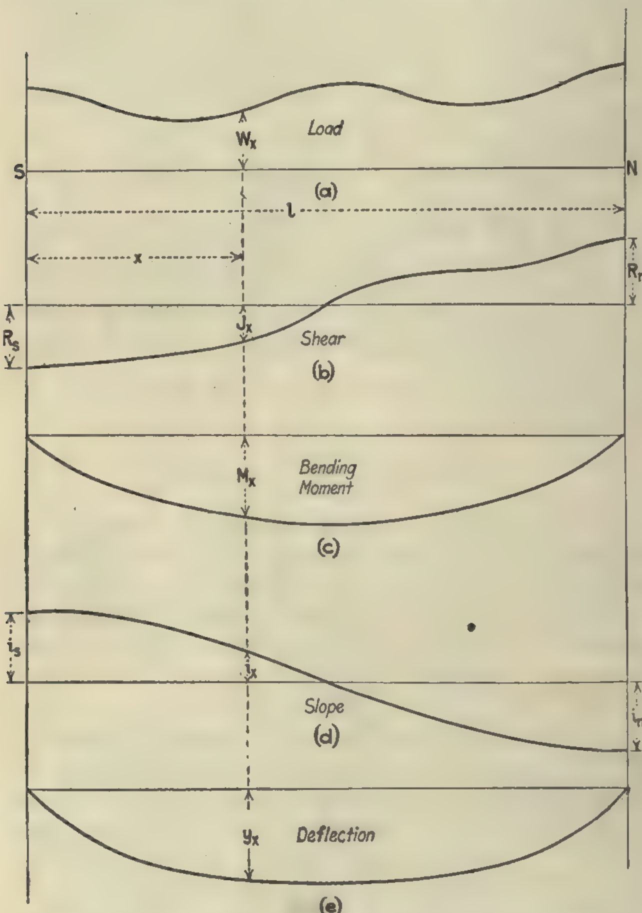


FIG. 8. ANALYSIS OF DEFLECTION ON A BEAM

When the beam is not of uniform cross-section throughout the length as is the case with many turbine

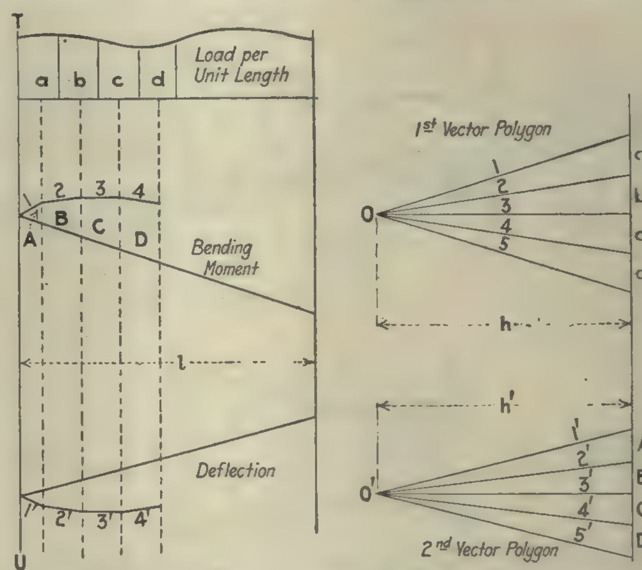


FIG. 9. ANALYSIS OF BEAM WITH IRREGULARLY DISTRIBUTED LOAD

rotors, it will be necessary to select the moment of inertia of some one element of length for use in the deflection-curve scale, and after the bending-moment diagram is found according to the above instructions each ordinate is to be multiplied by the ratio $\frac{I_x}{I}$, where I_x is the

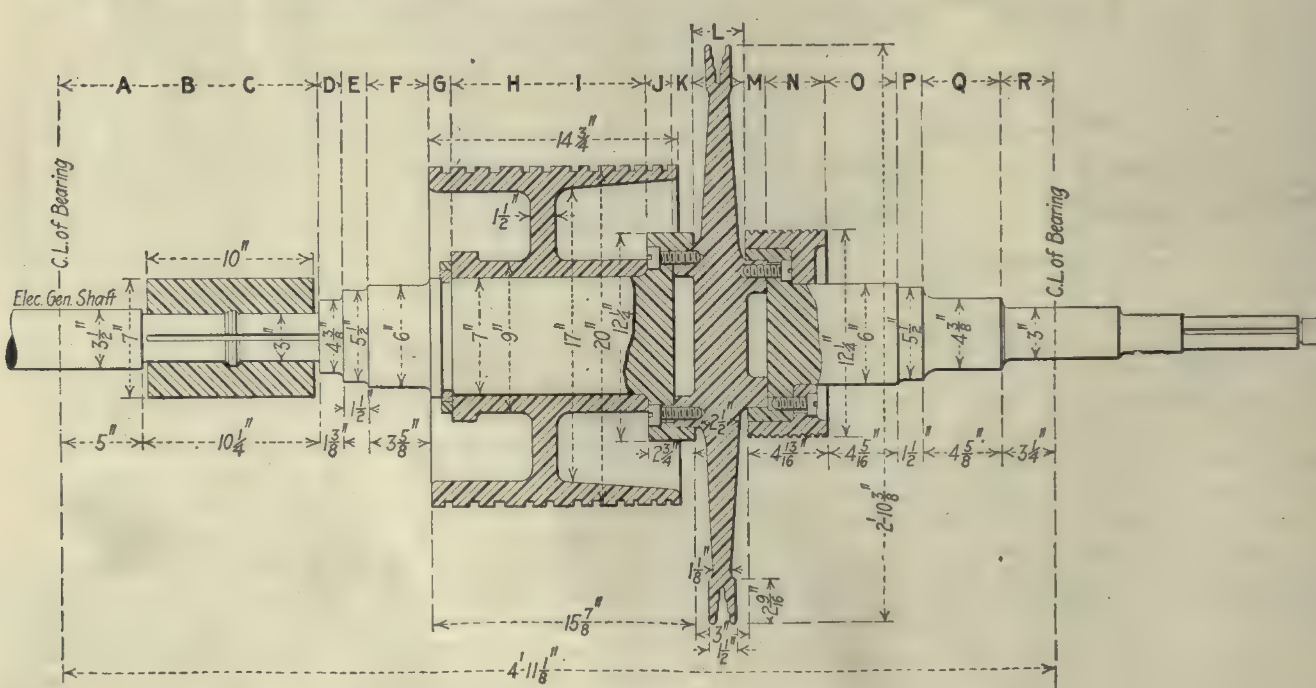


FIG. 10. DETAIL OF TURBINE ROTOR

moment of inertia of the section to which the particular ordinate of bending moment relates. From this modified bending-moment diagram the deflection curve is to be reconstructed.

This procedure is disclosed in the solution of the following examples:

Determination of the Critical Speed of a 500-Kw. Impulse Reaction Turbine Rotor

The rotor shown in Fig. 10 is directly connected at the left end to an electric generator shaft. The determination of the critical speed requires first the determination of the load diagram of the shaft. This load to include the weight of the shaft as well as the weights of all the attached parts. It will be found convenient to divide the length of the shaft into sections $A, B, C, \ldots Q, R$ as shown in Fig. 11 for the purpose of conveniently estimating the weights of the several parts of the rotor and distributing the load along the length of the shaft axis. Some judgment must be exercised in making these computations in order that too much labor be not entered into when the conditions of the problem to be considered do not justify the expenditure of a great deal of time.

The sections A, B, C are assumed to be equivalent to a 3-in. shaft for the reason that the additional weight of the coupling will probably be compensated for by the greater stiffness. At least the situation is unknown since the stiffness will depend on the accuracy of the fit. Furthermore, taken one way or the other the critical speeds resulting will not be noticeably different.

The load for each section is found and set down in the following table:

LOADS FOR VARIOUS SECTIONS OF A TURBINE ROTOR

Section	w Load, Lb.	y Deflection, In.	y^2	wy	wy^2
A	10.17	0.00185	0.00000342	0.01883	0.0000348
B	10.17	0.00488	0.00002381	0.04970	0.0002423
C	10.17	0.00673	0.00004530	0.06850	0.0004622
D	5.85	0.00640	0.00004096	0.03740	0.0002400
E	10.05	0.00636	0.00004045	0.06400	0.0004065
F	29.00	0.00623	0.00003881	0.18100	0.0001125
G	14.56	0.00601	0.00003612	0.08740	0.0005252
H	335.95	0.00560	0.00003136	1.88000	0.0105369
I	335.95	0.00483	0.00002333	1.61300	0.0078388
J	44.81	0.00437	0.00001909	0.19700	0.0008510
K	27.50	0.00420	0.00001764	0.11550	0.0004850
L	771.30	0.00388	0.00001505	2.99264	0.0116806
M	30.00	0.00357	0.00001267	0.10710	0.0003801
N	112.00	0.00321	0.00001030	0.35800	0.0011536
O	36.00	0.00263	0.00000692	0.09400	0.0002490
P	10.05	0.00208	0.00000432	0.02110	0.0000434
Q	20.19	0.00149	0.00000222	0.03028	0.0000448
R	6.50	0.00049	0.00000024	0.00325	0.0000015

The first vector polygon is drawn as found in Fig. 11 with a load scale of 1 in. = 200 lb. and a pole distance

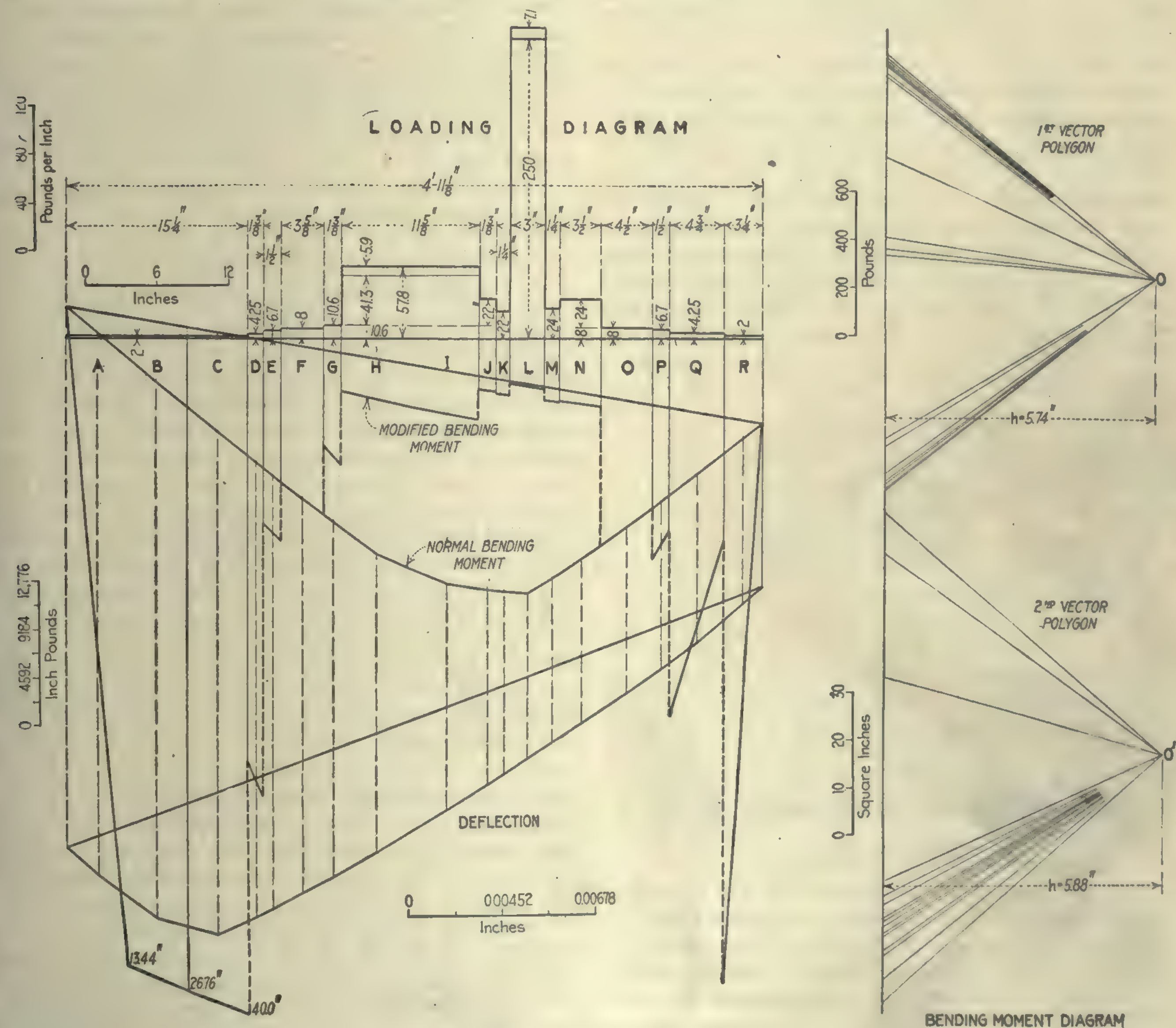


FIG. 11. CRITICAL SPEED FOR TURBINE ROTOR

$h = 5.74$ in. Verticals are constructed through the middle of each section of length in the load diagram for the purpose of locating the terminus of each segment of the bending-moment curve. The *normal* bending-moment curve is then found as above described. Since the shaft is not of uniform cross-section throughout its length, the influence of variable cross-section in the deflection of the shaft is accounted for by multiplying each ordinate of the normal bending-moment diagram by the ratio

$$\frac{I \text{ (selected section)}}{I_x \text{ (any section)}}$$

In these computations the selected section is section F, 6 in. in diameter, and the other sections are referred to it. Thus the ordinates in the normal bending-moment diagram under section D are multiplied by the quantity $\frac{I_F}{I_D}$ to determine the ordinates of the modified bending-moment diagram from which the deflection curve is ultimately determined. The scale to which both bending-moment diagrams are to be read is 1 in. $= 200 \times 4 \times 5.74 = 4{,}572$ in.-lb.

The load line of the second vector polygon is laid down to the scale 1 in. = 10 sq.in. of bending-moment diagram, each successive element of the load line corresponding to the areas in the modified bending-moment diagram under each successive element of length $A, B, C \ . \ . \ . \ R$. The deflection curve is then found as shown, and the ordinates passing through the middle of each element in sections of length are recorded. The scale of the deflection curve is 1 in. $= \frac{200 \times (4)^3 \times 5.74 \times 10 \times 5.88}{EI_F} =$ 0.00226 in. E is taken as 30,000,000 and I_F is the moment of inertia of the selected section F which is 6 in. in diameter. The deflections (y) corresponding to each load appear in the third column, of the preceding table. The values of wy and wy^2 for each section are then found and their total results in the values $wy = 7.8987$ and $wy^2 = 0.352882$.

Accordingly, the critical speed is found to be

$$w = \sqrt{\frac{g \times Wy}{Wy^2}}$$

$$= \sqrt{\frac{32.2 \times 12 \times 7.8987}{0.0352882}}$$

$$= 289.2 \textit{ radians per sec.}$$

and

$$N = \frac{30}{\pi} \times 289.2 = 2{,}760 \textit{ r.p.m.}$$

The critical speed of the rotor when disconnected from any driven machine—that is, when acting as a beam freely suspended on two supports—will be as given above.

Gaining Speed by Slowing Down

By F. H. Bogart

The old adage, "The more haste, the less speed," is exemplified in some of the high-pressure-production efforts of the present day. A short time ago, a master mechanic was telling me of an incident in his own experience that clearly illustrates the point in mind. He had taken a position as subforeman in a department producing certain operations on a single component. The output of the department was controlled by the production from a bank of thirty automatic turret lathes.

My friend first noticed that supervisors, foremen and inspectors were rushing about, bringing pressure to bear at every point to get speed and increased output. The automatic turret lathes referred to were speeded up to a time cycle of about twenty-five minutes per piece on a part that should have been produced at the rate of one an hour. But in spite of this the daily output was far from satisfactory. The fast time cycle burned up the tools, the usual condition being that more than half the machines were down for repairs or want of tools the greater part of the time.

A few days after this mechanic went on the job, the general superintendent approached him and asked, "Well, Jones, have you anything to suggest that would help us to get more production?" Jones replied that the productive efficiency of the department as a whole was very low. "What do you mean?" snapped back the superintendent, "don't you think we are going fast enough?" "Oh, you're going fast enough, all right," said Jones, "but you would turn out your product faster if you went more slowly."

The superintendent thought for a moment and remarked, "I don't know but what you're right," and walked on. That was the last word so far as known that was ever spoken about the matter, and nothing was ever done that would indicate that this plain statement of unvarnished truth had any other effect than to make the superintendent sore on the man who met his request in good faith.

A condition like this seems to demand nothing but pure common sense and simple arithmetic.

The Practice of One Master Mechanic in Securing a Maximum Output

The master mechanic of one of the oldest screw products companies in the country said to me: "Whenever I am called upon to get the maximum output on a job, I design my cams and speed my machine to get the maximum cutting speed at every point. I then operate the machine at this speed for a period of from three to five hours, trimming down where the tools will not stand up for this time, and taking advantage of any waste periods that may develop. After a continuous run of several hours under these conditions, I slow the cycle down to 80 per cent. of the maximum and turn the machine over to the production superintendent. Experience has taught me that a machine operated at 80 per cent. of your maximum expectation will produce more work in the long run than it will if speeded to the limit, and at a small fraction of the expense for attention and upkeep required at the higher rate."

Speaking of this master mechanic reminds me of another unique expression of his that may not be out of place here. "I have found," he often used to remark, "that there is more time wasted on automatic work in cutting wind than in cutting metal. Show me a man that is always fussing to get his tools to cut faster, and I'll gamble his average output is low. Show me, on the other hand, a machine on which the cutting speeds are very ordinary, but on which the idle periods are trimmed to the limit, and I'll gamble the best automatic man living will not better its average output to any considerable extent."

Solving a Shop Circuit Problem

By C. E. Clewell*

SYNOPSIS—One of the most common shop problems is to decide on the size of wire to use for the supply circuit to some lamps or a motor to be located at a distance from the power house or from the nearest supply mains. In this article some fundamental aspects of the electric circuit are outlined and a typical problem worked out to demonstrate the application of these principles to a practical case. The reason for excessive voltage variations and line losses is explained, and a method for reducing such variations is given.

In the distribution of electric power throughout the shop there will always be more or less of a loss in the wires which constitute the circuits. These losses take the form, in the ordinary direct-current circuit, first, of a drop in pressure or voltage in the wires leading from the generator to the motor or other load, and second, in a loss of power in the circuit which is manifested as heat. The voltage loss means a reduction of the voltage applied to lamp terminals and a consequent loss of light and usually a reduced operating efficiency of the lamps, and in the case of motors, this voltage loss means reduced voltage at the motor terminals and a consequent reduction in speed and often the inability to maintain desired speed rates in motor-driven machine tools.

The voltage loss in a direct-current circuit may be shown conveniently in a diagram like that of Fig. 1[1]. Here there is assumed to be a voltage of 120 at the generator terminals in the power house at the point where these terminals are joined to the supply mains. From the generator terminals a simple two-wire circuit extends through the shop to a given motor. The resistance of one of these wires from generator to motor is assumed equal to 0.1 of a resistance unit (commonly called the ohm), and the current taken by the motor is assumed equal to 50 amperes.

A Fundamental Law of the Circuit

A fundamental law of the electric circuit is that due to Ohm, known as Ohm's law. For a wire circuit containing no external electric pressure, that is to say, in which the only opposition to the flow of current is due to the resistance of the wire, this law states that the voltage drop is proportional to the resistance of the circuit and to the current flowing through the circuit. This relation may be expressed by a formula as follows:

$$e = rI \qquad (1)$$

where e is the pressure drop in volts, r the resistance in ohms and I the current in amperes. Fig. 2 shows these relations clearly for a portion of a simple circuit, included between the terminals a and b.

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[1]The references here made to the direct-current circuit are merely for simplicity, because of the absence in such cases of the inductance and capacity sometimes present in alternating-current circuits. In the ordinary shop alternating-current circuit the effect of inductance and capacity is often small enough, so that it may be treated on the same basis as the direct-current circuit, in which case the principles outlined in this article will apply equally to both direct- and alternating-current distribution circuits.

A reference to the diagram in Fig. 1 shows that the voltage drop by Ohm's law along one wire out from the generator to the motor is 5 volts, and the corresponding drop along the return wire from motor to generator is also 5 volts, making a total of 10 volts lost in the wires of the circuit. With 120 volts across the generator terminals and a loss of 10 volts in the wires, there will remain 110 volts across the motor terminals.

If, now, the rated voltage of the motor be 110 volts, then with 120 volts at the generator and a circuit as indicated, the conditions will be satisfactory. Suppose, however, that another motor be connected to the terminals of this same circuit, as in Fig. 3, and that it also calls for 50 amperes in its normal operation. Then it is evident that the total current established in the circuit will be the sum of the currents taken by the two motors—namely, 100 amperes—and, as shown in Fig. 3, the voltage drop will now be 20 instead of 10, as in the first case. With 120 volts at the generator as before, the voltage across the terminals of each motor will drop to 100, which means an approximate reduction in speed of 10 per cent.

Important Factors To Consider

Based on the foregoing items, several important factors should receive attention in every circuit. First, it is apparent that for a given resistance in the circuit, the larger the current the larger will be the voltage loss. Hence, for a given circuit, at the terminals of which there are appliances, for example lamps or motors with definite voltage ratings, then there is a certain more or less clearly defined current value beyond which the voltage drop becomes great enough to reduce the voltage across these appliances excessively below their rated value.

In Fig. 1, for example, if the motor were rated at 110 volts, and the generator at 120 volts, the circuit shown would be suitable for 50 amperes, as far as the permissible voltage drop is concerned, whereas in Fig. 3 the additional motor will result in a current which in turn brings down the motor voltage to a value considerably below normal. One remedy in Fig. 3 would be to install wires of larger cross-section, so that the resistance of each wire was, say one-half as great as before—that is, 0.05 ohm. In such a case the 100 amperes due to the two motors would produce but 10 volts total drop, thus resulting in 110 volts across the terminals of each motor as is the case for the one motor in Fig. 1. Another remedy would be to run a duplicate circuit from the generator to the second motor, in which case the conditions from the generator to each motor would be identical with those shown in Fig. 1.

Current-Carrying Capacity

There is, however, another factor to be considered when determining the limitation of wire sizes for shop circuits. This refers to the current-carrying capacity of the wire itself. Insulated copper wire can only be heated up to a point somewhat below the temperature at which the insulation begins to deteriorate. The line loss due to the flow of current through the wires results in heat, and

hence the limiting temperature sets a limit on the current density or amperes per square inch of wire area, and it may sometimes happen that the safe current-carrying capacity has been exceeded even when the allowable voltage drop has not been reached. The voltage drop may readily be calculated on a basis of Ohm's law, but the safe current-carrying capacity must be based largely on experiment, and it is usual therefore to specify these values as shown in the accompanying table of values for copper wire.

In certain problems, furthermore, it may be desirable to calculate the resistance of a wire in ohms, based on its physical dimensions—namely, length and cross-section. This may be done with the aid of the fact that the resistance varies directly with the length and inversely with the cross-section, so that the resistance may be expressed by the following formula:

$$r = k\frac{L}{q} \tag{2}$$

where r is the resistance in ohms, L is the length of the wire in feet, and q its cross-section or area in circular mils[2]; k is a constant, which, for copper wire, has a value of about 10.4.

Referring to the wire table, it will be noted further that the resistance of a given size of wire has a higher value at 75 deg. than at 60 deg. This means that the higher the temperature of the wire the higher its resistance, and a simple relation exists between the resistances at various temperatures, expressed by the following formula:

$$r_t = r_o(1 + at) \tag{3}$$

where r_t is the resistance at some given temperature t above zero degrees (Centigrade), r_o is the resistance at zero, and t is the rise in temperature above zero; a is a constant, sometimes called the temperature coefficient, and for copper wire its value is approximately 0.004.

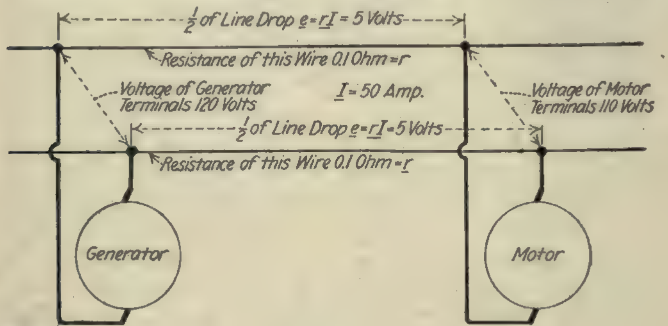


FIG. 1

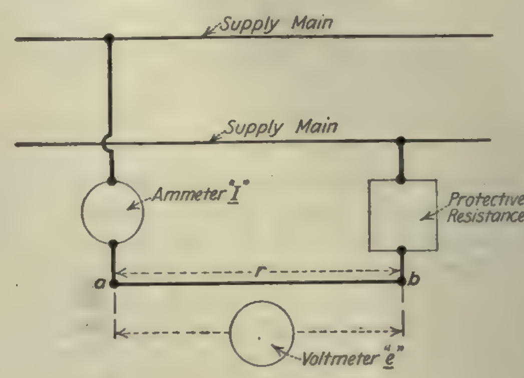


FIG. 2

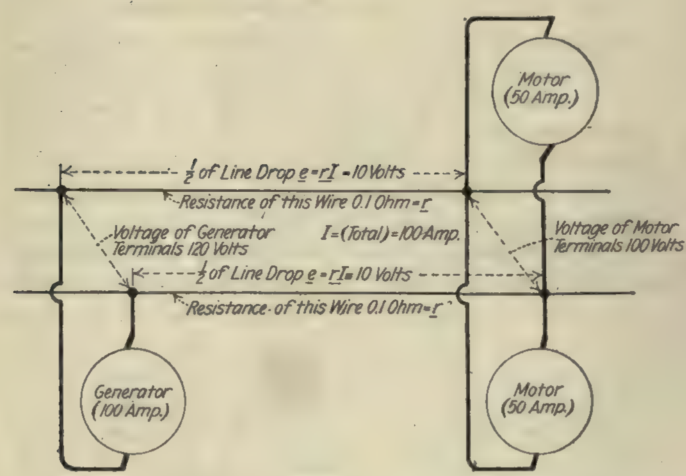


FIG. 3

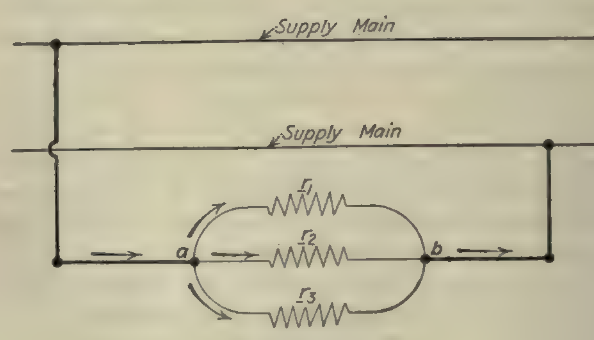


FIG. 4

FIGS. 1 TO 4. VARIOUS WIRING DIAGRAMS FOR SHOP CIRCUITS

Fig. 1—Diagram showing distribution of the voltages in a simple two-wire circuit. Fig. 2—Analysis in a simple circuit of Ohm's law. Fig. 3—Diagram similar to Fig. 1, but with a load of twice the value. Fig. 4—Connecting a number of resistances in parallel

The following problem is solved to indicate the application of some of the principles just outlined. A direct-current generator is to supply 10 kw. to a load 350 ft. distant over a rubber-covered wire circuit somewhat as shown in Fig. 1. The voltage required at the load is 110 and that of the generator terminals is 125. The problem is to find (a) the resistance of the wire necessary; (b) its size in circular mils; (c) the B. & S. gage number of the wire; and (d) to check the size for current-carrying capacity.

It will be noted in this problem that the volts drop are specified at the outset, because of the specification of the voltage at the generator (125) and that at the load (110), which means a total drop on both wires of the circuit, out and back, equal to 125 — 110 = 15 volts.

The power delivered to the load is represented by the product of its voltage (110) and its current (I), which

[2]The mil is 0.001 of an inch. The number of circular mils in the cross-section of a wire is found by squaring its diameter in mils. Thus a wire with a diameter of 0.1 in., or 100 mils, has an area of 10,000 circ. mils.

is equal to 10 kw. or 10,000 watts (since 1 kw. is equal to 1000 watts). The following relation may then be used to determine the current I:

$$110 \times I = 10{,}000$$

whence

$$I = 90.9 \textit{ amperes.}$$

The resistance of the wire may now readily be determined with the aid of equation (1) from which we have

$$e = rI, \text{ or}$$

$$r = e \div I$$

$$= 15 \div 90.9$$

$$= 0.165 \textit{ ohm} \qquad \text{(a)}$$

In other words the total resistance of the circuit out and back is equal to 0.165 ohm.

The area of the wire may now be determined by equation (2) as follows:

$$r = k\frac{L}{q}, \text{ or}$$

$$q = k\frac{L}{r}$$

$$= (10.4 \times 700) \div 0.165$$

$$= 44{,}121 \textit{ circ.mils.} \qquad \text{(b)}$$

Referring to the wire table, we find that a No. 4 wire has an area of 41,616 circ.mils, and a No. 3 wire an area of 52,441 circ.mils, so that the next larger size of wire to result in a drop of not more than 15 volts when 90.9 amperes are transmitted over 700 ft. of wire (350 ft. out and 350 ft. back) is a No. 3 (c). A reference to the wire table shows, however, that a rubber-covered No. 3 wire should carry only 76 amperes, so that to use this size for 90.9 amperes, although the voltage drop is well within the allowable limit, undue heating will probably result. Hence, it would be desirable in such a case to select a No. 2 wire, with a current-carrying capacity of 90 amperes (according to the table), although this size is larger than necessary as far as the allowable voltage drop is concerned (d).

COPPER-WIRE TABLE

B. & S. Gage No.	Diameters in Mils	Areas in Circular Mils c.m. = d^2	Current-Carrying Capacity, Amperes (1)	Current-Carrying Capacity, Amperes (2)	Resistances per 1,000 Ft. in International Ohms At 60 Deg. F.	At 75 Deg. F.
18	40.0	1,600.0	3	5	6.363	6.567
16	51.0	2,601.0	6	8	3.914	4.04
14	64.0	4,096.0	12	16	2.485	2.565
12	81.0	6,561.0	17	23	1.552	1.601
10	102.0	10,404.0	24	32	0.9785	1.01
8	128.0	16,384.0	33	46	0.6214	0.6413
6	162.0	26,244.0	46	65	0.3879	0.4004
5	182.0	33,124.0	54	77	0.3074	0.3172
4	204.0	41,616.0	65	92	0.2446	0.2525
3	229.0	52,441.0	76	110	0.1941	0.2004
2	258.0	66,564.0	90	131	0.1529	0.1579
1	289.0	83,521.0	107	156	0.1219	0.1258
0	325.0	105,625.0	127	185	0.09639	0.09948
00	365.0	133,225.0	150	220	0.07642	0.07887
000	410.0	168,100.0	177	262	0.06056	0.06251
0000	460.0	211,600.0	210	312	0.04811	0.04966

For current-carrying capacities, column (1) refers to rubber-covered wire; column (2) to wire with weather-proof insulation.

A check may now be made for the size of wire selected, to see what voltage drop will result for the given circuit. Referring to the wire table we find that the No. 2 wire has a resistance of 0.1529 ohm per 1000 ft. at 60 deg. F. Since the resistance varies directly with the length, 700 ft. will have a resistance equal to $\frac{7}{10} \times 0.1529 =$ 0.107 ohm.

From equation (1) the voltage drop will be equal to

$$e = rI$$

$$= 0.107 \times 90.9$$

$$= 9.73 \textit{ volts}$$

and we find that the voltage at the generator need be only $110 + 9.73 = 119.73$ instead of 125 volts as at first assumed.

Let us suppose, further, in the case just worked out, that after it has been found by calculation that a No. 2 wire is required, the only size available about the shop is No. 10. How, then, may it be determined as to the number of individual wires of the smaller size which, if combined into a cable, would result in a circuit of the same resistance as if one No. 2 wire was employed?

Consider equation (2). Here it is seen that the resistance varies directly with the length and inversely with the area of the wire. In other words the larger the area the smaller the resistance. To use a number of wires side by side, which would be necessary if No. 10 is used, these wires must be connected in parallel with one another. In a circuit where a number of resistances are connected in parallel, as shown in Fig. 4, each resistance having a different value, a simple expression may be written which will give the net or total resistance corresponding to the individual resistances in parallel.

By representing these individual resistances as r_1, r_2, r_3, etc., the expression for the total resistance is

$$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots} \qquad (4)$$

However, in a simplified case such as the one under consideration, where a number of like wires are to be placed in parallel, $r_1 = r_2 = r_3 \ldots$ so that equation (4) becomes

$$R = \frac{r}{n} \qquad (5)$$

and to find the number of wires of No. 10 size which must be placed side by side in the form of a cable to have the same resistance as one No. 2 wire, it is only necessary to use equation (5) where R is the resistance of the No. 2 wire—that is, 0.107 ohm; r is the resistance of 700 ft. of No. 10 wire (0.9785 ohm per 1000 ft. at 60 deg. F., see wiring table, or $\frac{7}{10} \times 0.9785 = 0.6850$ ohm per 700 ft.); and n is the number of No. 10 wires required in parallel. Substituting in the formula (equation 5) we have

$$R = \frac{r}{n}, \text{ or}$$

$$n = \frac{r}{R}$$

$$= 0.6850 \div 0.107$$

$$= 6.4 \textit{ or } 7 \textit{ wires}$$

This means that if 7 No. 10 wires are installed in parallel for each side of the circuit, instead of one No. 2 wire, the effective area will be practically the same in the two cases. Furthermore, the table shows that the current-carrying capacity of 7 No. 10 wires is well over the value to be transmitted.

Variations in Line Voltage

In a case like that of Fig. 3, let us suppose that the operations being performed by the machine tools, with which the motors are connected, are of such a nature that the load is continually changing in value. At certain instants it may happen that one machine is taking a deep cut and the other is practically idle; at other instants, both machines may be heavily loaded; and at still others, they may each be lightly loaded.

By way of illustration, let us assume that successive readings of an ammeter for measuring the total load on the line are 10, 50, 150, 60, 200 and 10 amperes. This would mean in Fig. 3 with a total line resistance of 0.2 ohm, successive line voltage losses of 2.0, 10.0, 30.0, 12.0, 40.0, 2.0 and for a constant supply voltage of say 130 (adjusted to give 110 volts at the motors with normal full load of 100 amperes), the successive voltages across the motors would be, in turn, 128, 120, 100, 118, 90 and 128, or a very excessive voltage variation of 38 volts (90 to 128) equivalent to about 38 per cent.

This illustration shows that with circuits possessing an inadequate area of copper, the voltage variation may be very great with consequent unsteadiness in the operation of lamps and motors. In this same case it would be possible to redesign the circuit so as to result in a very much more favorable set of operating conditions, by merely increasing the size of the wire. Suppose, for example, that wire with three times the area were used, thus having one-third the resistance, then the maximum voltage drop in the foregoing case would have been 10 instead of 30, with a corresponding improvement in the operation of lamps and motors which might be on the circuit.

The flow of current with a value I through a wire results in an energy loss of

$$W = rI^2 \ (watts) \qquad (6)$$

where W is the line loss in watts; r the resistance of the line wires in ohms; and I the current in amperes. This loss of energy represents a direct reduction in the efficiency of power transmission and the greater the line loss for given power transmitted, the lower this value of transmission efficiency.

In considering this question it must be remembered that while the energy loss in the distribution circuits represents a money loss, the installation of heavier wire for the purpose of reducing this loss means a higher first cost of the copper, with a consequent increase in the interest and depreciation chargeable against the shop circuits. It becomes desirable, therefore, to strike a mean between these two opposing factors, and in practice this plan is usually the one adopted.

Careless Promises of Delivery

By J. P. Brophy*

Are we departing from the truth deliberately or unconsciously? Careless promises on delivery in the machine-tool and other lines of business seem to be a fad nowadays. Is it a case of anything to obtain the order, or is it because we are so independent that we do not care? If a promise is made and broken and an inquiry is made as to the reason and when delivery may be expected, the reply is not likely to be one of regret. It is apt to be just a few excuses about being so very busy and hoping you will be patient; if you will wait from two to four months longer, they will be very much pleased

What do you think of this manner of escaping from an obligation that should be binding? And what can be done to prevent it? This laxity in delivery is very prevalent at present and is not often excusable. It is not the American way to claim damages in such cases. Therefore, we all suffer and protest—pleading, if necessary, to have the machinery we purchased delivered as soon as possible, and let it go at that.

*General Manager, Cleveland Automatic Machine Co.

It might be well to remember that when machinery of any kind is purchased on, say, four months' delivery and a delay of six to ten months is experienced, there is a serious side to this unpleasant condition. When the order is sent in, factory arrangements are begun months in advance to make certain deliveries; dependence is placed on the honesty of the selling company to ship on the time agreed upon or not more than a week or two later. When delivery is not made for months beyond the promised date and the purchaser cannot keep his own promises, his customers are enraged, and he loses them.

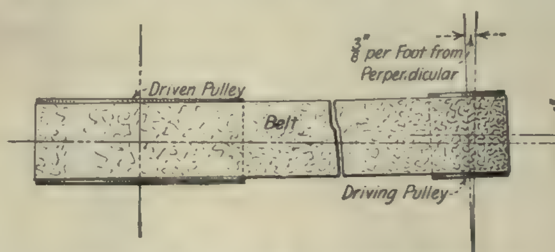
Are we going to do nothing in such cases but repent the mistake we made in trusting the company from whom we purchased, or can we use other methods? Something should be done to subdue the ambition to get unfairly earned dollars. Those who are actually guilty of such unbusinesslike behavior as deceiving their customers and thereby damaging them should be obliged to make good all damages.

Belts Connecting Pulleys on Vertical Shafts

By E. W. Wrigley

Sometimes there is difficulty experienced in making large horizontal belts (between pulleys mounted on parallel vertical shafts) hold to the centers of the pulleys. We had such a case not long ago, and the experience gained may be of value to others having similar problems.

The belt was used to drive a large grinding mill and connected the pulley on the vertical motor with the main pulley on the vertical shaft of the mill. It was triple leather and 24 in. wide. The pulleys were 24 and 72 in. in diameter, on 18-ft. centers, and the belt speed



LAYOUT OF SHAFTS, PULLEYS AND BELT

was about 2100 ft. per min. Both pulleys had a liberal crown, but the belt was so heavy that there was a tendency to slip down, even when run as tight as the bearings would stand.

The trouble was entirely overcome by raising the motor (or driving pulley) 4 in. higher than the mill (or driven) pulley, and inclining the motor shaft toward the mill ⅜ of an inch per foot, as shown in the illustration. The belt was run as tight as possible and care was observed at first to take up the stretch at frequent intervals, for in this position the bottom was stretched more rapidly than the top. As soon as the belt was stretched out and worked in, we had no further trouble.

A difficulty threatened at first in that the representative of the electric company withdrew the guarantee from the motor, because of its being run out of vertical. But after conferring with the home office, he passed it. No actual trouble ever developed along this line in the year that the machine has run since being changed

Cam Layout for Brown & Sharpe Automatics

By Samuel R. Gerber

SYNOPSIS—The satisfactory operation of automatic screw machines depends largely on the proper layout of the cams that control their movements. This article gives information covering this important phase of automatic screw machine operation.

In laying out cams for Brown & Sharpe automatics it is best to follow a system, for with the adoption of a workable system errors are either eliminated or lessened. A system covering the order of operations to be followed in laying out cams for Brown & Sharpe automatic screw machines is shown in Table 1.

TABLE 1. OPERATIONS IN LAYING OUT CAMS FOR BROWN & SHARPE AUTOMATIC SCREW MACHINES

A. Make rough sketch of part required	I. Calculate the number of revolutions necessary for each operation
B. Determine the method to be used	J. Determine the total time necessary to make one part
C. Determine the work of the form and cutoff tools	K. Calculate the total number of revolutions necessary to make one part
D. Determine the location of the form and cutoff tools	L. Calculate the number of hundredths of cam surface necessary for each operation
E. Determine the revolutions per minute of spindle forward and reverse	M. Determine the location of the various lobes of the cam
F. Determine the order of operations	
G. Determine the throw for each tool	
H. Select from data sheets the proper feed for each tool	

An explanation of those steps in Table 1 that are not obvious will probably be of assistance.

Item B refers to the method to be used; that is, determine whether the part should be made with form and cutoff tools only or whether hollow mills should be used. Form and cutoff tools only are used when the length of the body does not exceed three times the diameter of the stock. When the width of the form tool exceeds one and one-half times the diameter of the stock, the cutoff tool should be made so as to form one-half of the body. Box tools are used when a good finish and a high degree of accuracy are required. Reamers are used for accurate size holes. Turret knurls are used for flat knurls. Swing knurls are used for knurls with a radius.

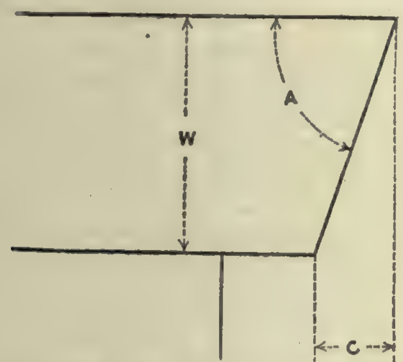


FIG. 1. THE CUTOFF TOOL

Item C refers to the work of the form and cutoff tools. If avoidable, combination form and cutoff tools should not be used. In all cases have the form tool straddle the head to break through the scale of the stock to a depth of 0.01 in. for the cutoff tool. This is done to prevent the sharp point of the cutoff tool from having to cut through the scale. This, however, should not be done where the added length makes it impossible to use the slotting or burring attachment when wanted.

Item D refers to the determination of the location of the form and cutoff tools. Where possible, the relative positions of the form and cutoff tools should be such that the cutting off of the finished part is performed simultaneously with the forming of the body of the next.

Item E refers to the determination of the revolutions per minute of the spindle both forward and reverse. The reverse speed may be determined by the formula

$$N = \frac{12S}{\pi d}$$

where

$N =$ Revolutions per minute;
$S =$ Proper surface speed in feet per minute;
$d =$ Diameter of stock in inches.

The forward speed, used only for die on, provided the surface speed does not exceed 54 ft. per min., is determined from the formula

$$N = \frac{1.1n^3V}{nD - 0.55}$$

where

$n =$ Threads per inch;
$V =$ Volume of metal removed per minute equals 0.185 cu.in.;
$d =$ Diameter of screw.

If the surface speed does exceed 54 ft. per min., determine the revolutions per minute by means of the formula $N = \frac{12S}{\pi d}$. In this case d is the diameter of the thread body. Having determined N forward and reverse, use the nearest available speeds furnished on the machine. Under no conditions, however, should the determined revolutions of the forward speed be raised.

Item F refers to the order of operations. For screws made with form and cutoff tools only, the order of operations is generally as shown in Table 2.

TABLE 2. ORDER OF OPERATIONS FOR SCREWS MADE WITH FORM AND CUTOFF TOOLS ONLY

1. Feed stock	6. Dwell
2. Revolve turret five times	7. Clearance
3. Form	8. Die on
4. Dwell	9. Die off
5. Cutoff (and form)	10. Revolve turret

The operations "Dwell," Nos. 4 and 6 in Table 2, are required to insure a true, round thread body. About four or five revolutions are usually sufficient for this purpose. Operation "Clearance," No. 7 in Table 2, is required to allow the form and cutoff tools to drop back out of the way of the oncoming die. From 0.03 to 0.05 of cam surface usually allowed for this purpose.

TABLE 3. ORDER OF OPERATIONS FOR SCREWS MADE WITH HOLLOW MILLS

1. Feed stock	8. Dwell
2. Revolve turret	9. Clear
3. Rough mill	10. Revolve turret four times
4. Revolve turret	11. Die on
5. Finish mill	12. Die off
6. Clear	13. Cutoff
7. Form	14. Clear

For screws made with hollow mills, the order of operations is generally as shown in Table 3.

No definite order of operations can be given for other parts. This must be determined according to the requirements of the part.

Item G refers to the determination of the throw for each tool.

The Form Tool—The throw of the form tool is usually 0.005 in. more than the actual depth of cut. This is a clearance allowed to insure against the tool jumping into the stock.

The Cutoff Tool—The throw of the cutoff tool is one-half the diameter of the stock plus 0.020 in. As the angle A, Fig. 1, is a constant, 85 deg., the clearance C will vary with the width W of the tool. The width of the cutoff tool varies from 0.050 to 0.100 in., depending on the size of the stock to be cut. As this clearance C never exceeds 0.020 in., we are always safe in allowing this amount of clearance.

Die On—The throw for the die on is found as follows:

T = Throw for die on;

p = Pitch of screw;

r = Number of threads on screw or number of revolutions for die on;

n = Number of threads per inch;

$$p = \frac{1}{n};$$

$T = r(p - 0.005)$ for screws, where r = 30 to 15;

$T = r(p - 0.010)$ for screws, where r = 15 to 0.

The object of subtracting 0.005 or 0.010 in. from the pitch of the screw is to allow the die holder to lag behind the die and so avoid the possibility of the die being pushed onto the screw while it is cutting.

Die Off—In the case of die off, the die holder must lag 10 per cent. more, because it has gained that much over the die during the time when the spindle was at a dead stop before its direction had reversed.

T_1 = Throw for die off;

$T_1 = r_1(p - 0.0055)$ for screws, where r = 30 to 15;

$T_1 = r_1(p - 0.011)$ for screws, where r = 15 to 0;

r_1 = Number of revolutions for die off.

The number of revolutions for die on is equal to the number of threads on the screw = r.

The number of revolutions for die off is equal to the number of threads on the screw plus 10 per cent. This 10 per cent. is added to allow sufficient revolutions of the spindle to make up for the revolutions that were lost when the spindle was at a dead stop before its direction had reversed—$r_1 = 1.1r$.

Hollow Mills—The throw on the hollow mill is equal to the length of the part to be cut.

Item I refers to the calculation of the number of revolutions necessary for each operation. This is found by dividing the throw by the feed per revolution. In the case of die on, the number of revolutions is equal to the number of threads on the screw body.

Item J refers to the determination of the total time necessary to make one part. First convert the die on revolutions at the forward speed into their equivalent revolutions at the reverse speed, as follows:

r = Number of revolutions for die on at forward speed;

r_1 = Equivalent revolutions for die on at reverse speed;

N_1 = Revolutions per minute forward;

N = Revolutions per minute reverse;

t = Time for die on in seconds;

then

$$t = \frac{60r}{N_1};$$

$$\frac{N}{60} = \text{Revolutions per second reverse;}$$

$$r_1 = t\frac{N}{60} = \frac{60rN}{60N_1} = \frac{rN}{N_1}.$$

To this equivalent number of revolutions add the revolutions determined for all the tools.

R = The sum of all revolutions required for the tools;

N = Revolutions per minute reverse;

T_1 = Time in seconds to perform these operations;

then

$$T_1 = \frac{60R}{N}.$$

To this must be added the time necessary to revolve the turret and to feed the stock. The times for revolving the turret and feeding the stock are ½ sec. on the No. 00 machines, ⅔ sec. for the No. 0 machines, and 1 sec. for the No. 2 machines.

Item K, the total number of revolutions, at both forward and reverse speeds, necessary to make one part, is obtained as follows:

T = Total time to make one piece;

$P = \frac{NT}{60}$ = number of revolutions to make piece at reverse speed;

$P_1 = \frac{N_1 T}{60}$ = number of revolutions to make piece at forward speed.

Item L, the number of hundredths of cam surface necessary for each operation, is obtained as follows:

p = Number of revolutions required for any operation at reverse speed;

p_1 = Number of revolutions required for any operation at forward speed;

H = Number of hundredths of cam surface required for any operation;

then

$H = \frac{100p}{P}$, or $H = \frac{100p^1}{P_1}$, in the case of the forward speed.

It is usually best to allow 0.01 more of the cam surface for revolving turret than for feeding stock.

Item M, the determination of the locations of the various lobes of the cam, is as follows: Starting from zero, lay off in succession the number of hundredths for each operation. The sum of the hundredths required for all operations must total one hundred; in other words, the whole of the cam surface must be used. Combine as many operations as possible, but the box tool must work alone; the reamer must work alone; the cutoff must keep at least 0.040 in. from the drill when cutting off and drilling simultaneously; the finish mill must work alone.

This method of procedure in laying out cams will not only reduce the time required for the work, but will eliminate, or at least cut down, the chances of making a mistake.

Encouraging Thrift in Workmen

By Entropy

SYNOPSIS—This article contends that a bank balance may not indicate thrift as much as a mortgage. It suggests the encouragement of thrift on the part of employees by assisting in coöperative buying as a means of tightening the bonds between the men and the firm.

It may be no particular business of an employer whether his workmen are thrifty or not, but it is very much the business of the community of which the employer is a member. Every man has two assets—one his own individual earnings, the other the things which he has as a member of society. He has parks, city water, sewers, good roads, schools, fire protection and innumerable other things that represent the accumulated savings of a thrifty people. He may not be thrifty himself, but to the extent of his taxes he is compelled to save money.

What does thrift really mean? The average social worker, who is looked down upon by the average workman, thinks of it as money in the bank, while as a matter of fact, money on deposit subject to instant call may not represent thrift at all. It may represent a period of accumulation for the sake of one grand blowout, while the next-door neighbor struggling under a seemingly insurmountable burden of debt may be truly thrifty. The latter may have bought something of real and permanent value—a piano, a house or even a Ford—and may be worried almost to death to pay for it and yet be more thrifty than the man with $1000 in the bank waiting for warm weather to throw up his job and go off on one grand spree.

Money is good for nothing except by virtue of the ability to use it. A dollar has a different value to every man. A savings-bank account, which is usually taken as an index of thrift, may mean nothing at all and cannot mean anything until we know what it will be spent for. Some men can save money. They have the instincts of a miser, and they hate to let it pass out of their hands. Such men get small value for their money, as they take no chances with it, but either hide it away or put it where it draws but 3 or 4 per cent. interest.

Another man knows his weakness for letting it slip through his hands and deplores it, but yet he has no regrets for his purchases. He may be short of cash, but he has something to show for it. He may not be able to take a few shingles off his roof and go down town and buy a suit of much needed clothes with them; but has had something that means real thrift, because he must keep them and because it is hard enough to realize on their value so that he has a chance to think many times before he does exchange them for something of temporary value.

Bank Balance Not All Important

The interest of the community, and incidentally the employer, is then in the purchases or investments of the workman rather than in his bank balance. Primarily, a bank is a place to leave money on interest until enough accumulates to make an investment of some size.

Many employers are looking eagerly at everything that offers a hope of retaining their employees for longer periods of time. They have just awakened to the fact that it costs real money to be everlastingly breaking in new men. For a while they thought all that they had to do was to check the discharges, but after a little they discovered that discharges are usually few relative to the number who leave of their own accord. How to check this roving from one shop to another is the problem that stands out prominently today. Therefore, every man who comes along with a group-insurance scheme, a coöperative-store plan, a pension plan or a savings scheme finds a ready ear. There is danger that in this very eagerness to meet employees more than halfway, which has recently developed, employers may be led into doing things that are of no value to anyone except the promoters of these schemes.

It is safe to say that all men resent paternalism. They all appreciate opportunity, if they see it. If a corporation opens a savings department and agrees to pay something more than the going rate of interest, the employees will naturally look on it with favor and will take advantage of it, if their suspicions are not roused by the higher rate offered. They may fear that the concern will do what has been done in the past and fail, leaving them with neither their savings nor their interest. If a corporation offers its stock for sale at less than the market rate, the employee will be inclined to invest, just in proportion as the issue is a bargain, provided there are no strings to the offer. Unfortunately, there appears to be no way to do this without strings. For if anyone has the privilege of buying at a low price, he will inevitably speculate by selling at the market whenever he feels that he can take the largest profit. If he must offer the stock to the company at par, there is no great object in buying.

Quit Spending Money Foolishly

And so it goes with every kind of savings and thrift proposal. The difficulty is to find something that will induce the employee to quit spending money foolishly. The question of how much actual cash he can show is not the question; it is how much has he added to the total wealth of the world. A man may die in the poorhouse; but if he has brought up a family of thrifty children, he has done more for the world than a man who has never married and who leaves half his total wages to found a home for indigent cats.

Whatever form of accumulation can be found to appeal to the individual should be put in his way. One man may find himself happy in the possession of an attenuated equity in a house. He likes to have a garden, and he proudly spends $100 worth of time raising $10 worth of vegetables. He is thrifty in the first instance; and he may be in the latter, if he would have otherwise spent the same time going fishing, where he would only catch 50c. worth of food. Another man may buy a lot of household furniture on the installment plan. If he gets real value and takes care of it and is not stung on the interest charge, he is just as thrifty as anyone can be.

The large factor in all of this, and the only place where the employer fits in, is to see that his employees get full

value for their money and that they do not pay more than market rates for their borrowings. It is a perfectly legitimate thing for an employer to use his credit to enable a faithful worker to buy at the same rates which he himself enjoys. If he is laying in a stock of coal, he can easily arrange for his employees to enjoy a corresponding rate; and if the employee cannot pay all at once, it is only adding to his thrift to allow him to have the pay deducted from his pay envelope, less only the prevailing rates of interest.

Helping Employees Buy Cheaply

The remaining question is that of security. If privileges of advantageous purchase are offered to everybody, there will be some defaults, because there are always sharks who will obtain employment only for the sake of beating the game. But if this privilege is extended in proportion to length of service, then there can be but very little danger of loss. A new employee should not be helped beyond the amount that the company always owes him. A corporation with 1000 employees averaging $15 a week, which pays off Friday night, will always owe its help at least $12,500. That amount of money available to them in the form of credit, together with assistance in determining the lowest market prices, will work wonders in forming bonds of friendship and permanency of employment.

Just so soon as it becomes known that the longer one works for a given firm the more help he can have in making his money go far the longer men will stay, particularly if they know that the time of beginning to get these advantages is not long deferred. It is the reward for five or ten years' service that seems so far away from the new employee that it has no power of attraction whatever.

Every one of us, no matter what his theories about special privileges, appreciates them. We may declare our democracy; but if we can afford it, we travel in Pullman cars. We look forward to the time when we can see the play from the orchestra rather than from the family circle. We have seen large fortunes built up from special privileges, and we are all ready to work our heads off for them.

A Universal Triangle

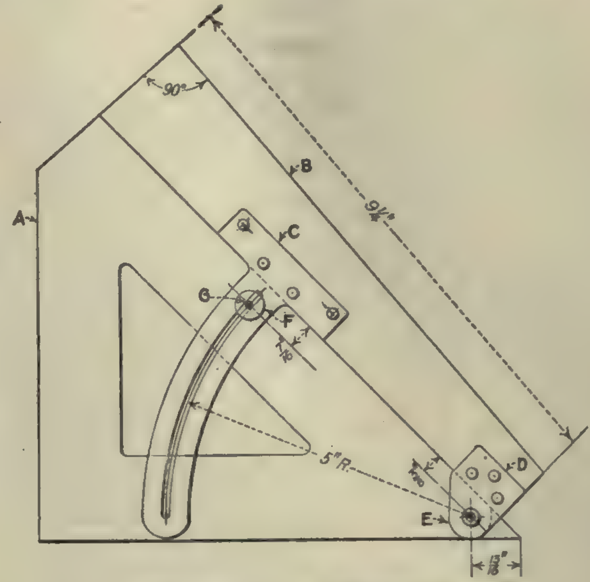
By Charles H. Ponitz

The illustration shows a combination triangle that is convenient and also a time saver. All the principal dimensions used in the making of the triangle are given.

A was made from a standard 45-deg. celluloid triangle, the upper edge cut as indicated and the lower edge rounded to permit the blade *B* to open. The blades *B*, *C* and *D* were made from a standard 60-deg. triangle; *C* and *D* were riveted to *B* by means of copper rivets. At *E* a copper rivet ⅛ in. in diameter was used, riveted in such a manner as to permit *B* to swing about it as a center. The slot in *C* was made long enough so that the outside edge of *B* would open up a little beyond the vertical.

A small brass plate was set in the 45-deg. triangle on the lower side at *F* and secured with two small rivets. This gave a firm anchor for the pin *G*. A brass washer and nut complete the clamping device. All rivets on the lower side were countersunk.

With the universal triangle it is possible to draw lines at any angle. By turning the triangle an angle, on one side of the vertical, may be transferred to the other side without any resetting. For short lines it is



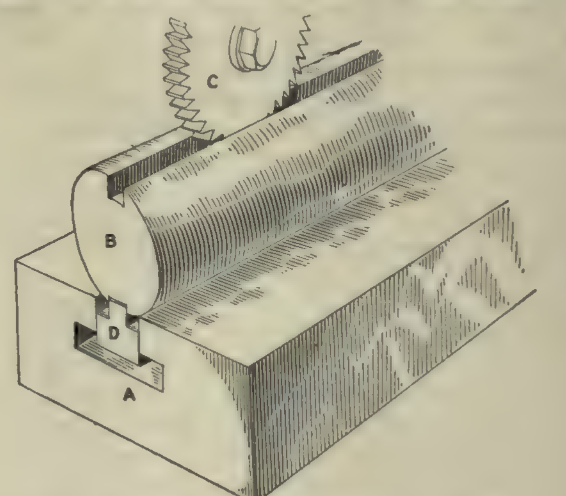
THE TRIANGLE ASSEMBLED

not necessary to turn the triangle to obtain a line at 90 deg., this being accomplished by using the right angled side marked 90 deg.

Cutting Keyways at 180 Degrees

By J. A. Raught

Some time ago, I was given a truck load of short shafts that were to be keywayed at each end; but one was to be directly opposite the other. The accompanying illustration shows the method I originated for the purpose. At *A* is the miller table; *B* is the shaft, *C* the



THE WORK AND THE LOCATING DEVICE

cutter, and *D* the piece for centering the shaft for the second keyway after the first has been cut.

The centering block *D* is made of a piece of square steel about 1 in. long, with the sides ground to fit snugly in the T-slot, as shown, and with the top sides milled away to leave a feather that fits snugly in the keyway. This method has proved very satisfactory and can be employed for keywaying large shafts on the planer.

United States Munitions*

The Springfield Model 1903 Service Rifle

Striker, Mainspring and Extractor—I

SYNOPSIS—The striker, mainspring and extractor form three important parts of the firing mechanism, the latter coming into play and removing the shell after the bullet is fired.

OPERATION 1. FORMING BODY IN AUTOMATIC SCREW MACHINE

Transformation—Fig. 958; machining diagram, Fig. 959. Machine Used—Gridley automatic, Fig. 960; Fig. 961 shows set-up on Hartford automatic. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Tool-Holding Devices—Holder and box tool. Cutting Tools—Fig. 962; A, circular grooving tool; B, roughing mill for point; C, form tool for point; D, cutting-off tool. Number of Cuts—Four. Cut Data—350 r.p.m.; ½-in. feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 963; A, contour of point and length; B, diameter and total length. Production—25 per hr.

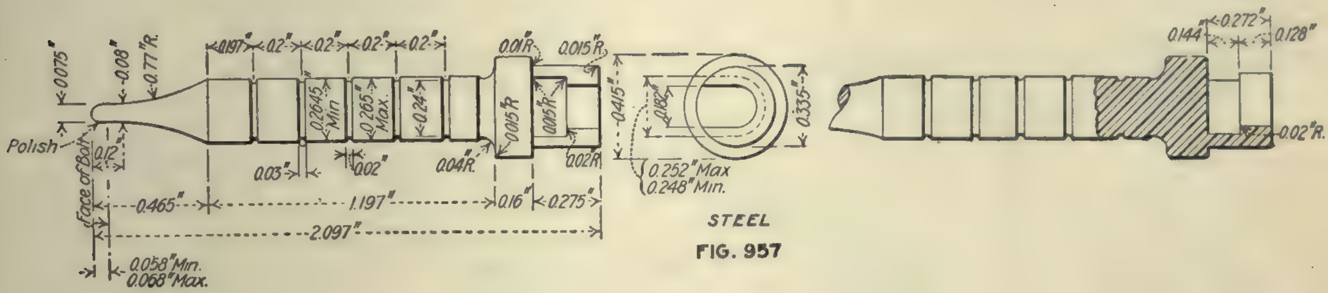


FIG. 957

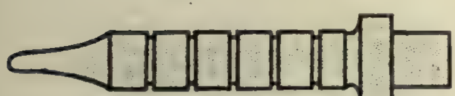


FIG. 958

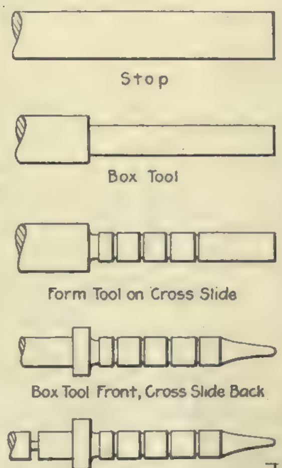


FIG. 959

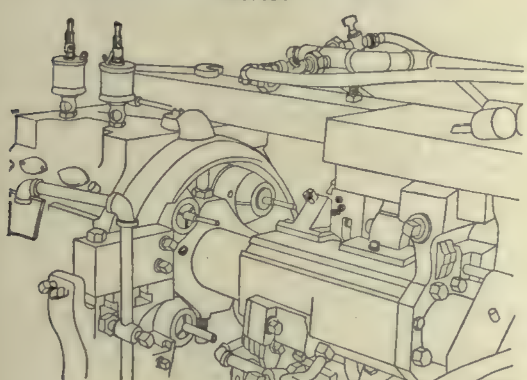


FIG. 960

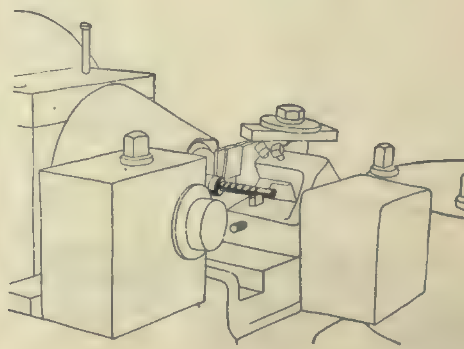


FIG. 961

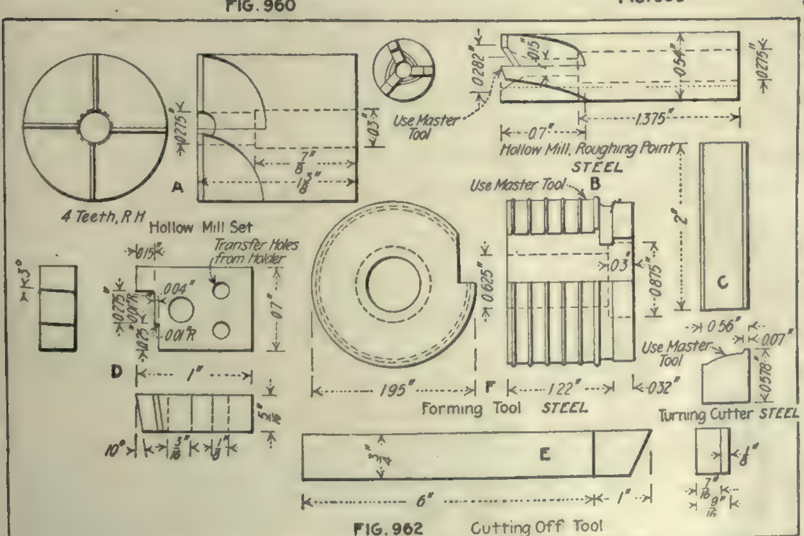


FIG. 962

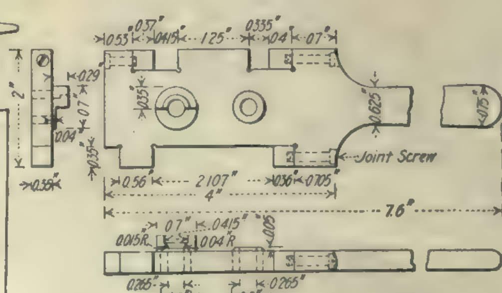


FIG. 963

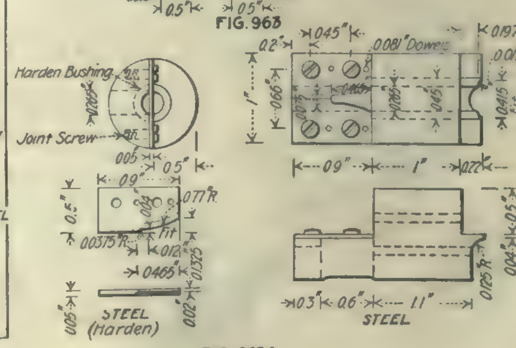


FIG. 963A

OPERATION 1

The Striker

The striker, as shown in detail in Fig. 957, is the piece that actually comes in contact with the percussion cap in the base of the rifle cartridge. It is held in position on the end of the firing-pin rod by the firing-pin sleeve and is made of Class B steel, 0.42 in. in diameter. It is wholly an automatic screw-machine job, with the exception of milling and profiling the side opening and recess which receives the end of the firing-pin rod. This, as has been shown in the assembly of the firing mechanism in the first article, page 636, Vol. 45, allows the end of the firing-pin rod to be slid in sideways where it is held by a sleeve, backed up by the mainspring which drives the striker against the cartridge. The point of the striker is hardened and the temper drawn in a lead bath to 900 deg. F. This is necessary to make it stand up against the hundreds of blows to which it is subjected during the life of the rifle.

OPERATIONS ON THE STRIKER

Operation
1 Forming body in automatic screw machine
2 Squaring and drilling rear end in hand screw machine
3 Profiling for firing-pin head
4 Filing, general cornering
5 Tempering and hardening
6 Finishing point (in lathe)

Mainspring

The mainspring, as shown in detail in Fig. 973, is made of 0.049-in. steel music wire, wound on a special machine, the ends ground flat, compressed for a certain period and then tested. The mainspring consists of 33½ coils with a pitch of 6 turns per inch, the wire being 0.049 in. in diameter. The spring is wound to a length of 5.583 in. and acquires a set of something more than an inch. It must sustain a load of 16 to 19 lb. at its cocked length, which is 1.825 in.

The special coiling machine used on this work has a very ingenious automatic cut-off. When the spring has been wound to a length of 33½ coils, the outer end makes a contact which energizes an electromagnet and in so doing, liberates a knife that cuts off the spring to the correct length.

FIG. 964

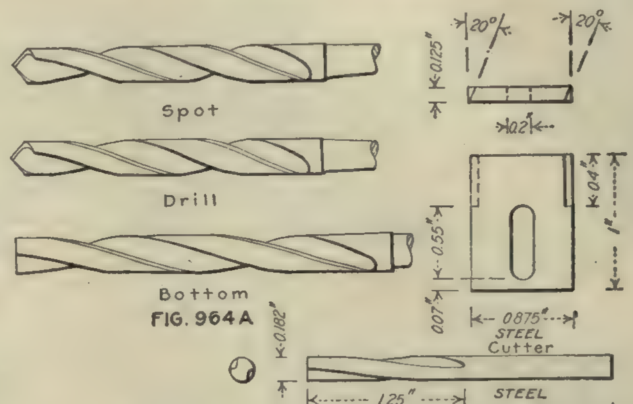


FIG. 964A

2 Flutes R H Spiral, 1 Turn in 2.8"

FIG. 966

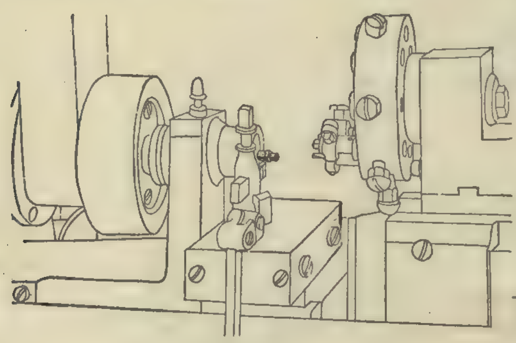


FIG. 965

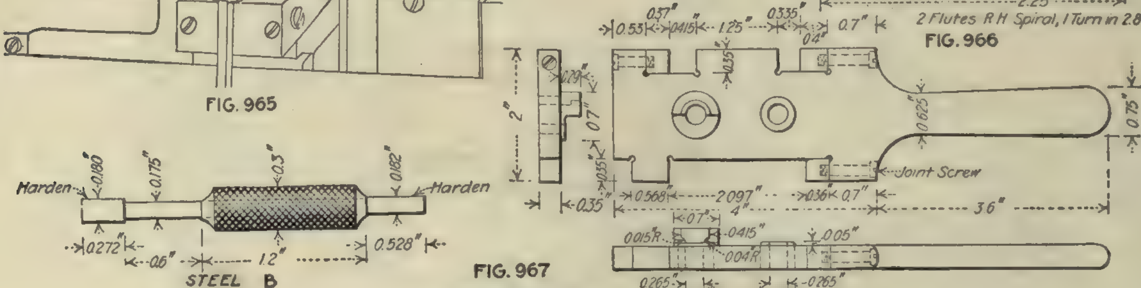


FIG. 967

OPERATION 2

OPERATION 2. SQUARING AND DRILLING REAR END IN HAND SCREW MACHINE

Transformation—Fig. 964; machining diagram, Fig. 964-A. Machine Used—Hand screw machine, Fig. 965. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Tool-Holding Devices—Vertical turret. Cutting Tools—Drill and squaring cutter, Fig. 966. Number of Cuts—Three. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—800 pieces. Gages—Fig. 967; A, diameter of rear end and length; B, size and depth of hole. Production—85 per hr.

OPERATION 3. PROFILING FOR FIRING-PIN HEAD

Transformation—Fig. 968. Machine Used—Pratt & Whitney No. 1 profiler, Fig. 969. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws grooved to fit, Fig. 970. Tool-Holding Devices—Taper shank. Cutting Tools—End mill, Fig. 971. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ⅛-in. streams. Average Life of Tool Between Grindings—3,000 pieces. Gages—Fig. 972; A, length from point to bottom of recess; B, depth and outline of recess; C, length from bottom of recess to point. Production—45 per hr.

OPERATION 4. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing, cornering and generally brushing up. Apparatus and Equipment Used—File. Production—85 per hr.

OPERATION 5. TEMPERING AND HARDENING

Number of Operators—One. Description of Operation—Point of striker is heated in an open fire to 1,450 deg. F., then quenched in water; it is drawn in lead bath to 900 deg. F. Apparatus and Equipment Used—Oil-burning furnace and lead bath.

OPERATION 6. FINISHING POINT IN LATHE

Number of Operators—One. Description of Operation—Polishing end in lathe with emery cloth. Apparatus and Equipment Used—Bench lathe and emery cloth. Production—600 per hr.

OPERATIONS ON THE MAINSPRING

Operation
1 Coiling
2 Finishing

OPERATION 1. COILING

Machine Used—Special winding machine. Number of Operators per Machine—One. Work-Holding Devices—Wire wound between rolls A, Fig. 974, makes contact at B; this operates electromagnet C, which moves a cutoff knife at D and cuts spring to proper length of 33½ turns. Cut Data—50 r.p.m. Production—500 per hr., coiled and finished.

OPERATION 2. FINISHING

Number of Operators—One. Description of Operation—Springs are placed on a rod, Fig. 975, which will hold 22 springs compressed (with washers between) so the coils touch, so as to set the springs, which are allowed to remain for 48 hr.; before assembling the lock mechanism each spring is tested in the bench machine, shown in Fig. 976; the spring is slipped over a rod at A and compressed by means of a handle B; a pointer at C shows the pull on the spring; the allowable limits are from 16 to 19 lb.

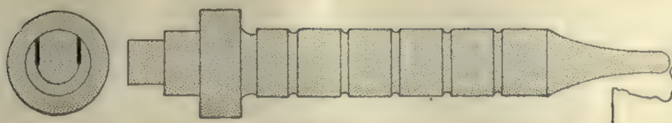


FIG. 968

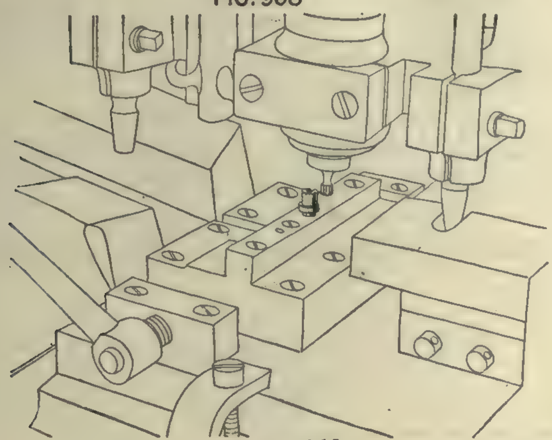


FIG. 969

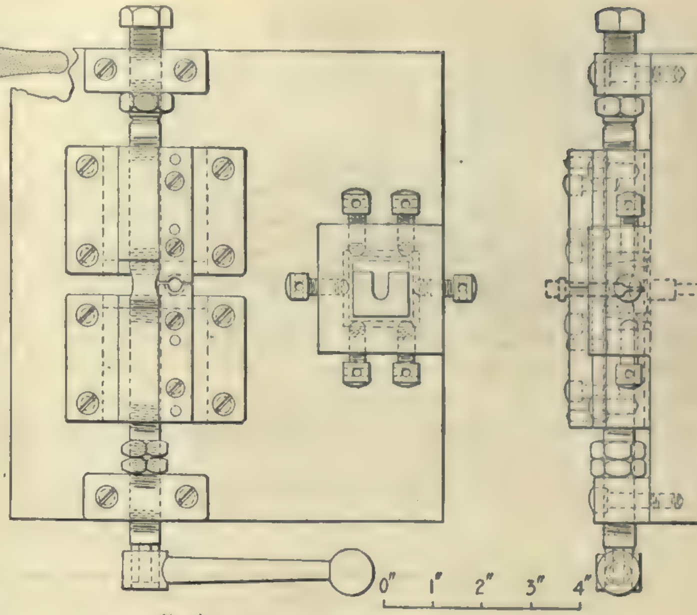
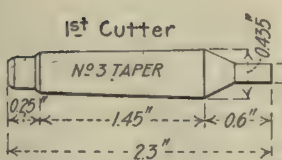


FIG. 970



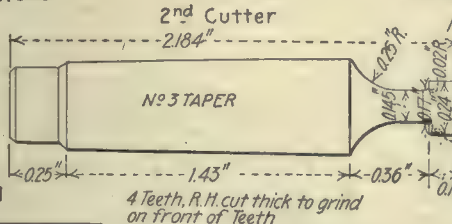


FIG. 971

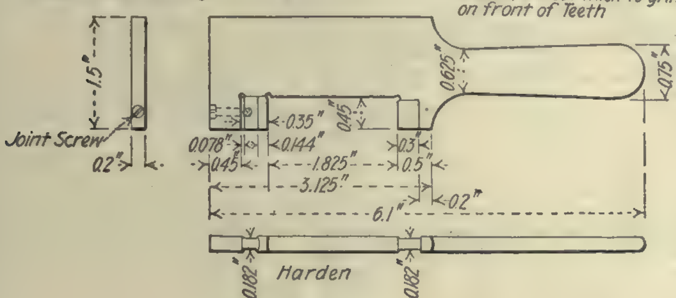


FIG. 972A

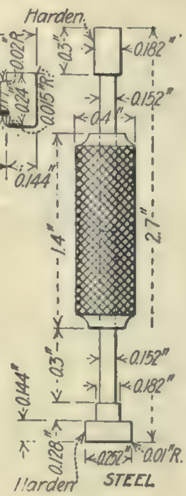
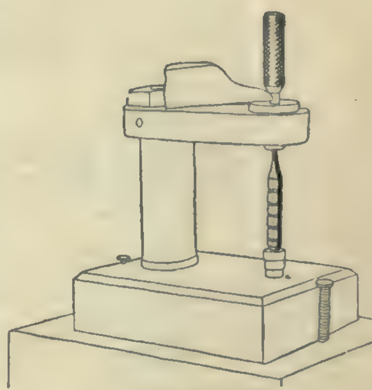


FIG. 972 B



972 C

OPERATION 3

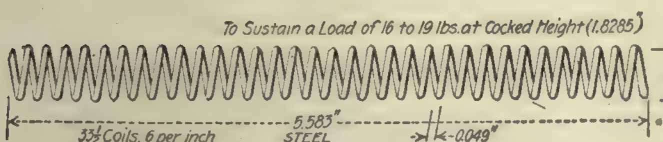


FIG. 973

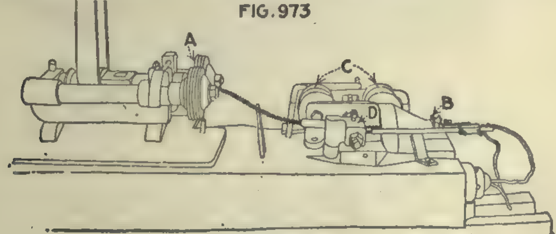


FIG. 974

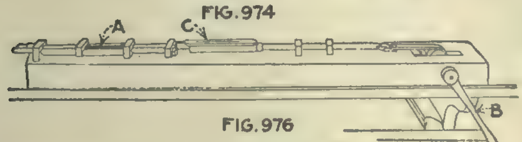


FIG. 976

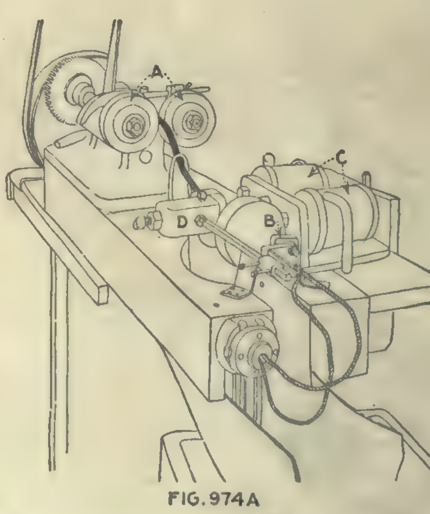


FIG. 974A

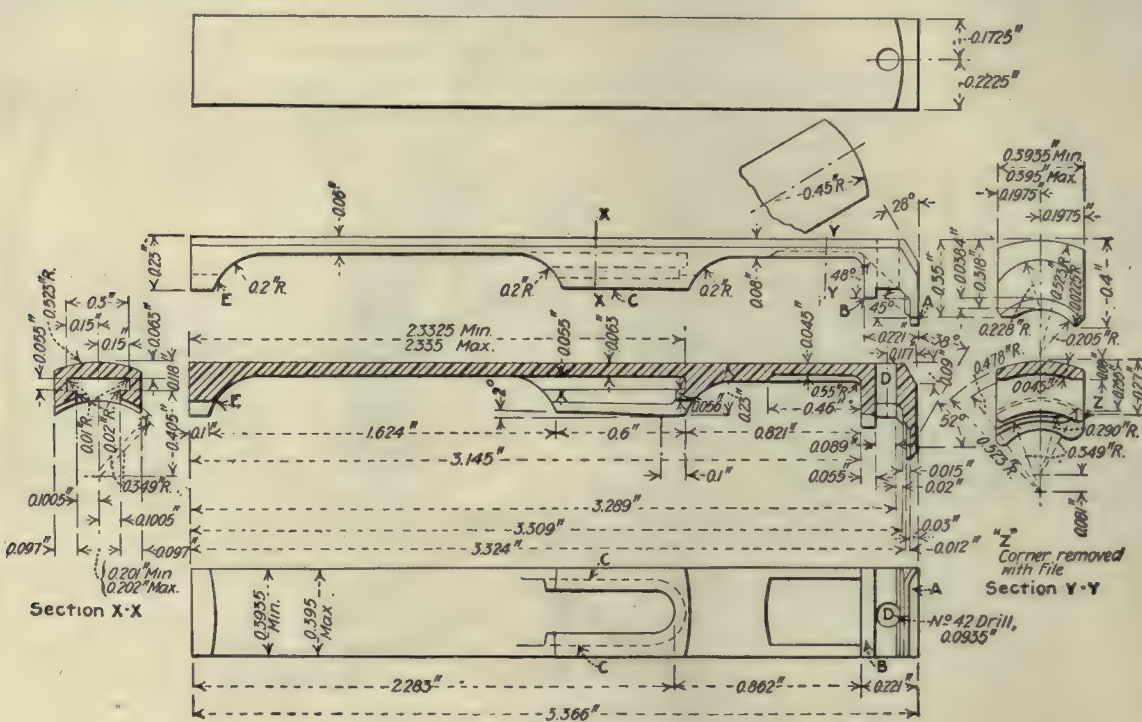
FIG. 975

OPERATION 3

The Extractor

The extractor, as shown in detail in Fig. 977, is made of Class B steel, 0.33 in. square. This steel must take a spring temper. The material is almost entirely cut away by various milling operations. The hook *A* extracts the cartridge case from the rifle after firing. The tongue *B* rides in the extractor groove in the end of the bolt and prevents any movement of the extractor. The lugs *C* are undercut to receive the ears of the extractor collar. The hole *D* is for the escape of gas after firing, while *E* is a backrest curved to fit against the bolt body.

This is a very particular piece of work as unless the front end grips the cartridge flange properly the shell will not be extracted and the rifle becomes inoperative. The piece is of a difficult shape to hold, which makes the special fixtures used of even greater interest than usual.



FORGED STEEL
FIG. 977

OPERATIONS ON EXTRACTOR

Operation
- A Forging from bar
- B Annealing
- B-1 Pickling
- C Trimming
- D Cold dropping
- 1 Milling bottom edge
- 3 Milling top edge
- AA Removing burrs left by operation 3
- 4 Milling left side and front end to finish (4 and BB grouped)
- BB Removing burrs left by operation 4
- 17 Milling right side to finish
- 17½ Straightening
- 5 Hand-milling circle over lug slot and rear end, roughing (group 5 and 6½)
- 6½ Hand-milling circle over lug slot and rear end to finish
- 6 Hand-milling circle over lug slot on angle (group 6 and CC)
- CC Removing burrs left by operation 6½
- 7 Drilling gas hole
- DD Removing burrs left by operation 7
- 7½ Straightening
- 11 & 12 Hand-milling clearance on hook and rear of hook
- 13 Hand-milling slot for bolt
- 14 Hand-milling head space, rear of hook
- 15 Hand-milling clearance for bolt lug
- EE Removing burrs left by operations 13 and 14
- 18 Hand-milling bevel on hook
- 15½ Straightening
- 16 Jig-milling hook and bevels, front end
- 19 Profiling corners of hook
- 8 Hand-milling lug slot, rough
- 9 Profiling lug slot to finish (group 9 and FF)
- FF Removing burrs left by operation 9
- 10 Profiling lug slot, undercut
- 26 Reaming gas hole, in lathe (26 and 28 grouped)
- 27 Filing, general cornering
- 28 Bending for tension
- 29 Hardening and tempering
- 30 Straightening to correct tempering
- 31 Polishing outer surface
- 32 Browning

OPERATION A. FORGING FROM BAR

Transformation—Fig. 978. Number of Operators—One. Description of Operation—Forging from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. hammer. Production—120 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal; left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnaces; oil burners.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Pickling scale from neck. Apparatus and Equipment Used—Wood tanks, wire baskets and pulley block; time, 10 to 12 min.

OPERATION C. TRIMMING

Machine Used—Bliss three-stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—20,000 pieces. Lubricant—None. Production—600 per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Cold dropping to straighten after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. hammer. Production—800 per hr.

OPERATION 1. MILLING BOTTOM EDGE

Transformation—Fig. 978. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 980; details in Fig. 981. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters and two spiral mills, Fig. 982. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Gages—None. Production—35 per hr.

OPERATION 3. MILLING TOP EDGE

Transformation—Fig. 979. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 980; details in Fig. 981. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, and two spiral mills, Fig. 982. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 983. Production—30 per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATIONS 1 AND 3

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 3. Apparatus and Equipment Used—File.

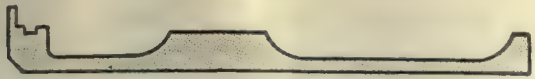


FIG. 978, OP. A

FIG. 979

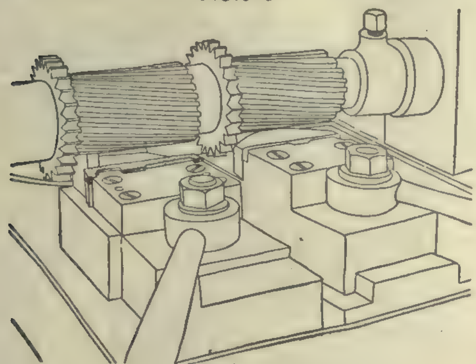


FIG. 980

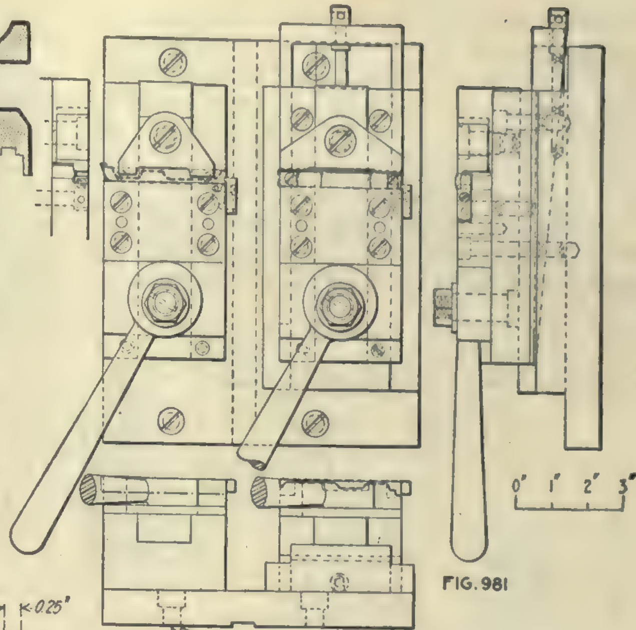


FIG. 981

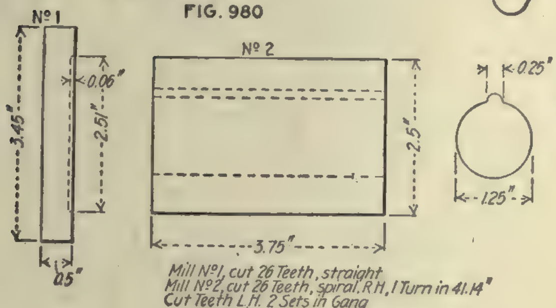


FIG. 982

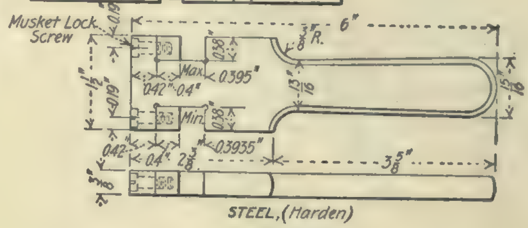


FIG. 983, OP. 3

OPERATION 1

OPERATION 4. MILLING LEFT SIDE AND FRONT END TO FINISH

Transformation—Fig. 984. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws against stop, Fig. 985. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang miller, Fig. 986. Number of Cuts—One. Coolant—Compound. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 987; A. length; B. contour and thickness of ends. Note—Grouped with operations 1, 3 and 17.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 17.

FIG. 984

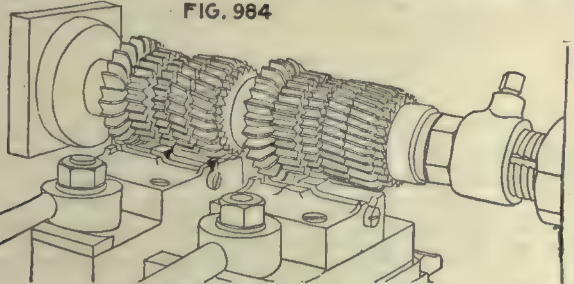


FIG. 985

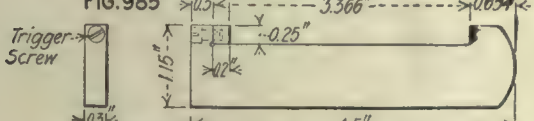


FIG. 987A

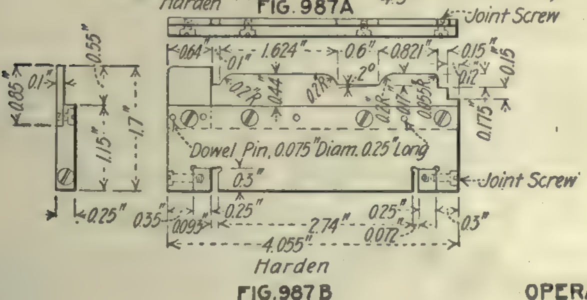


FIG. 987 B

OPERATION 4

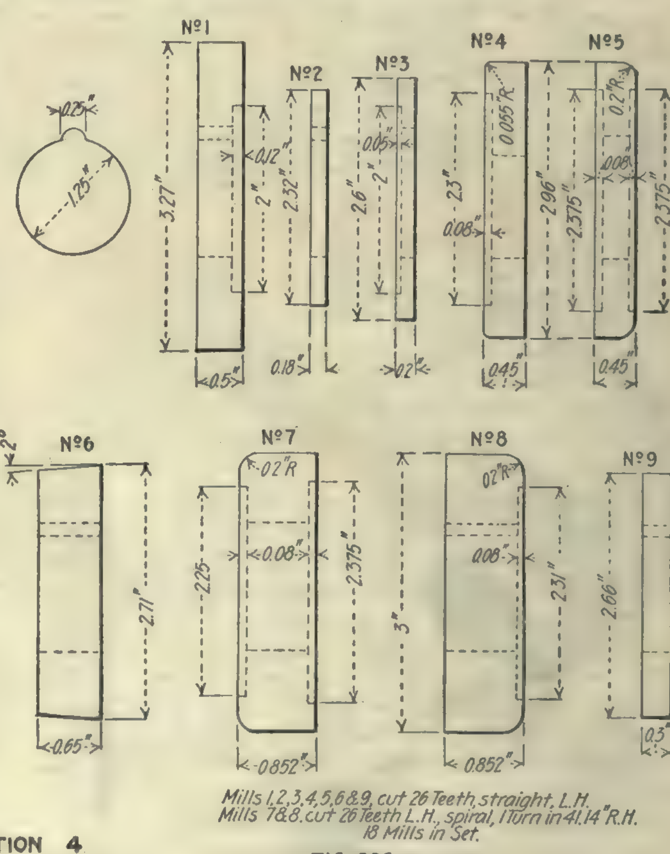


FIG. 986

The extractor, in common with many other parts of the rifle, is machined in pairs in many of its operations. In some of these the work is done in exact duplicate while in others the work is done on different parts. The profiling, both for forming the front end so as to insure its always gripping the flange of the cartridge, and for the undercutting of the flanges which receive the ears of the extractor collar, is an extremely particular operation. The undercutting is especially fussy owing to the slot or undercut being only 0.056 in. deep, and it is rather a which must be kept within close limits. The gages and methods are shown with each operation. Many of these have a central stem which represents the body of the bolt. The piece fits against this and the various points are gaged with relation to the fit on the central stems.

OPERATION 17. MILLING RIGHT SIDE TO FINISH

Transformation—Fig. 988. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Pushed to stop, clamped with vise jaws, Fig. 989. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 990. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—3,000

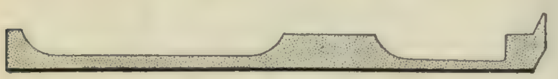


FIG. 988

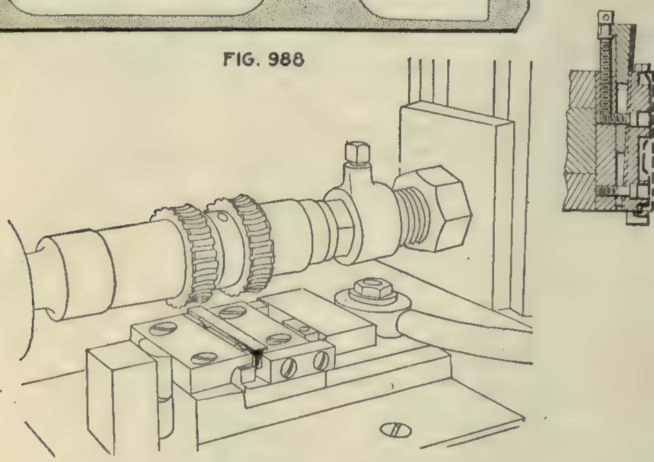


FIG. 989

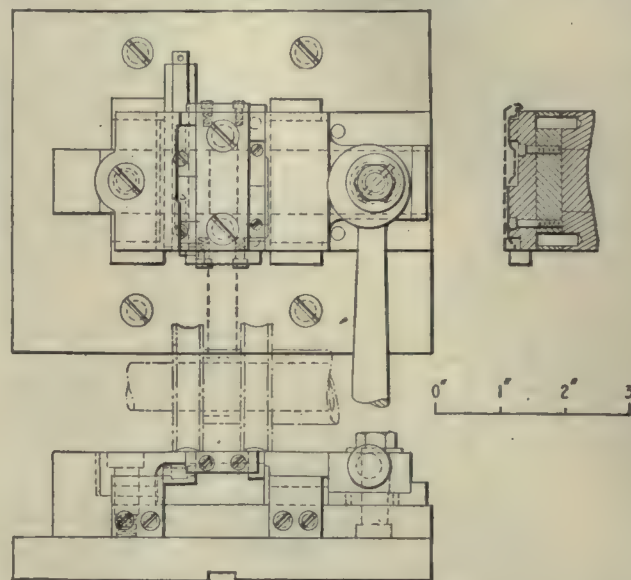


FIG. 989A

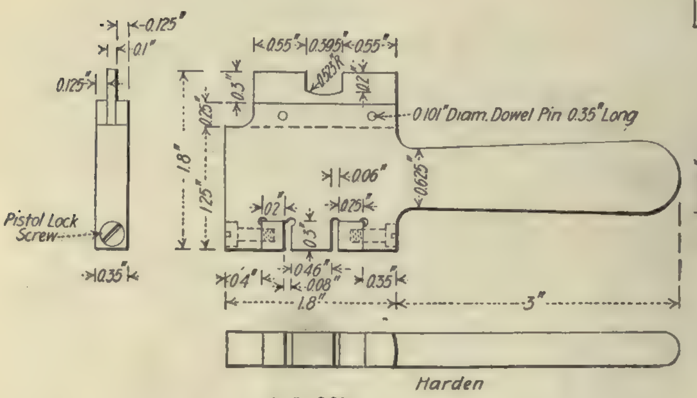


FIG. 991

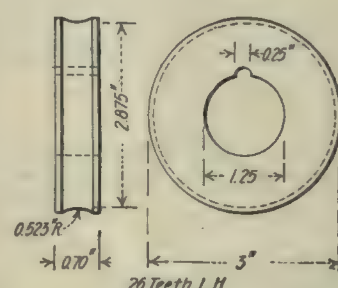


FIG. 990

OPERATION 17

difficult operation, as the cutters are delicate and must be handled very carefully.

The use of a profiling form for this work affords a suggestion to builders of various machines requiring small and delicate T-slots for any purpose. The usual way of milling is not so satisfactory where the slot is to be at all accurate.

The piece is finished all over, some fairly heavy cuts being taken as can be seen in Figs. 980 and 985 where gangs of milling cutters are used in both cases. In the latter case especially the cut is quite heavy, involving as it does the use of nine cutters in each gang. This makes the fixtures which hold such a slight piece against the stresses of a cut of this size, of particular interest. Needless to say the piece must be bedded firmly in the fixture as well as being securely clamped by the jaws; these are cam controlled as is usual in the fixtures used in the armory.

The gaging of this piece is also of interest as there are many points bearing various relations to each other,

pieces. Gages—Fig. 991; thickness, contour of front. Production—150 per hr.

OPERATION 17½. STRAIGHTENING

Number of Operators—One. Description of Operation—Taking out kinks. Apparatus and Equipment Used—Lead block, straight-edge and hammer. Production—175 per hr.

OPERATION 5. HAND-MILLING CIRCLE OVER LUG SLOT AND REAR END, ROUGHING

Transformation—Fig. 992. Machine Used—Whitney hand miller, Fig. 993. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 994. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 995. Number of Cuts—One. Cut Data—320 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Production—80 per hr.

OPERATION 6½. HAND-MILLING CIRCLE OVER LUG SLOT AND REAR END TO FINISH

Transformation—Same as Fig. 992. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, same as Figs. 993 and 994. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, same as Fig. 995. Cut Data—320 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Gages—Fig. 996; A, thickness of lug slot; B, contour. Production—80 per hr.

OPERATION 6. HAND-MILLING CIRCLE OVER LUG SLOT ON ANGLE

Transformation—Fig. 997. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, same as Fig. 994, except work is held at proper angle. Tool-Holding Devices—Taper shank.

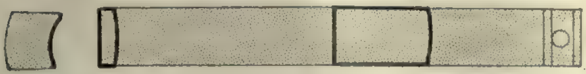
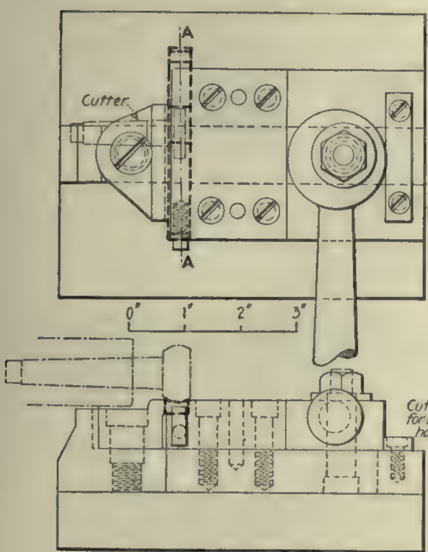
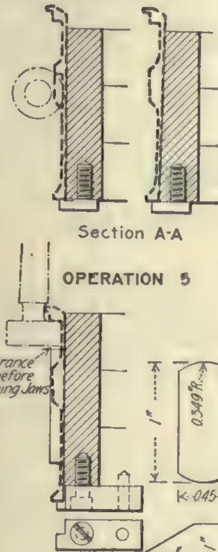


FIG. 992





OPERATION 5

FIG. 994

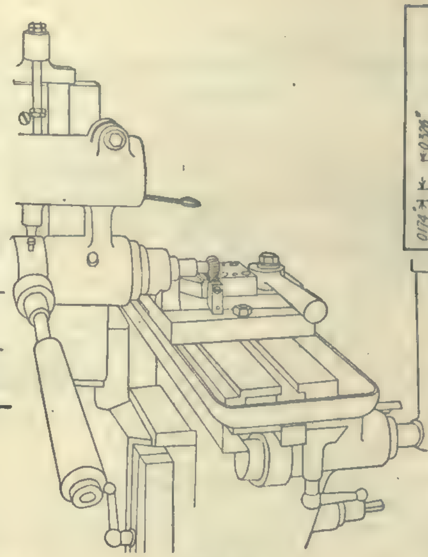


FIG 993

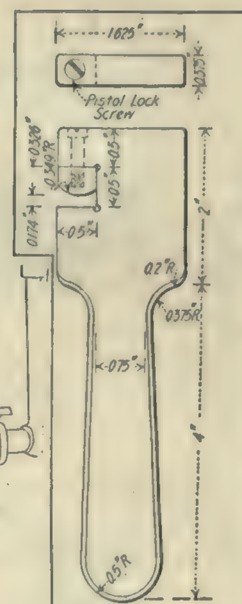


FIG. 996A

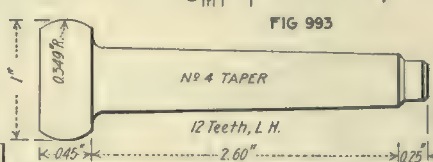


FIG. 995

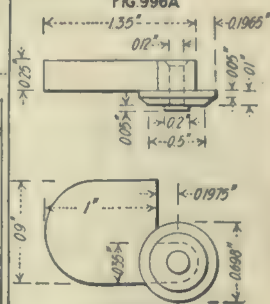


FIG. 996B, OP. 6½

FIG. 997

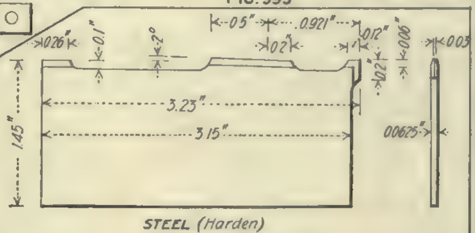


FIG. 998

OPERATION 6

Cutting Tools—Same as Fig. 995. Number of Cuts—One. Cut Data—420 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—20,000 pieces. Gages—Fig. 998, contour. Production—200 per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 6½

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 6½. Apparatus and Equipment Used—File. Production—Grouped with operation 6.

OPERATION 7. DRILLING GAS HOLE

Transformation—Fig. 999. Machine Used—Woodard & Rogers single-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Figs. 1000 and 1001. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1002. Production—120 per hr. Note—This hole is drilled for the escape of gas generated or liberated at the firing of the cartridge.

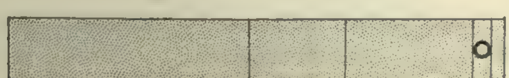


FIG. 999

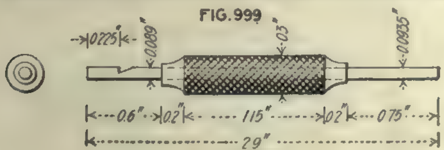


FIG. 1002

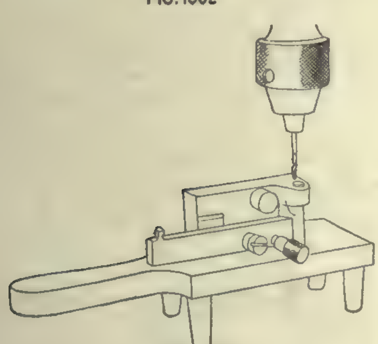


FIG. 1000

OPERATION 7

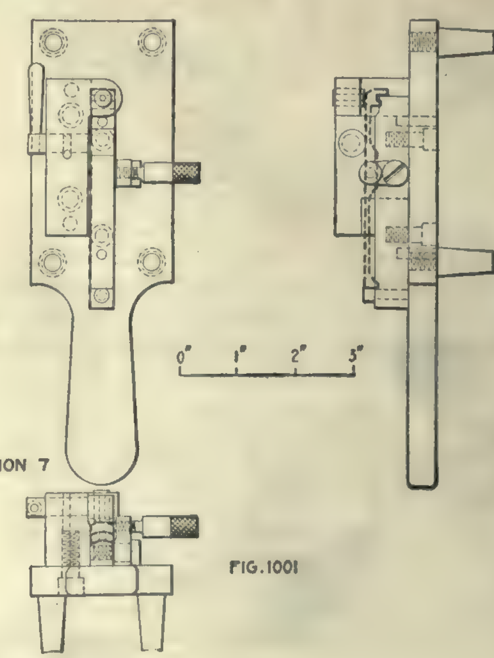


FIG. 1001

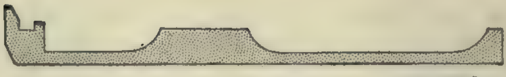


FIG. 1003

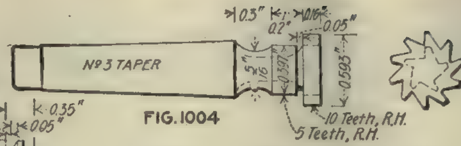


FIG. 1004

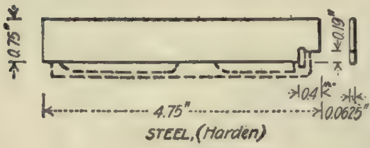


FIG. 1005

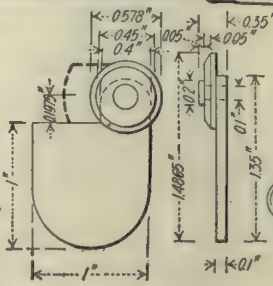


FIG. 1005A

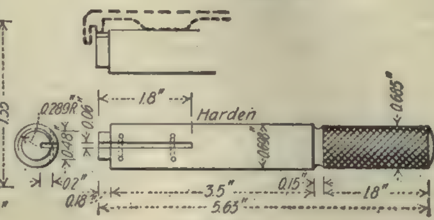


FIG. 1005 B

OPERATION 11 & 12

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7½.

OPERATION 7½. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening for finishing operation. Apparatus and Equipment Used—Lead block, straight-edge and hammer. Production—170 per hr.

OPERATIONS 11 AND 12. HAND-MILLING CLEARANCE ON HOOK AND REAR OF HOOK

Transformation—Fig. 1003. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Same fixture as Figs. 993 and 994, with change of cutter; held in vise jaw. Tool-Holding Devices—Taper shank. Cutting Tools—Miller cutters, Fig. 1004. Number of Cuts—One. Cut Data—360 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Fig. 1005; A, location from side; B, lining up with extractor lug and rear end. Production—175 per hr.

OPERATION 13. HAND-MILLING SLOT FOR BOLT

Transformation—Fig. 1006. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; same fixture as Figs. 993 and 994, with change of cutters. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1007. Number of Cuts—One. Cut Data—360 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Fig. 1008; A, thickness of hook; B, location of slot from back end; C, relation to extractor lugs. Production—175 per hr.

OPERATION 14. HAND-MILLING HEAD SPACE, REAR OF HOOK

Transformation—Fig. 1009. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; same fixture as Figs. 993 and 994, with change of cutter. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1010. Number of Cuts—One. Cut Data—360 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Fig. 1011. Production—175 per hr.

OPERATION 15. HAND-MILLING CLEARANCE FOR BOLT LUG

Transformation—Fig. 1012. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; same fixture as Figs. 993 and 994, with change of cutter. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1013. Number of Cuts—One. Cut Data—360 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Fig. 1014, radius of clearance. Production—175 per hr.

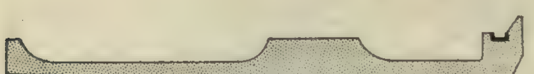


FIG. 1006

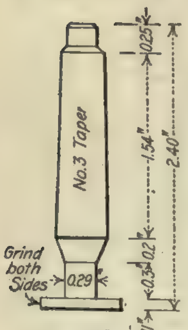
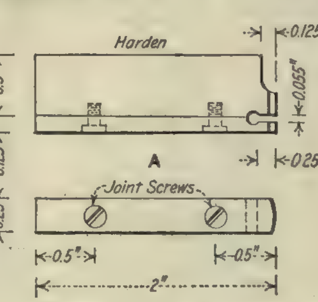


FIG. 1007



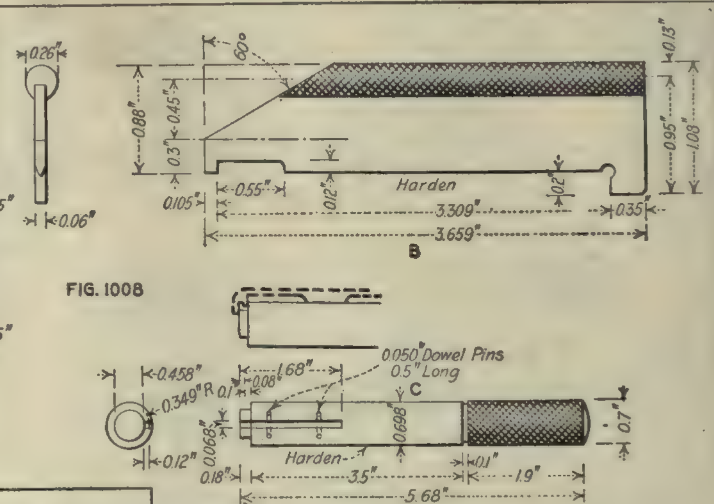


FIG. 1008

OPERATION 13

FIG. 1009

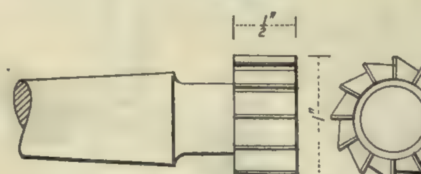


FIG. 1010

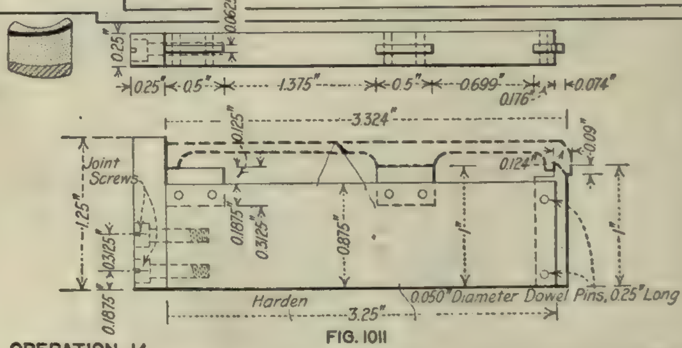


FIG. 1011

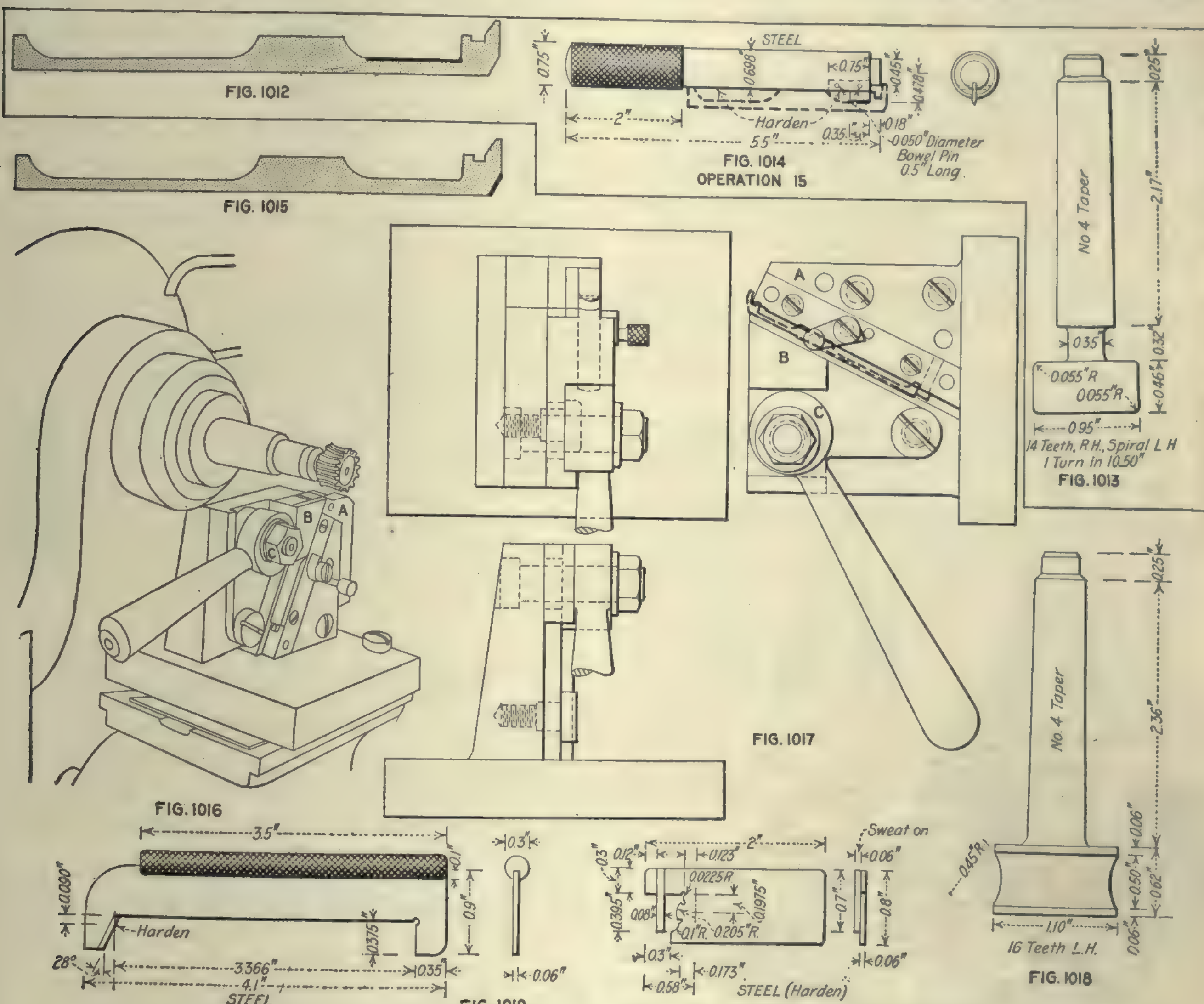
OPERATION 14

OPERATION EE. REMOVING BURRS LEFT BY OPERATIONS 13 AND 14

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 13 and 14. Apparatus and Equipment Used—File. Production—Grouped with operation 15.

OPERATION 18. HAND-MILLING BEVEL ON HOOK

Transformation—Fig. 1015. Machine Used—Garvin No. 3 hand miller. Number of Operators per machine—One. Work-Holding Devices—Clamped to form at proper angle, Fig. 1016; details in Fig. 1017; work held against A by shoe B and cam C. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1018. Number of Cuts—One. Cut Data—320 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1019, relation of bevel to back and end. Production—400 per hr.



OPERATION 18

OPERATION 15½. STRAIGHTENING

Number of Operators—One. Description of Operation—Same as operation 17½. Apparatus and Equipment Used—Same as operation 17½. Production—Same as operation 17½.

Data from Automatic Screw-Machine Tests

By R. G. Samuel

The following data were obtained from experiments conducted in one of the large typewriter factories. In Table 1, data relative to the results obtained with forming tools are given.

The feeds given in Table 1 should be used in conjunction with the speeds given. For lower speeds than those given, slightly higher feeds may be used. Where the diameter of the stock is more than two-thirds of the width of the formed cut, slightly higher feeds may be used. Where the diameter of the stock is less than two-thirds of the width of the formed cut, use hollow mills in place of a forming tool.

TABLE 1. FORMING TOOLS OF BLUE CHIP STEEL

Speeds

Machine Steel Diameter of Stock, In.	Feed per Revolution, Ft. Lubricant, Lard Oil	Lubricant, Soluble Oil
0.080 to 0.250	135	...
0.250 to 0.500	155	200
0.500 to 1.000	175	200

Feeds

Width of Cut, In.	Feed per Revolution, In. Screw Stock	Brass
0.080 to 0.150	0.001	0.004
0.150 to 0.250	0.0008	0.003
0.250 to 0.375	0.0007	0.0025
0.375 to 0.500	0.0006	0.0020
0.500 and over	0.0005	0.0015

A forming tool that is irregular in shape may be considered as being composed of several sections of various widths. In this case the feed per revolution is determined by the shape of the tool and considering each section of the form as an individual tool of the width of that section. A tool of this kind may be used when the diameter of the stock is less than two-thirds of the width of the formed cut, but when greater widths than this are to be machined, serious difficulties are likely to be encountered with a tool of this type.

A forming tool must dwell at the end of its cut to insure a round body. This dwell should be determined by the accuracy and finish required and should not exceed seven or eight revolutions.

In Table 2 are given the safe surface speeds to use with cutting-off tools.

TABLE 2. CUTTING-OFF TOOL OF BLUE CHIP STEEL

(Surface Speed for Machine Screw Steel)

Condition	Feed per Revolution, Ft. Lubricant, Lard Oil	Lubricant, Soluble Oil
Tool cuts into scale of stock	140	175
Tool cuts into raw stock	175	200

The safe speed for hexagon machine screw steel is 110 ft. per min. (figured on the diameter of an inscribed circle). The safe feed per revolution for round stock is 0.001 in., while for hexagon stock the safe feed per revolution is 0.0013 in.

Higher feeds may be used with lower cutting speeds. Feeds as high as 0.0015 in. per revolution have been used successfully at speeds of 80 or 90 ft. per min.

Care must be taken not to use high feeds on stock of small diameters or when cutting off a screw. In the case of the screw a feed higher than 0.001 in. per revolution will cause an excessive burr to be left on the head of the screw.

A cutting-off tool will produce better results when placed near the chuck than when it is a distance from the chuck.

In Table 3 are given the feeds for drills from 0.060 in. in diameter upward.

Drills—A satisfactory speed for carbon drills in soft steel is 60 ft. per min.; for high-speed drills in soft steel, 130 ft. per min.

TABLE 3. DRILLING FEEDS PER REVOLUTION

Stock

Drill, Dia., In.	Soft Steel Carbon, In.	Soft Steel H. S., In.	Brass Carbon, In.	Drill, Dia., In.	Soft Steel Carbon, In.	Soft Steel H. S., In.	Brass Carbon, In.
0.060	0.0015	0.0015	......	0.160	0.0035	0.0050	....
0.080	0.0017	0.0017	......	0.170	0.0037	0.0050	....
0.100	0.0020	0.0020	......	0.180	0.0040	0.0050	....
0.110	0.0023	0.0023	......	0.190	0.0042	0.0050	....
0.120	0.0025	0.0025	......	0.200	0.0045	0.0050	....
0.130	0.0027	0.0050	......	0.210	0.0047	0.0050	....
0.140	0.0030	0.0050	......	0.220	0.0050	0.0050	0.018
0.150	0.0032	0.0050	......	.....	......	......	....

All drills over 0.220 in. feed 0.005 in. per revolution.

The maximum feed of drill in No. 0 and No. 2 machines is 0.005 in. per revolution, on account of the holding power of the chuck.

For a throw or depth of drill of 0.300 in. or over, use two or more drills if possible. Otherwise use drop out to cool drill and to relieve strain.

When cutting off and drilling simultaneously where the drill goes clear through the piece, the drill must finish its cut by the time the cutoff tool reaches a point within 0.04 in. of the hole drilled. In the case of a reamer the cutoff tool may come within 0.025 in. of the hole drilled.

Reamers—The speed for carbon steel reamers is 65 ft. per min.; for high-speed steel reamers, 130 ft. per min. A satisfactory feed for reamers is from 0.010 to 0.012 in. per revolution. The proper chip thickness to be cut by a reamer is 0.003 in. The throw for a reamer is equal to the length of the part plus 0.010 in. for clearance.

Box Tools—The safe speed for box tool blades of blue chip steel is 150 ft. per min.; for box tool blades of carbon steel, 75 ft. per min. The feed per revolution to give a good finish is 0.015 in. The maximum chip thickness removable is 0.007 in. The minimum chip thickness removable is 0.004 in.

A box tool is used where a high degree of accuracy and quality is required.

A box tool can be used when cutting two shoulders on a part, by setting two blades in their proper positions in the holder. In this case the shoulder is squared up at the same time that the body is accurately finished. The box tool must dwell to square a shoulder.

Box tooling and centering operations can be combined by placing a centering drill in the shank of the box tool, but this is not desirable because of the possibility of disturbing the box tool cut when centering.

Hollow Mills of Blue Chip Steel—The safe speed for hollow mills is 150 ft. per min. with lard oil. The feed per revolution for the roughing cut is 0.010 in.; for the finishing cut, 0.015 in. The maximum chip thickness removable in the roughing cut is 0.100 in.; in the finishing cut, 0.015 in.

A chip thickness of 0.020 in. at a feed of 0.015 in. per revolution has been successfully removed from 0.160-in. stock.

Care must be taken to prevent the stock from buckling on account of too great a chip thickness or too great a feed.

Knurling Tools—The turret knurling tool is used for flat knurling, and the knurling swing tool is used for knurling an arc. The throw for a turret knurling tool is equal to the thickness of the knurl. The throw for a knurling swing tool is equal to the depth of the knurl, usually about 0.050 in. The feed per revolution for a turret knurling tool is as follows: Knurl on, from 0.007 to 0.010 in.; knurl off, from 0.015 in. to 0.020 in. The feed per revolution for a knurling swing tool is 0.002 in.

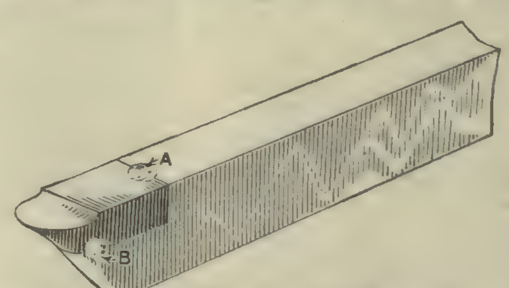
The foregoing feeds are taken from few observations, but the use of these feeds has given satisfactory results on a large amount of work.

Welded-Tip Cutting Tools

By M. Carry

The practice of oxyacetylene welding to utilize short ends of high-speed steel on a mild-steel shank has already been described in the pages of *American Machinist*, but this, I believe, is a better method.

I have found that only three spots are necessary to weld the high-speed steel tip to the shank in a secure



THE TIP IN POSITION

manner, one at *A* and one on each side at *B*, near the front.

These spots are only inserted to hold the cutting steel in position, while the strain of the cutting is taken up by the shank underneath.

Besides being quick and cheap, the tip can easily be removed when too short, by simply forcing a wedge between the two steels, the shank being again used by welding on another tip.

Letters from Practical Men

Assembling Fixtures for Headless Screws

The use of a simple but efficient method of inserting headless screws in munition parts and other work is here shown.

A hardwood block *A* is grooved on the top face to seat a brass or steel tube *B* that is large enough inside to receive the diameter of the screw. The front end of the block is cut away to receive the plate *C*, which forms a table for the work. The plate should be secured to the block by screws. A cast-iron or steel angle is fastened to the plate for centering the work in line with the hole in the tube.

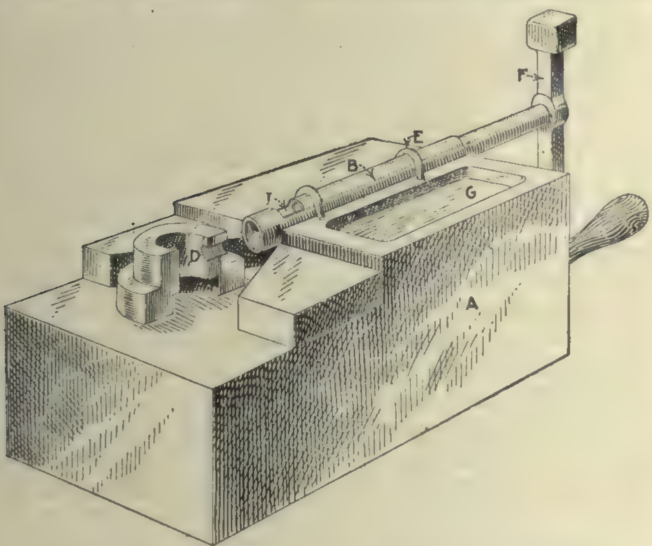


FIG. 1. PUTTING SCREWS INTO AN ADAPTER

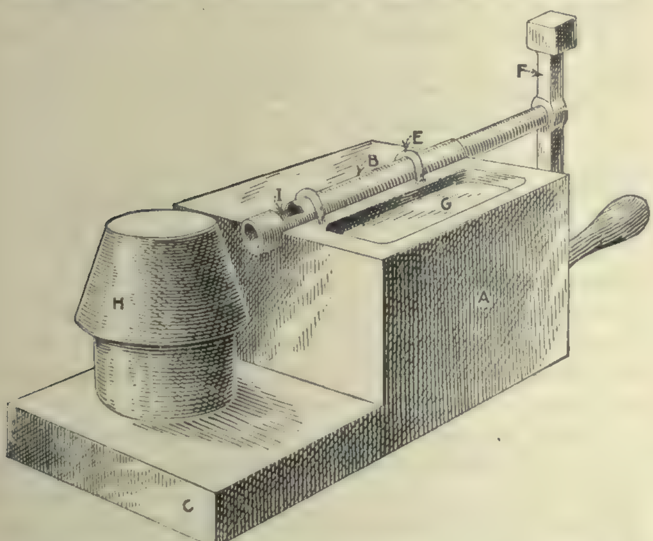


FIG. 2. INSERTING SCREWS IN A FUSE BODY

The top face of the plate *C* should be so located that the center of the hole in the work will line up with the hole in the tube *B*. At the front end of the tube an opening *I* is cut on top, long enough to receive the screws. The tube is located in the groove of the block and secured by two staples *E* driven into the wood.

The screwdriver, which is a free fit in the tube, is operated by a crank *F*, which should be weighted at the opposite end from the handle, for balance. By dropping a screw in the opening at the top of the tube, seating the work against the angle and turning the work so that the hole will line up with the screw, the screws are quickly driven into place.

By making the block large, a tray to hold the screws can be cut out in the top face, at *G*. The illustrations, which show an adapter *D* (in cross-section) and the fuse body *H* of a detonator fuse, clearly indicate the usefulness of this simple device, which can be applied to other lines.

Allston, Mass. J. J. EYRE.

Dashpot for Starting Rheostats

Most shops today, both small and large, are powered with electric motors. Because of the relatively high cost of installation very little attention is paid to the starting apparatus, which usually consists of a knife-switch and a hand rheostat, or "starting box," as it is called. The motor is brought up to speed by swinging the arm on the box by hand, and so the acceleration depends entirely upon the operator.

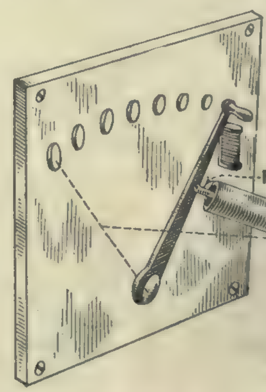


FIG. 1

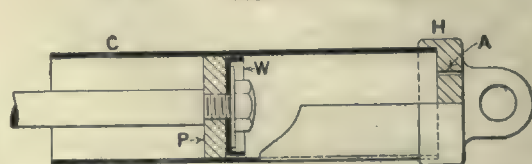


FIG. 2

THE DASHPOT AND ITS APPLICATION

An attachment to prevent hasty starting and consequent burned-out fuses and motors is shown herewith in the form of an air dashpot. It consists of a dashpot cylinder *C* hinged at one end on a bracket *B*, with a piston rod *R* pivoted to the starting arm. The dotted lines in Fig. 1 show the position of the arm and the dashpot before starting, and the solid lines indicate the

location in the final position. As the arm moves to the right the piston travels farther into the cylinder and expels the air ahead of it through the vent *A*. This vent being small, the action of the piston is retarded and with it the starting arm. In Fig. 2 is shown a detail of the dashpot and the piston. *C* is a sleeve sweated into the head *H*, and *W* is a leather cup washer secured to the piston *P* with an iron washer and nut.

Bridgeport, Conn. W. BURR BENNETT.

Economy in the Use of Packing

The cost of packing constitutes an item of no small amount in power plants, and economy in its use is well worth the attention of every engineer. The superintendent of a plant told a packing salesman recently that he would rather have the money for packing that had been wasted in that plant than that spent for packing actually used. The salesman admitted he was about right.

Gaskets for flanged fittings are often cut by laying a sheet of packing on the flange, taking pains to have the sheet extend over a little on all sides then hammering the packing over the edges of the flange, thus cutting a ring the full width of the flange besides wasting a little packing all around it. As has often been pointed out, a ring that will fit just inside of the bolt holes really makes a better gasket than one that covers the whole flange, and it costs less than half as much. One man cut a cylinder-head gasket that cost thirty cents. Another used up material that cost $1.30, and the job was no better.

Another source of waste is in improperly cutting gaskets from left-over circular pieces. Many engineers will take a circle larger than needed, cut the center out and leave the remainder on the fitting or whittle it off in such a way as to render it useless. The proper way is to cut out of the circle a concentric ring just the size needed,

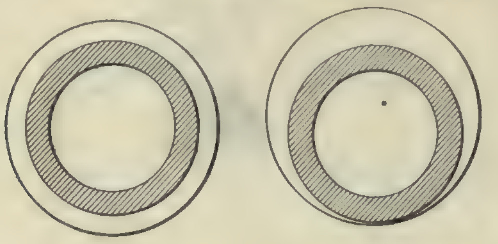


FIG. 1 FIG. 2

REDUCING WASTE IN CUTTING GASKETS
Fig. 1 the right and Fig. 2 the wrong way

leaving a ring outside and a circle inside for use on fittings of other sizes. Figs. 1 and 2 show the right and the wrong way; enough packing is wasted in the latter case to make a gasket of a larger size.

Tubular packing is a very economical form to use for flanges, and there need be no waste, as short pieces may be spliced together to make any size of gasket desired. By running a copper wire of about No. 16 gage inside of the tubular gaskets, they are suitable for pressures up to 125 lb. The wire should go all the way around and lap a little on the side opposite the splice in the gasket. The ¼-in. size is large enough for flanges up to 5 in. and ⅜ for larger sizes. The ⅜ size weighs over twice as much as the ¼-in., so the smaller should be used wherever suitable. Engineers need to learn that there is such a thing as good enough and that if a thing is good enough there is no use in trying to make it better, because it cannot be made better. All over enough is usually wasted.

In cases where it is difficult to keep the tubular gaskets in place while putting the work together, they may be tied in position with a soft string or small copper wire threaded through the bolt holes.

An engineer, in putting up an 8-in. steam line, was skeptical about tubular gaskets and used several other kinds in preference. However, he ran out of other material and was forced to use one tubular gasket. When the pipe line was put in service, the tubular gasket was the first to be made steam-tight and it remained in use after all the others had been renewed.

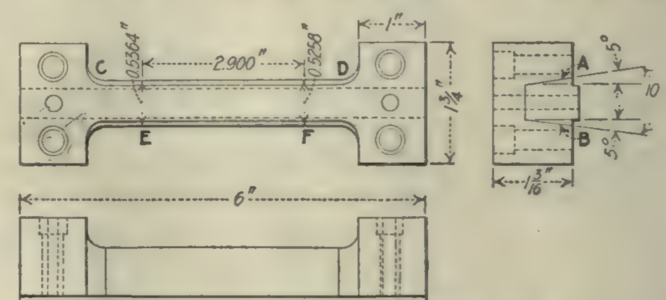
If engineers will figure out the cost of the packing they use and think what they would do if they had to pay for it themselves, their packing expense will be cut in half.—*Power*. G. E. MILES.

Green River, Wyo.

A Surface-Grinder Job

A part of a profile fixture to be used for a taper slot was to be made of the dimensions given in the accompanying illustration. In 2.900 in. there must be a taper of 0.0106 in. with a 5-deg. angle to suit the pin of the profile machine. When the drawing for this work was given to me, I scratched my head for about an hour before I could think of the most accurate way to do it. Finally, I decided upon the following method:

First, I made a setting piece of steel ⅛x½x5.80 in. Then I placed the job in an angle vise with my setting piece on the edge of the tongue on the bottom of the



ANGULAR SURFACE-GRINDER JOB

profile. The tongue, of course, was accurately parallel. With the use of a height gage I set the part so that my setting piece was 0.0106 in. higher at one end than the other.

In this position I ground a flat of ⅛ in. from *C* to *D*, as shown at *A* and *B*; then I set the angle vise at 5 deg. and ground the profile surface. After this was done, I reversed the piece in the angle vise and repeated the operation on the other side of the profile.

To test the part before turning it over to the inspector, I put some bluestone on the flat surface *A*. Setting the work on end, I scratched a line at *E* and *F*, then measured the thickness on the flats *A* and *B* with the 1-in. micrometer. It came out right to 0.0106 in., as the drawing called for. The 5-deg. angles on each side I tested with a plain sine bar and height gage.

Can some reader suggest a simpler and easier way of doing this work, which is one of the many difficult tasks that come with profiling? CHARLES SEHL.

Philadelphia, Penn.

Discussion of Previous Question

A Flagrant Case—and an Apology

[Referring to an editorial on page 83 of last week's issue, under the same title as the heading of this article, the D. & W. Machine Co., Inc., sends us a copy of a letter of regret written to the Warner & Swasey Co., with permission to publish it. This letter follows.—Editor.]

Jan. 3, 1917.

Warner & Swasey Co., Cleveland, Ohio.

Gentlemen—We have been advised by the *American Machinist* that you have taken exception to the cut used in editorial describing the D. & W. turret screw machine.

When we decided to build a screw machine, it was natural for us to follow the make we considered the best and we are frank to confess that we copied the Warner & Swasey, as your patents had expired and we were not infringing in any way. You are very well aware that the custom of copying is nothing new, as most manufacturers have done this some time in their career.

While we did copy your machine, we were very careful not to build an inferior machine, and we feel that our machine is as accurate and true as any machine offered.

During the rush of starting, however, a very grave error was made by using a photo of one of your machines, and for this we want to offer our most sincere apologies, and regret very deeply any inconvenience caused you thereby. We know it is very aggravating to have anyone make an inferior copy, but we can assure you that our copy is a high-grade machine and will not cast any reflections on the Warner & Swasey.

Trusting that you will accept our apology and assuring you that we will use every care not to commit any error that will bring a criticism from you in the future, we are, yours very truly,

D. & W. Machine Co., Inc.,
THOMAS F. DU PUY.

Does a Piston Stop at Reversal?

A question such as "does a piston stop at reversal?" can only be asked by those who are not aware that the engineering profession has supplied definitions for the terms used in mechanics and dynamics. The moment a man like Mr. Glass (page 823, Vol. 45) starts to manufacture his own expressions and definitions, bolstering his argument on the assertion "to stop means to produce a state of rest," then plunging into quasi-scientific depths by talk on harmonic curves and the like to give his question the necessary weight, I no longer wonder that such arguments still come up.

"To stop means to produce a state of rest." But what does Mr. Glass mean by a state of rest? Does he mean lack of velocity, or does he mean no velocity during a definite period? As it is, the whole question is not a scientific one; it is a juggling of definitions, a haphazard mixing up the words velocity, motion, stop and rest.

Scientifically, this long since fought-out question is this: The positive motion of the piston can not become a negative one unless the velocity of the piston has reduced itself to naught, though this entire lack of velocity lasts only an infinitely small fraction of time. Now I leave it to Mr. Glass to define the words rest and stop. If he says: Rest means entire lack of velocity, then the piston does stop. If he defines rest as the lack of speed during a definite period, then the theoretical piston does not stop.

Brooklyn, N. Y. JAN SPAANDER.

On page 823, Vol. 45, Mr. Glass contends that the piston of a steam engine does not stop at reversal. I disagree with him. Referring to the diagram, let DA represent the crank and AB the connecting-rod. If the crank moves from A to A_1, there must be an intermediate position C at which the centers of the crankshaft D, the crankpin A and the crosshead B are in a straight line. This is the position at which reversal takes place. As the crank and the piston approach this point, the crank

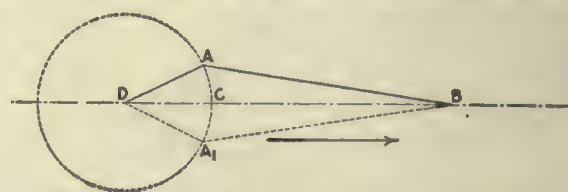


DIAGRAM OF THE CRANK, CONNECTING-ROD AND PISTON

has a uniform angular velocity W, and the velocity of B (assuming a connecting-rod of infinite length) is as follows:

Velocity of $B = W \times$ sine of angle CDA. When this angle becomes zero, we have velocity of $B = W \times$ sine 0 deg. $= W \times 0 = 0$. In other words, B has stopped.

It is apparent that the motion of B in the direction of the arrow has ceased and that the motion in the opposite direction has not yet started. If, as Mr. Glass says, it has not stopped, in what direction is it moving when the three centers are in a straight line?

Woonsocket, R. I. HARRY BROOK.

On page 823, Vol. 45, W. C. Glass asks for proof that he is wrong in his opinion that a piston does not stop at the end of its stroke. If the crank moves with uniform velocity, then, with a connecting-rod of infinite length, the velocity of the piston varies from a maximum, when the crank is at right angles to the line of piston motion, to zero, when the crank is on dead center. Now can motion be imagined without velocity—that is, without rate of motion? It does not follow that because a body moves a certain distance in a given time that body has not stopped in that time, and the only thing to do is to take each position and give its velocity at that position.

It is true that in the case of the piston the time of rest is only that taken for the center of the crankpin to cross the line joining the piston and the shaft center, and this is theoretically no time at all. However, with harmonic

motion, the velocity can only be found by specifying either a definite time (not length of time) or a definite position, as the velocity is always changing. Actually, a piston does stop at the end of its stroke for a definite length of time, even if there is no lost motion at the pins or elasticity in the materials of construction.

Nottingham, England. ALBERT F. GUYLER.

Which Is the Better Way To Impart Information?

On page 1041, Vol. 45, is a letter by W. D. Forbes, entitled "Which Is the Better Way To Impart Information?" It is a question that is not easy to answer offhand. I have been a teacher of machine design and allied subjects for some 15 years. With students of all degrees of preparation, I have had to change the presentation of the same subject between wide limits to suit the man being taught. To some, Mr. Forbes' 60-word presentation would convey all the information needed; to others it would mean little. The 700-word presentation would probably reach the second fellow all right, because there is more or less of a "story" in it. Personally, I do not like the story-telling method in the least, but I know it will often succeed when the bald presentation of the facts will not.

A good many years ago I put in some time at sea as an engineer for the American Line. I went there from a fresh-water town, and I was pretty much of a landlubber about everything marine. But I had had a good technical education, and I found out after a while that my "mates" were quite willing to swap some lessons on practical marine engineering for some coaching on stresses and strains, elementary thermodynamics, sketching, valve diagrams, etc., although they would not give a particle of information without a *quid pro quo*. These men were nearly all Englishmen and Scotchmen—splendid "fitters" or handwork machinists—but a great many had never had more than elementary schooling before entering the shops. It was up to me to give them enough theoretical instruction to enable them to pass the examinations for licenses, and these examinations are pretty stiff, especially those given by the Board of Trade in England.

After a little experience I found certain regular stumbling blocks and had to devise ways and means to get around them. One of them was the British thermal unit. To tell one of these men that a barrel of warm water contained more heat than a pint of boiling water was apt to arouse strenuous objection, but they usually saw through it after a little persuasion. The product of a force by its lever arm, making moment, and of a force by a distance traveled, making energy, was another bump in the road. Many were greatly puzzled by the fact that it required a bigger shaft to carry, say, 5000 hp. at 60 r.p.m. than at 600 r.p.m., with the same stress. A pound of stress and a pound of weight were confusing, also.

I remember a musician's once telling me that there was a stress of about 20 tons on the frame of a piano, due to the combined pull of all the tuned wires. I do not know how accurate this may be, but I accepted the figures as a good example of a high degree of stress existing where it might not appear to a layman and once mentioned it to a class of young men as such an example. One of them looked at me with a fine expression of incredulity and exclaimed: "Now, I hardly can believe that. I helped three other fellows carry one in the other day, and it was pretty heavy; but I'm blamed if it weighed any 20 tons!"

Many good engineers and mechanics have a vagueness and credulity about things outside their immediate personal experience that are both amusing and pathetic. Others, who ought to know better, adopt the Missouri attitude and literally dare you to make them understand something new to them; or else they must go ahead and try something out for themselves, just to see what will happen, no matter what the experiment may cost the boss, the company or the school. I have learned by costly experience that one out of every so many men who begin to do experimental work in an electrical laboratory will always ignore certain fundamental rules, no matter how often they are explained and lecture demonstrations made. It is very easy—and cheap—to show the effect of an excessive current through a resistance, by burning up a bit of iron wire; yet some men will see that done and apparently understand fully the reason and be able to state glibly that "I^2R = the number of watts converted into heat when the current I amperes flows through R ohms resistance." But the same men or one of them will be pretty sure to pick up the first $75 precision ammeter he gets hold of and put it across the line instead of in series; or else he will put in one whose scale is 5 amp. to read the starting current for a 5-hp. motor.

There was at one time a Scotch second engineer on the "New York," of the American Line, who was as fine an operating steam engineer and all-around mechanic on marine work as I ever knew. This old craft was a crack ship in her day and was originally built for the Inman Line, long deceased, to British Naval Reserve specifications. This meant she had no openings from pumps, etc., above her water line. Most big steamships discharge the condenser-cooling water well above the water line, also the bilge-pump, sanitary and other discharges; but on the "New York" these openings were below the water level.

Old "Mac," as I can safely call him without in any way identifying him, once drew my attention to this below-water discharge and remarked that it vastly increased the work done by the pumps. I told him I could not see why, and he explained that "whin ye pump the water up and left her fall clear, ye do vara leetle wark; but the way she is geared, ye pump against the whole Atlantic Ocean!" Later I found many other engineers with the same notion; and unless they had a little elementary knowledge of hydraulics, it was useless to argue with them.

I remember another good man who wanted to find the square of some number, say 1764, in a table that ran only to 1000. So he took half of 1764, or 882, found its square and then doubled it. He would not believe it was wrong until I made him multiply out 1764 by 1764 and divide it by the square of 882; but then he learned that the square of a number is four times the square of half the number. Now a man who has an elementary knowledge of algebra can see at once that $a \times a = a^2$; and $2a \times 2a = 4a^2$, from which the above rule is proved once and for all, for all numbers. But the fellow who proves it for 882 and 1764 may have an idea in the back of his head that, however true it may

be for those numbers, it might not hold for some other numbers.

A machinist once insisted to me that 3.1416 was a silly number to use, when 3 was just as good. He then proved it by scribing a circle with his dividers and stepping round it with the radius. Of course, it took six steps. Then, as the diameter was twice the radius, the circumference was three diameters! Very few practical men who figure a great deal, and figure correctly, know that 0.7854 is one-fourth of 3.1416, or that when they state a taper in so many inches per foot they can find the angle at once from the tangent by a little easy figuring. And on the other hand, I have met many men high up on the theoretical side of thermodynamics and steam-engine work generally, who did not know that one-half the boiler pressure is a very close estimate for the mean effective pressure on the piston of the standard type of automatic-cutoff high-speed steam engines exhausting into the atmosphere, with the cutoff at the normal position of one-fourth.

I once had a class of young men in drafting to whom I gave a simple design, one detail of which was a ⅝-in. stud about 3½ in. long. Every one of them drew the stud with a right-hand thread at one end and a left-hand at the other. This was in a technical school where they took a just pride in their shops and shopwork, so I went down to the machine-shop instructor and asked him where the boys could have got the idea that a stud was made in that way. He looked rather sheepish and then showed me a lot of pieces made just like their drawings. He explained that he had assigned it as an exercise in cutting threads on the lathe and had had them cut both threads on one piece to save time and material. He agreed with me at once that it had given a wrong impression and that it was a mistake to try to teach machine-tool work by making pieces that, however well they might show the processes and operations done on the machine, were of no practical use themselves.

It seems that I have gone a long way from what I intended when I started; but Mr. Forbes' letter has served me as a text—or an excuse—to preach at some length on this teaching game, or as Gilbreth might call it, "transference of skill." More and more the problems of the foreman and superintendent resolve themselves into teaching. The old idea, still prevalent in England up to the present war, that it was impossible to make a machinist without six or seven years' apprenticeship, has been knocked higher than the famous kite by the experience of the munition makers with women, boys and men physically unable to enlist. A few months' teaching made as skilled a worker as six years' knocking around the shop and picking up information in any old way.

Americans and Canadians who have had experience working beside English and Scotch mechanics know how jealous and secretive they are about imparting the least bit of information; and I have heard even good American machinists, who ought to know better, bitterly denouncing a shopmate because, in their words, he had "stolen the trade." Whether the so-called thief had mastered the trade or not made no difference; the fact remained that he had learned it without the preliminary apprenticeship, and therefore, he was more or less of a scoundrel.

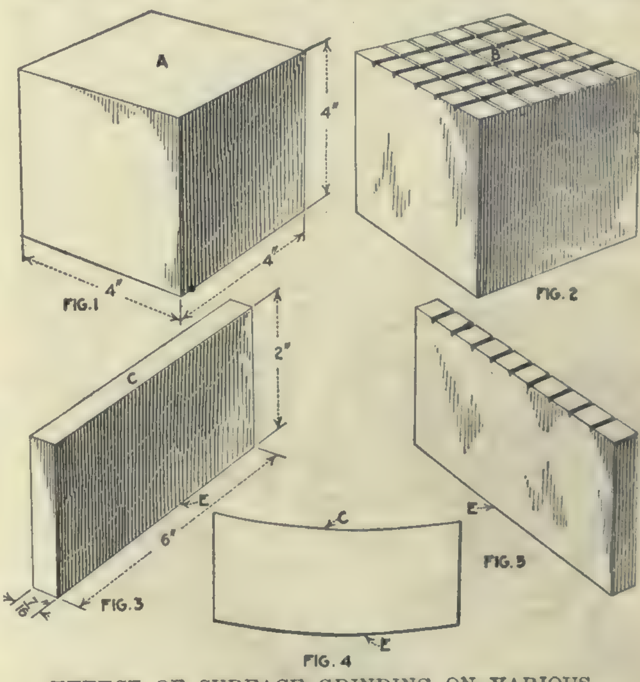
Apropos of the ignorance of many good men when they step outside of their accustomed path, I am reminded of a certain Scotch machinist whose first name was Adam. He was a crackerjack on locomotive work, but he drifted into a job on the American Line "shore gang" some years ago. When he came aboard to begin work, he was told to "take leads on the port No. 1 crosshead pins." He got some pieces of lead wire and went to work. In the course of an hour or two he reported to the second engineer for another job. "Did ye get those leads?" said the second. "Aye!" said Adam. "Where are they?" asked the second. "They're in there," replied Adam, pointing to the crosshead brasses on the connecting-rod, "and they'll no come out this time!"

Halifax, N. S. W. S. AYARS.

Does a Grinding Wheel Peen?

The following statement was edited into my article, "Straightening Thin Hardened-Steel Gages," page 912, Vol. 45: "It is not so well known, however, that this peening effect shows itself on hardened steel when ground in a surface grinder." This is such a reversal of my former writings and so contrary to my beliefs that I think a résumé of what causes me to take the view I do of the action of abrasive wheels, laps and abrasives in any form will help to bring out the deductions of others.

My deduction is: The heat generated by an abrasive wheel run at correct speed is of great intensity and has



EFFECT OF SURFACE GRINDING ON VARIOUS TEST BLOCKS

a purely local effect confined to the surface being ground and is productive of contracting stresses.

The wheel used in these tests will be the equivalent of a 46-G, Norton scale, wheel, as I have found this a good grade for hardened carbon steel. The reason we use a cool cutting wheel for these tests is because it enables us more nearly to gage, or rather obtain, the mount of heat derived with various specific depths of cut. Obviously, the heat varies with the depth of cut—that is, the greater the depth of cut the greater the heat generated—and the quantity of heat generated by the wheel determines the effect. With a heavy cut the effect on the work will be more pronounced than with a light one, and with similar conditions of work size, material

hardness and so forth, the effects of similar depths of cut will be similar.

For instance, take a block of the proportions given in Fig. 3, and a cut 0.0001 in. deep the full width of the face *C*, using a wheel ½ in. wide. Then measure the curvature of the face *E* and tabulate it. Take a similar cut, but 0.001 in. deep, and tabulate the curvature due to that depth of cut. It will be found that similar curvatures, or effects, can be reproduced at will, provided the conditions (depths of cut, etc.) under which they are obtained are similar.

Having generated the desired amount of heat by selecting a certain depth of cut for the wheel when grinding the test pieces of heavy cross-section, we dissipate as rapidly as possible all the heat we can and attempt to prove that shrinkage takes place and not stretching or peening.

To show what happens, we will begin with the test piece illustrated in Fig. 1. It will be observed that this cubical piece is of considerable mass and has body enough to resist the surface expansion caused by the intense heat generated at the minute point of contact of the wheel while grinding. It must be remembered that this point of contact, or rather line of contact, for the wheel has breadth, moves with the traverse of the work and is very narrow; and the cut lubricant, if one is used, and the contiguous cold metal chill the surface of the work the moment it has passed clear of the cutting and heating influence of the wheel. That this sudden chilling leaves the surface in a state of tension—that is, contraction—can be proved; but first we will prove with the aid of a true surface plate or lap that the wheel, if fairly sharp, will not peen.

The surface *A*, Fig. 1, has been carefully ground with 0.001-in. depth of cut, then 0.0005- and 0.0002-in. depths for the finishing cuts.

The finished surface *A*, if tested on the surface plate, will prove low in the center. The only reason I can give for this is: The heat is retained longer at the center of the surface *A*, but radiates faster from all sides; a cut of 0.0001-in. depth, instead of 0.0002 in. for a finish cut, would give less heat; also, the surface would be nearer a plane. That shrinkage or contraction is the cause of the error can be proved by grinding the surface *A* with a 0.001-in. depth of cut. This will leave the surface *A* so decidedly concave that it could not be produced by any error in the machine.

The block in Fig. 2 is proportioned the same as that in Fig. 1, but the surface *B* is cut up into squares to permit more rapid dissipation of the heat. A cut 0.001 in. deep will leave the surface *B* about as true a plane as the surface *A*, Fig. 1, with its 0.0002-in. depth of finish cut; it will also leave the centers of the checks a little low.

As the contraction is not great enough to curl a piece of steel as strong as the Fig. 1 or 2, we will use the proportions of the piece shown in Fig. 3 and get a shape like Fig. 4, if the wheel is lowered direct upon the surface *C*, Fig. 4, using a ½-in. wheel face with sufficient depth of cut to produce heat enough to distort the cross-section. Checkering Fig. 5 like Fig. 2 will reduce this tension, and it will remain fairly straight on the surface *E*, Fig. 5.

It is therefore safe to say that a wheel will not peen a surface, or have a peening effect; but it will have just the opposite effect, caused by the intense heat, which is instantly dissipated, resulting in a contracting tension.

Then the question is, Can a condition be produced that will eliminate heat? This statement will answer all conditions: Any wheel that produces red-hot sparks, whether flooded or dry, will produce contraction.

In the previous tests we have used a cross-section that was strong and have purposely created heat enough to bring about conditions which overcome that strength. In the tests for eliminating heat we will have to be governed by opposite conditions; that is, the work will have to be weak enough to show the effects of the smallest cut that will produce a spark. We therefore use the crossfeed, as this will produce the smallest spark.

During this test there may be some conditions that produce results which are exceptions to the rule. That is to say: Once in a while a piece of stock will be ground that will curl the opposite way—it will be concave on the bottom. However, 99 per cent. of the pieces are of even thickness throughout, but go concave on top when removed from the magnetic chuck; and I have not been able to reason out why the other 1 per cent. curve in the opposite direction.

I have ground pieces that were 0.005x½ in. by 1¼ in. long, but practically always find that the smallest cut I can take, which is 0.00005 in., will curl the ends of the pieces *away* from the magnetic chuck.

I think the foregoing has proved that a wheel will not peen, and the question now is, What is peening?

There is an axiom, "Like conditions produce like effects." Yet here are three seemingly different conditions that produce like effects—lapping, oilstoning, and peening with a hammer. This peening is an objectionable feature in finishing a thin piece of steel by lapping. I have discovered, however, that the peening effect of an oilstone is not objectionable, but desirable, as it can be utilized to straighten thin pieces of steel that are ground parallel and to size, but which have taken a bent set either from grinding or lapping. Also, it gives a damaskeened finish that is pleasing to the eye.

This does not answer the question, What is peening? It is confusing when three seemingly different *cold* causes will produce the same effects that we think we know are produced by intense heat. I now refer to the piece mentioned as the exception to the rule.

The effects produced on this piece of metal are similar to those of peening, but on all the other pieces ground the opposite effects to those of peening are produced. The face of the wheel is just as sharp when grinding the odd piece as it is when grinding the many. Does that wheel peen the odd piece of stock? C. A. Macready.

Springfield, Mass.

How Do You Harden Circular Forming Tools?

A reader asks for information in regard to the experience of others in hardening high-speed-steel circular forming tools of irregular shape and great accuracy. The *American Machinist* is glad to pass along this request, hoping that information may be brought out that will be of service to the questioner and other readers of the paper. Information on this subject should be as specific as possible regarding the temperature and duration of the preheat, temperature and duration of the high heat, quenching and drawing operations, also the protection of delicate edges.

Editorials

Great Britain in 1916

Preparation for and participation in war formed in 1916 the chief outlet for the energies of the people of Great Britain. While all war and home demands must be met, the calls for British productions from overseas markets necessarily take a second place; and it is well to recall that some 5,000,000 men will be under military service by the end of March next. Including the regular forces on the Indian establishment, the estimates for 1914-15 had provided for a total home and colonial establishment of about 800,000. This without reference to the navy, which, in material at any rate, has been stated to have doubled itself, will show the effect of the European War on the manhood of Great Britain. Clearly, the call is not confined to the man engaged in the ranks, and industry generally has been regulated with the one object Great Britain has set before her. Nowhere is this more evident than in engineering works, the majority of which are under direct Government control. In fact, the Ministry of Munitions now controls 4585 establishments. A ministry or even a department will do anything from building a complete village to publishing a technical journal.

The cost of the European War reckoned in mere money cannot readily be conceived by the ordinary person, even if he confines his view to Great Britain. Here, since the war broke out, votes of credit have been granted by the House of Commons totaling £3,532,000,000; adding £330,000,000 for civil expenditure, the total is £3,862,000,000 (approximately $17,537,600,000), this applying to the period that ends on Feb. 24 next. It is probable that by the time the financial year ends—that is, in March next—Great Britain will have spent or lent about £4,100,000,000 (say $19,680,000,000) since the outbreak of war, of which about a quarter will have been raised by taxation. Keeping to the current financial year, the total expenditure for that period will probably be about £2,000,000,000 ($9,600,000,000). The exact figure is as yet unknown, and the minimum estimate of outgoings is at present £1,950,000,000. The budget allowed for advances to allies, etc., of about £450,000,000; but this will certainly be exceeded, so that apart from loans the actual expenditure of Great Britain will probably be of the order of £1,400,000,000 ($6,720,000,000). The normal expenditure on the civil service, debt, army and navy, etc., is, say, £300,000,000 (these are round numbers only) or rather more, leaving the extra expenditure due to the war at about £1,100,000,000 ($5,280,000,000). Toward this excess the taxation may be expected to bring in about £200,000,000, for the revenue will be of the order of £500,000,000 ($2,400,000,000) or more.

Looking at money values, the overseas trade of Great Britain can only be regarded as booming, although for once the ratio of exports to imports is causing real concern. The latter will create a record for Great Britain. The total exports, which of course include reëxports, will probably well exceed £605,000,000 ($2,904,000,000); and if the imports do not quite reach the £1,000,000,000 ($4,800,000,000) limit, they should at least clearly exceed £950,000,000 ($4,560,000,000). Of exports of British production and manufacture the total should be about £510,000,000 ($2,448,000,000), which is a decidedly marked advance, only beaten in 1913, while once again the reëxports—that is, the exports of foreign or colonial merchandise—will probably not quite reach the £100,000,000 ($480,000,000) limit. As to quantities, taking shipping figures as guides, the tonnage entered and cleared, including cargoes, will probably be slightly less than in 1915, when the figures showed about three-quarters the tonnage of 1914.

Turning to a detail in which readers of this journal are specially interested—machine tools—the 1916 imports will probably be valued at or about £3,000,000 ($14,400,000). Before the war they had not even reached the half-million figure. Exports of British manufacture should be worth about £1,100,000 ($5,280,000), or not very different from 1914 or even 1913, when for the first time they passed the £1,000,000 ($4,800,000) limit. Reëxports in this line are relatively unimportant and will probably be valued at a total of £25,000 ($120,000). The values per ton, sometimes of interest, show a steady growth. Thus the imports as compared with 1914 show an increase in price on this basis of about 50 per cent. and will probably work out at about £130 ($624) a ton, while exports are worth something like £100 ($480) a ton, and machine-tool reëxports, which for some reason or other are always particularly valuable on the weight basis, work out at nearly £200 ($960) a ton. It must clearly be understood that the machine tools here referred to are engineering productions that are placed in this category by the British Board of Trade; the values bear no relationship to figures published by other countries under this heading.

Everybody recognizes that last year was one of increasing wages and rising expenditure. The official estimate of the general level of retail prices of food in the United Kingdom shows an increase during the whole war period of 84 per cent. Some few branches of industry have been hit, particularly those that experience Government restrictions on import and the trades connected with building, most of which of the ordinary kind at least has for long been stopped.

Catering concerns have suffered; and manufacturers of articles of luxury have had to look in other directions, though where stocks have been available they have sold readily retail, owing to the increased wages and also to increased profits in most industries and commercial undertakings. Part of the profits must necessarily be paid back into the treasury, the proportion for ordinary concerns being now 60 per cent. of the excess as compared with a pre-war standard, or alternately the excess over a percentage standard varying, according to the nature of the concern, from 6 to 15 per cent. on the capital at the end of the pre-war trade year. This is additional

to income tax. The excess profits may yield about £110,000,000 ($528,000,000) for the year, or 25 per cent. more than the estimate of the Chancellor of the Exchequer.

Electric and gas undertakings have met with fortunes that depend largely on how far their output has been applied to war work. With a view to saving coal, Great Britain last summer had a period highly appreciated of "daylight saving," and naturally the effect on, say, an electricity undertaking varied according to the ratio between the power and the lighting units. Figures have shown that in residential areas in Birmingham the reduction was about 16 per cent. when compared with the corresponding period of the previous year; in Winchester the proportion was about 25 per cent.; and at Ealing, a western suburb of London, 23 per cent. To compensate, prices were raised, and the consumer was nothing in pocket.

Everybody now knows of the great use to which women are being put industrially and in the commercial world. It would be difficult to mention a branch in which they have not taken the place more or less successfully of male workers. We have drawn some attention to their employment in engineering; for transport purposes on trams and buses they have proved invaluable, but in farming and agriculture they have more slowly made their way. Still about 140,000 women have been officially registered by the board of agriculture. Long ago the number of women employed as railway clerks in Great Britain exceeded 14,000. That many will remain after the war seems clear. The coming of women has certainly led to improvements in factory details, as for instance in the supply of lavatory accommodation and of canteens. Employment of women, too, has pressed forward welfare work, and the lady superintendent in charge of affairs is anything but uncommon. It was the present Prime Minister of Great Britain who referred to the humanizing of industry; the advent of women has meant a very considerable step in that direction. Women have even reached the sacred precincts of the London Law Courts in subsidiary branches of work.

Another feature is the necessarily increasing control of individual life and activities by the Government. Great Britain has, apparently with satisfaction, adopted something like a dictator system, and Government interference, of a beneficent character of course, is at present being hopefully anticipated in connection with industry and commerce. Turning to minor matters—the Government has instituted a department of scientific and industrial research for the benefit of the national industries on a coöperative basis. Some relief will be given as regards taxes in return for traders' contributions on behalf of such research, and it is understood that certain mechanical engineers at the outset made a substantial gift for the purpose. One of the earliest investigations is to be on the use of coke, this in view of the future of the coal supply. In other directions the coöperative spirit seems prominent. For instance, aided by Government funds, some 31 Sheffield and other firms combined to equip a factory in Lancashire for the manufacture of the tungsten powder needed for high-speed steels. Production has now been going day and night, Sundays included, for some 18 months, and from the start the metal produced has averaged 98½ per cent., or say 1 per cent. purer than the metal formerly supplied by Germany. The output is about three tons a day.

The future is anticipated with confidence. Building having long been practically stopped, this home industry must revive, with a consequent demand on the metal trades. The productive capacities of engineering factories have expanded, one estimate (probably an underestimate) showing a growth of 50 per cent. during the war. Production in quantity is better understood than it ever was, and the movement for standardization long ago extended to shipbuilding, as to the future of which there need be no fear. Quite a number of new industries have been started owing to the stoppage of enemy supplies, and the relative scarcity of male labor, combined with the extended employment of women, will mean a greatly increased demand for labor-saving appliances of all kinds and for all purposes—including domestic.

Group Insurance and the Spirit Behind It

A recent address by the president of the Equitable Life Assurance Co. calls attention to the development of what is known as group insurance of employees, whereby the employer takes out a policy covering everyone in his employ. In insurance language every life earning a pay check has a definite insurable value that is to be covered by insurance. The plan brings life insurance to a large number of families that would otherwise remain unprotected.

The name is perhaps a trifle misleading as it is just as much individual insurance as though the insured paid his own premium. The only distinction is that the policy lapses so far as he is concerned, when he leaves the employ of the company.

The human element is being considered more and more in all business organizations. This plan is a further step in the right direction, and from all appearances health insurance will be the next step; it is in fact well on the way.

We believe that industrial insurance will and should come as a measure of social justice, but we can hardly agree with Mr. Day that "its object is to increase the efficiency of workers and stimulate their loyalty." This puts it on such a commercial basis as almost to condemn it to failure if this is the sentiment behind it. As with accident compensation, it is a burden to be borne by the industry and not by the individual.

There is little doubt as to this plan proving a good paying investment and tending toward mutual good feeling between employer and employed. But you cannot buy loyalty with insurance policies. It must be earned by giving the employee an ideal and setting him an example to which he can be loyal. When the insurance of employees is a part of a general policy of fair dealing, it will strengthen the loyalty already existing; but when proposed as a method of increasing loyalty and efficiency it falls into the category of exploitation and is sure to be disappointed.

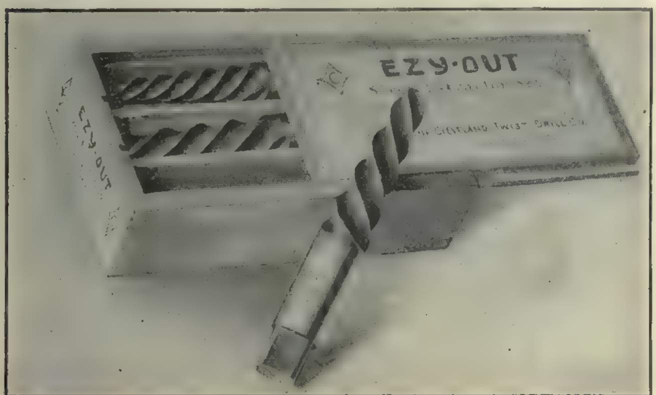
Group insurance is in force in a number of large shops and is benefiting all concerned. It seems bound to increase; but let it be installed on the proper basis, if the best results are to be obtained.

Shop Equipment News

Extractor for Broken Screws

The Cleveland Twist Drill Co., Cleveland, Ohio, is placing on the market a new tool known as the Ezy-Out Screw Extractor.

The illustration shows a set of three extractors of varying size. When a screw is broken off, a small hole



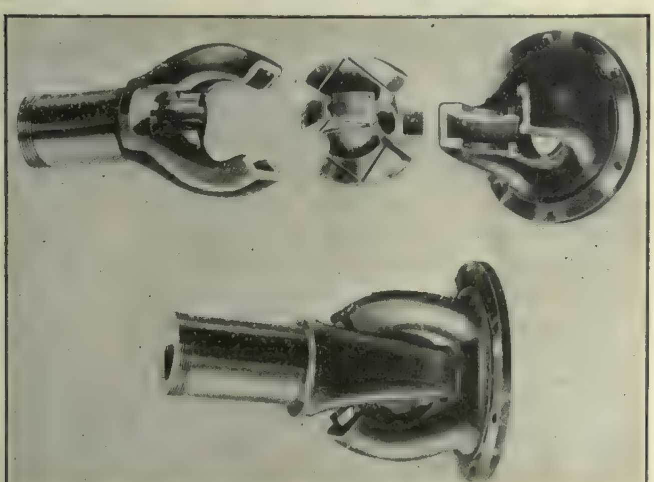
SET OF EZY-OUT EXTRACTORS

is drilled in it and the extractor is inserted and turned to the left. The left-hand spirals grip the screw until the tool is firmly seated, when further turning to the left will back the broken end out of the hole.

Universal Joint

The universal joint shown in the accompanying illustration has recently been placed on the market by the Plank Flexible Shaft Machine Co., Grand Rapids, Mich.

Only three parts are used in the joint—the center block and the two end yokes. The latter is carried out beyond



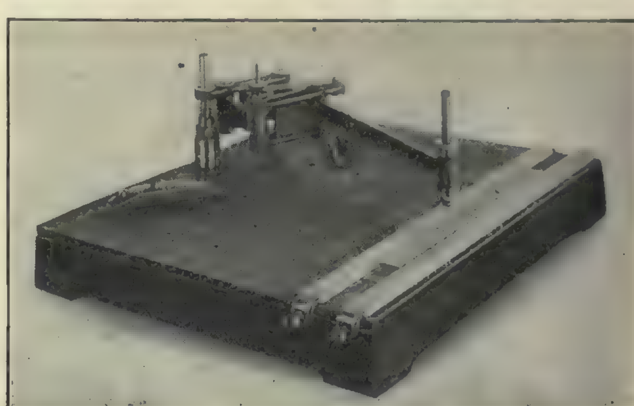
UNIVERSAL JOINT

the center line in such a manner that the use of pins or bolts for holding the joint together is not necessary. The center block is drilled and grooved for purposes of lubrication.

Tracing Machine for Etching

The Spicer Tabulating Machine Co., Washington, D. C., has placed on the market a machine for reproducing letters, figures, designs, etc., on tools to be etched.

As shown in the illustration, the machine is constructed on the pantograph principle and is furnished with metal matrices, or copy blocks, that may be arranged in any desired combination. In passing the stylus over these

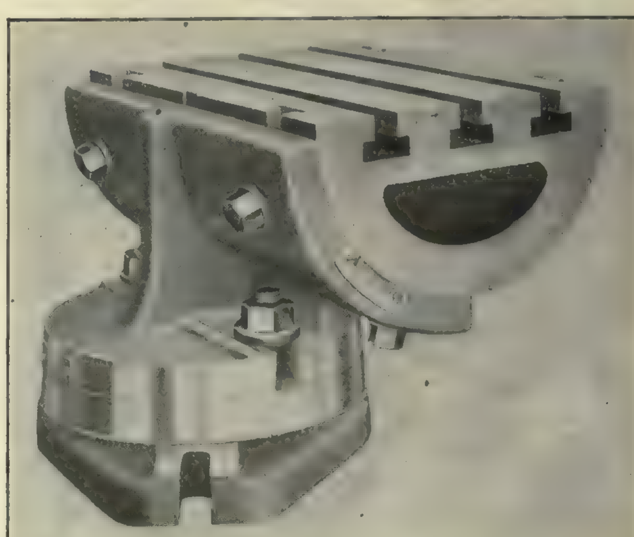


TRACING MACHINE FOR ETCHING

matrices the tracing point reproduces them to a smaller scale on the surface to be etched. Matrices are furnished to etch letters and figures $\frac{1}{16}$, $\frac{3}{32}$, and $\frac{1}{8}$ in. in height. Matrices bearing special designs are made to order.

Universal Angle Plate

The Boston Scale and Machine Co., Boston, Mass., has placed on the market the universal angle plate shown herewith. The plate is so made as to have a motion

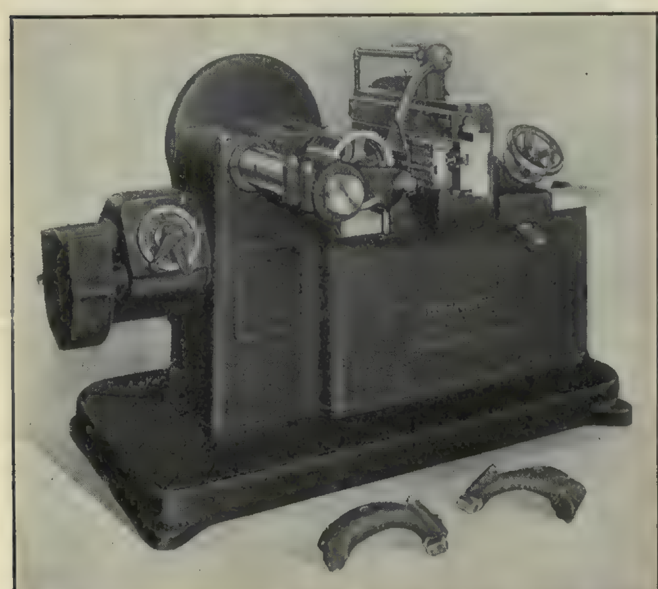


ANGLE PLATE WITH UNIVERSAL FEATURE

through 360 deg. horizontally and 90 deg. vertically, and can be adjusted at any angle without disturbing the work which may be bolted to it. The working surface is through the axis of the arc of vertical oscillation. Verniers are provided that read to angles of 5 min. The plate is made in four sizes—4x6 in., 6x8 in., 8x10 in., 12x18 in.— the larger sizes being equipped with a worm adjustment for the table.

Automatic Gear and Rack Planer

The machine here shown, an automatic gear and rack planer made by the Bickett Machine and Manufacturing Co., Cincinnati, Ohio, has had several new features recently added to it. Both roughing and finishing cutters are used. The roughing cutter, which has a corrugated cutting edge and is of the general shape of the tooth, cuts on the forward stroke, while the finishing cutter, which is the exact shape of the tooth, cuts on the return stroke of the ram. A variable-feed mechanism is used which causes the feed to diminish gradually as the cutter approaches its full depth of cut; and when this point is reached, the feed dwells for a few strokes in order to insure a finish.



GEAR AND RACK PLANER

Outside diameter of gears cut, 28 in.; length of rack cut at one setting, 30 in.; width of face cut, 8 in.; maximum size of teeth, 4 diametral pitch; diameter of work spindle, 4 in.; 40-gal. lubricant tank in base; floor space, 46x73 in.; weight, 2800 lb.

The machine is arranged for either countershaft or motor drive. The ram makes 150 strokes per minute at normal speed.

Cleaning and Plating Machine

In the illustration is shown a continuous-process cleaning and plating machine that has recently been placed on the market by the Munning-Loeb Co., Matawan, N. J.

The machine consists of a series of tanks containing cleaners, rinsers, dips and plating solutions arranged in the form of an oval about 50 ft. in length. Above the tanks is arranged a carrier system made up of two endless chains, driven by an electric motor and carrying a number of vertical rods on which the work is hung. The rods are raised and lowered at the proper points, to pass the parts to be plated through the baths and over the dividing walls, by means of a cam mechanism. The speed of the carrier system is 2 ft. per min., but this may be varied to suit conditions.

CONTINUOUS PLATING MACHINE

How To Mix Plaster of Paris

By J. S. Hogg

Having profited a great deal by reading in the *American Machinist* different articles on castings from cheap plaster of paris patterns, I give your readers some more points that count for success in mixing plaster of paris. Have the required amount of water in the basin, then add the plaster of paris to the water (just as you would make old-fashioned porridge). Let the plaster of paris trickle through your fingers. Keep adding it to the water until the water just ceases to absorb it. The contents are then mixed by hand, as lumps can be felt and squeezed out.

To keep the model from sticking to the plaster of paris cast, I usually cover the model with thin wax paper; but with small patterns with fine detail I usually dip the model in hot wax to cover it with a thin film of wax. Plaster of paris patterns can be made very light in proportion to their size by filling the inside with ashes or coke.

I have seen very expensive steel dies used for embossing sheet metal when cast-iron dies from cheap plaster of paris patterns would have answered just as well. I have used cheap cast-iron dies to enclose pan handles with 7/8-in. depth of draw, when everyone was in favor of steel dies. These cast-iron tools have made over half a million handles and look good for several thousand more.

Machining Centrifugal Pumps

A reader asks for a description of the best and most practical method of machining the castings of horizontally split volute centrifugal pumps.

Convention of the Automobile Engineers

The annual meeting of the Society of Automobile Engineers was held at its headquarters in the Engineering Societies' Building. It began on Jan. 9 and ended on Jan. 11. The first two days were given over to meetings of the Standards Committee, the professional session beginning at 1:30 p.m., Thursday, Jan. 11.

The society took the first steps toward changing its name to the Society of Automotive Engineers, a mail ballot being necessary to complete the change. The society will then include the American Society of Aëronautic Engineers, the Society of Tractor Engineers, the National Gas Engine Association and the American Society of Agricultural Engineers. The National Engine and Boat Manufacturers' Association has already recommended to its engineer members that they join the society.

The papers presented were: "Some Problems of Airplane Construction," by Capt. V. E. Clark, U. S. A., Capt. T. F. Dodd and O. E. Strahlmann; "The Ultimate Type of Tractor Engine," by H. L. Hornung; "Dynamic Balancing of Rotating Parts," by F. Hymans; "Remarks on Dynamics of the Automobile," by M. W. Akimoff; "Some Essential Features of High-Speed Engines," by A. F. Milbrath; "Heat-Balance Tests of Automobile Engines," by Prof. Walter T. Fishleigh and Walter E. Lay, and "Aërial Navigation Over Water," by Elmer A. Sperry. Several of these have been abstracted for publication.

H. L. Hornung pointed out that the tractor was bound to have a direct effect on the cost of living, not only because it took the produce from four acres to keep a horse, but because it enabled more land to be cultivated with the same amount of labor. The tractor engine is a difficult problem because of the conditions under which it must operate. Dirt, dust and even leaves are drawn into the carburetor, while the lubrication is too often dependent on any kind of oil the local dealer happens to have, a case being cited where linseed oil was used in cylinders.

The burning of kerosene was not considered so much a question of the carburetor as of the motor, the design of the combustion chamber and intake manifolds being all-important. The manifold should maintain a proper heat and velocity in the spray of oil, which does not become a gas until it comes into the compression chamber.

Another interesting point brought out by the author is the fact that tractor motors run at a higher speed than those in either aëroplane or automobile. They must be so simple as to be easily taken care of and must not use appliances that cannot be replaced easily by anyone.

F. Hymans, in his paper on "Dynamic Balancing of Rotating Parts," pointed out the necessity of obtaining dynamics for running balance of rotating parts, especially in automobile-engine construction. He discussed the manifestations of the lack of static and running balance, such as vibration and high bearing pressures, and presented formulas for calculating bending moments and centrifugal forces, for a crankshaft out of balance.

Methods for obtaining static balance were described and the possible conditions existing after static balance is obtained were treated with especial reference to the existence of one or more couples. The author gave descriptions of both the Norton and Akimoff machines, which are used to locate couples and correct for them. The principles of operation were made clear, and the advantages and disadvantages of each type were brought out fully. Mr. Hymans believes that it is now feasible to put all the rotating parts into true balance when finally assembled.

In his remarks on the dynamics of the automobile N. W. Akimoff, the designer of the second balancing machine just referred to, recited some of his experience along this line. He believes that an incompatibility exists between the results achieved in this country by the growth of the automobile industry and the almost complete lack of rational data on the most essential elements of kinetics relating to the modern automobile. He submitted considerations to be used in establishing a rational theory of spring suspension in general, and devoted a little time to the first principles of dynamics of springs, to damping, kinematic features of harmonic motions, energy consumption and shock absorbers.

Mr. Akimoff then analyzed an introductory problem, involving an imaginary one-wheel "elemental car," meant for purely inductive purposes. Finally the main problem was presented, in the form of an analysis of a skeleton car, springs suspended and simplified as much as possible. Three periods of its oscillation were calculated and certain considerations were derived therefrom relating to car suspension.

In his paper on aërial navigation over water Elmer A. Sperry called attention to the unreliability of the magnetic compass when used for aërial navigation and to the possible development of the gyroscopic compass for this purpose. He explained how the drift of an airplane in flight makes it difficult to follow with accuracy a given course devoid of landmarks, unless an accurate drift indicator using the principle of the stroboscope is available.

He then described the development of such an instrument of his own design and also the means for synchronizing it with the compass. The speaker outlined the use of the automatic synchronized instrument in flight over land and described in detail its application to flight over water. In their relation to the use of the instrument were considered rules for aërial navigation over water, observation as to the movements of wavecrest and determination of wind velocity and direction.

Mr. Sperry remarked that the Navy Department is ordering a gyroscopic compass to be employed on airplanes, and that by extreme refinement in design and execution it is expected by the Department that the weight of this instrument will be reduced to 20 or 30 lb.

He stated that an aviator can hold his course true to the compass and still be following a course having a wide angle of deviation from that in which he thinks he is flying. Carlstrom, for example, in his noteworthy flight from Chicago to New York, found he was drifting 17½ deg. when flying over Cleveland. His apparent course had to be changed to this extent to neutralize drift and to maintain the true direction along the south shore of Lake Erie. This angle was given him by his drift set, which, although not indispensable, he used throughout his flight. He had, however, the shore line and general landmarks to guide him, but the case would have been entirely different had he been flying at sea.

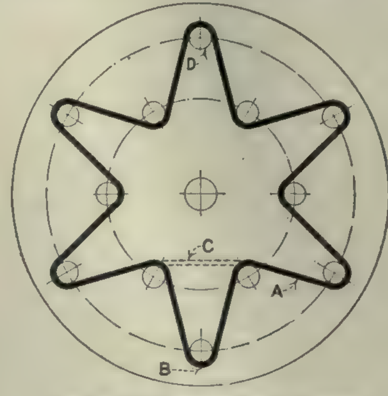
Flexible-Coupling Trouble

One day I got a "trouble call" to see a 35-hp. induction motor connected by flexible coupling to the countershaft of a large wood planer.

"The motor is out of balance and jumping as if it was going to pull the floor up, so I shut 'er down," I was told. I looked it over, but could see nothing wrong. I turned the motor and countershaft over by hand, and all turned free and true. I then turned on the "juice," and "out-of-balance" was no name for it. The countershaft mounted in the frame of the massive planer ran perfectly quiet, but the motor, set on the plank floor, was springing the flooring fully a quarter of an inch. I noticed, though, that when the current was shut off, the vibration ceased even though the motor was still at nearly full speed; but when I turned the current on again, the vibration was as bad as ever. This set me to investigating the flexible coupling, and there I found the trouble.

In the illustration the pins on the inner circle belong to the motor half of the coupling and those on the outer circle to the countershaft half. *A* is a leather strap used to make the flexible connection. This strap had broken, and being then too short, the millwright had left it off the pin *B,* so it would reach and laced it on as shown by the broken line *C.* This practically cut out three pins and gave a drag crank effect to the coupling, which caused the trouble while under power.

This effect is easily understood by imagining a man in the place of the motor turning the shaft by means of a crank—his feet made fast to the floor. On the up half of the crank revolution the man would be pushing down with his feet as much as he was lifting with his hands, while on the down half he would be lifting as much from his feet as he was bearing down with his hands.



TYPE OF COUPLING USED

I slipped the strap off pin *D,* and the whole trouble was cured. The motor was in no way "out-of-balance," but the power transmission was.—R. M. Orr in *Power.*

Obituary

James Maclay died at his home in Paterson on Jan. 4, after an illness of several weeks. He was a member of the McNab & Harlin Manufacturing Co., manufacturer of brass and iron goods. Mr. Maclay was the last of the original members of this firm and was a director of the Silk City Safe Deposit and Trust Co.

Personals

Manning E. Ruff has been appointed superintendent of the Curtis Pneumatic Machinery Co., St. Louis, Mo.

Orlando F. Weber has resigned as assistant general manager and vice-president of the Maxwell Motor Co., Detroit, Mich.

Sterling H. Bunnell, of R. Martens & Co., 24 State St., New York City, sailed for England on Jan. 6 on the "St. Louis."

J. W. Phillips, formerly of the Edgar Allen Co., is now associated with the Century Steel Co. of America as general manager.

George E. Fogarty, European representative of the Fitchburg Machine Works, has returned to this country for a few weeks' visit.

Henry W. Durham has severed his connection with Bergen County and will make his headquarters at 366 Fifth Ave., New York City.

Joseph R. Greenwood has severed his connection as general manager of the Ballwood Co. and is now associated with the office of Charles H. Higgins, architect and engineer, 30 Church St., New York City.

H. H. Gildner, for three years chief engineer of the S K F Ball Bearing Co., has taken a position with the F. R. Blair Co., Inc., as manager of the department specializing in universal joints and couplings.

Miss Kate Gleason has been elected vice-president of the Trailer Manufacturers' Association, which has just been organized at Detroit. Miss Gleason was formerly secretary of the Rochester Trailer Co., Rochester, N. Y.

Edward Snyder, formerly of the Barber Colman Co., Rockford, Ill., and of the Harris Automatic Press Co., Niles Ohio, has been appointed chief of the engineering department of the National Electric Welder Co., Warren, Ohio.

James E. Williams has acquired an interest in the Pennsylvania Forge Co., Bridesburg, Philadelphia, Penn., and becomes general manager. Mr. Williams was formerly superintendent of the forge division of the Packard Motor Car Co.

The Chain Belt Co., Milwaukee, Wis., has made several changes among its officials. C. I. Messinger has taken the position of first vice-president and W. J. Ballentine has been promoted from superintendent to second vice-president and works manager.

Charles M. Hammond, president of the Hammond Steel and Forging Co., Syracuse, N. Y., has sold his interests in the above concern and will become president of the Cayuga Tool Steel Co., Auburn, N. Y. The new concern will specialize on tool and alloyed steels.

D. M. Kagay has accepted a position with S. F. Bowser & Co., Inc., as manager of the publication department. Mr. Kagay leaves the Richards-Wilcox Manufacturing Co, where he has held the position of advertising manager and editor of the two house organs published by that firm.

Business Items

The Domestic Machinery Works, Wissinoming, Philadelphia, Penn., has recently incorporated its business under the name of the Richter Machine Co. Wolfgang Richter is president, and F. V. McMullin, of the Pennsylvania Forge Co, is secretary and treasurer.

The Pierce Machine Tool Co., of Chicago, manufacturer of screw machines, turret lathes, boring bars, etc., has just increased its capital stock from $25,000 to $50,000. W. B. Pierce is president, C. J. Bansbach vice-president, F. M. Pierce secretary and J. S. Campbell treasurer.

The Marshall & Huschart Machinery Co., Chicago, on Jan 3 elected the following officers: H. W. Jones, president; George C. Edwards, vice-president; William H. Reid, treasurer; Frank Seese, secretary; J. R. Porter, general manager. All have been with the company many years and now assume the active control of affairs. Mr. Marshall, the founder of the company, has resigned as president, but has retained a financial interest and will act in an advisory capacity. There will be no change in the general policy of the company.

Trade Catalogs

Screw-Machine Products. The Brown Bag Filling Machine Co. (screw department), Fitchburg, Mass. Circular.

Fairbanks Power Hammers. United Hammer Co., 141 Milk St., Boston, Mass. Catalog; pp. 16; 3½x6 in.; illustrated.

Creating an Industry—Doehler Die Casting Co., Brooklyn, N Y. This is an interesting book on the development of the making of die castings. Pp. 54; 6x9 in.; illustrated.

Engine Lathes. Summit Machine Works, 54 Hermon St, Worcester, Mass. Circular illustrating and describing 10-in. screw-cutting engine lathe and 10-20-in. gap lathe.

A Chain of Evidence. Morse Chain Co., Ithaca, N. Y. Publication No. 15, devoted to small power drives; pp. 20; 6x9 in.: illustrated.

Portable Electric Drills, Grinders, Etc. The Van Dorn Electric Tool Co, Cleveland, Ohio. Catalog; pp. 52; 4x8½ in.; illustrated.

Grinding Wheels Hampden Corundum Wheel Co., Brightwood, Springfield, Mass. Catalog; pp. 112; 6x9 in.; illustrated. This describes different types of wheels and contains tables and other useful data.

Hydraulic Presses and Pumps. The Hydraulic Press Manufacturing Co., Mount Gilead, Ohio. Export Catalog No. 70; pp. 84; 8x10 in. This describes and illustrates a line of hydraulic machinery adapted to foreign distribution.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City

Axle Work in a Railroad Shop

By Frank A. Stanley

SYNOPSIS—In railroad shop practice axle work forms an important feature. In this article complete details of apparatus designed to eliminate all laborious handling of axles are given. The apparatus is of simple form, consisting of a four-wheeled steel truck carrying above its platform a pair of arc-shaped cradles. The cradles are tiltable in either direction for the purpose of discharging the axle either to the right-hand or left-hand side of the carrier. For handling the axles in and out of the lathe a convenient form of sling, trolley and jib is shown.

In a recent article in these columns illustrating the work of the wheel shop of the Minneapolis, Saint Paul & Sault Sainte Marie Railway Co. at Shoreham, Minneapolis, Minn., reference was made to a special carrier for receiving axles from the dismounting press and transporting them to the storage piles on the platform outside the shop. This carrier operates on a track located at the right-hand end of the dismounting press, and its general features of construction and operation will be understood from Figs. 1, 2 and 3 herewith.

Details of Axle Carrier

Referring to Fig. 1, the carrier is shown at the inner end of its track with an axle in place ready to be run out through the opening in the shop wall and dropped on one of the axle piles on the storage platform outside. The axles on this platform are classified and piled up according to size and condition. Before each axle is run out on the carrier, it is inspected and marked to indicate the respective point at which it is to be dumped from its cradle.

In the process of dismounting wheels from their axles a good many of the latter are simply swung around on the jib crane over the press and deposited behind the axle lathes, for refitting at once for service. A great many more, however, are passed immediately out of the shop and onto the storage piles referred to.

The carrier itself consists of a four-wheeled steel truck carrying above its platform a pair of arc-shaped cradles, which normally are in the position shown in Fig. 1 for holding the axle. Underneath the platform there is a set of wedge-shaped members that are adapted to slide longitudinally to tilt the cradles in either direction for the purpose of discharging the axle either to the right-hand or the left-hand side of the carrier. This wedge-shaped controlling device, when in the position indicated in Fig. 1, holds both cradle members in a horizontal position so that the axle rests securely in place until the cradles are automatically tilted after the carrier has been run out along its track to a predetermined point for the discharging of the axle.

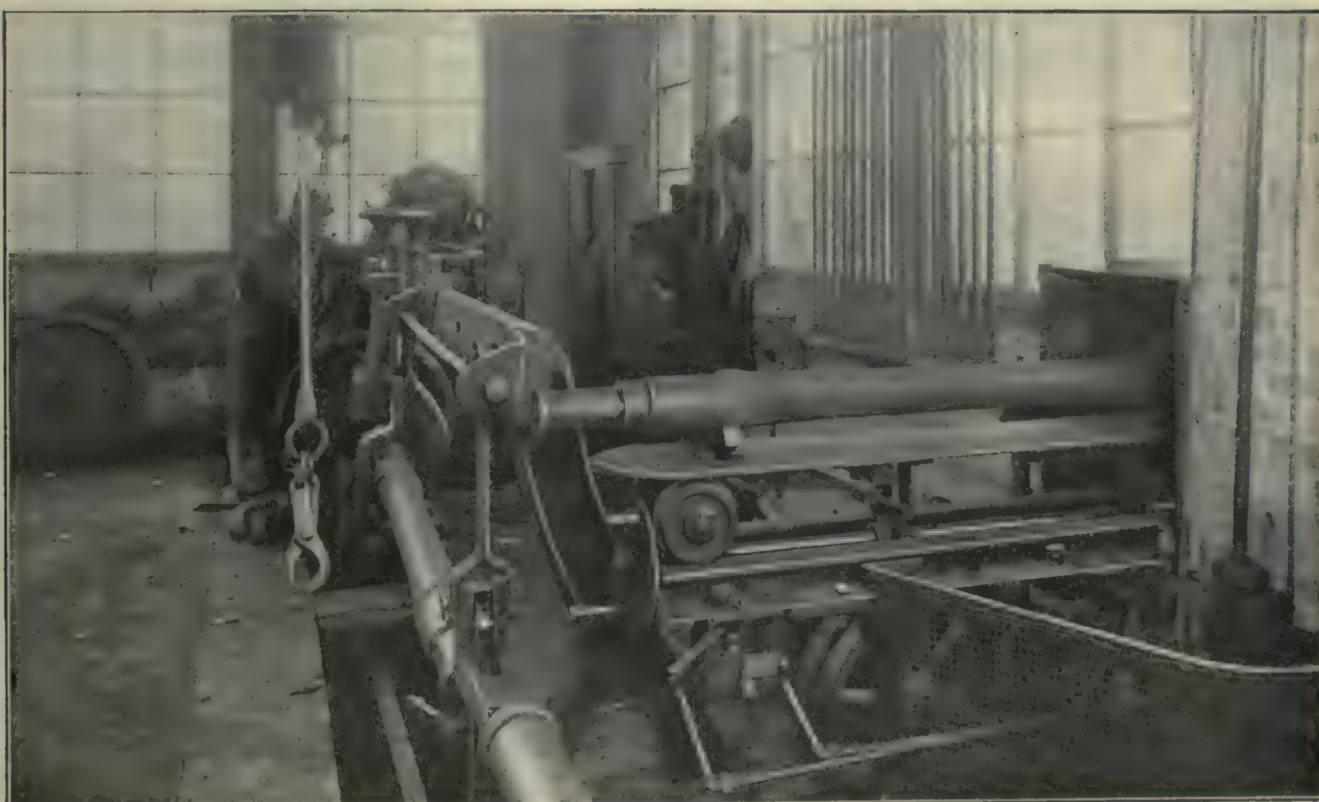


FIG. 1. AXLE CARRIER IN RAILROAD WHEEL SHOP

The truck, or carrier, is drawn along its track by a wire cable passing over drums beneath the ends of the track. The operation of the driving drum, and hence of the carrier itself, is effected by a long-stroke cylinder and piston with suitable gear and cable connections for

giving the desired length of travel and the requisite rate of speed for the carrier.

Between the tracks upon which the carrier operates there extends the full length a controlling shaft operated by the crank handle shown at the front of the vertical disk mounted at the inner end of the track. This controller shaft carries a series of dogs or stop collars, one of which is located immediately above each pile of axles or each station on the storage platform. Each of these controller dogs carries a projecting lug, which when the controlling shaft is turned to a certain position, is adapted to engage the wedge mechanism under the platform of the carrier truck and tilt the cradles to dump the axle at that point. When the operator of the dismounting press drops an axle upon the carrier, he sets the controlling crank handle to the proper notch on the disk referred to and pulls the valve lever. The carrier is drawn out past a swinging balance door over the opening in the shop wall and passes along the track until it reaches one of the stop dogs, which has been set into operative position by the turning of the crank handle.

FIG. 2. AXLE CARRIER ON ITS TRACK OVER A PILE OF AXLES

FIG. 3. AXLE-CARRIER CRADLE TILTED AND AXLE DISCHARGED

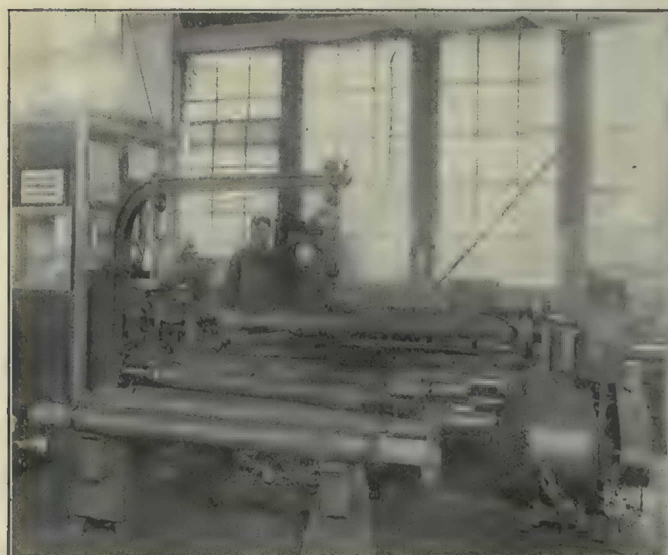


FIG. 4. AXLE-TURNING EQUIPMENT

FIG. 5. WHEEL-ASSEMBLING AND MOUNTING PRESS

Fig. 2 shows the carrier and an axle run well out on the track and immediately over the pile of axles upon which the axle on the carrier is to be dropped. Fig. 3 represents the carrier at the instant following the tilting of the cradle and the dumping of the axle. The operator now moves the valve lever at the inner end of the track, and the carriage runs back into the shop. There, at the end of its return travel, the cradle mechanism comes in contact with a fixed dog that draws the wedges into position to throw both cradle holders into horizontal place for receiving the next axle.

As will be noticed, this apparatus eliminates entirely all laborious handling of axles and accomplishes its results with little loss of time or effort upon the part of the machine operator.

The axle-turning lathes stand near the dismounting press. One of these lathes, with work piled up at its rear, is shown in Fig. 4. This view illustrates the convenient sling, trolley and jib for handling axles in and out of the lathe. It also shows the supporting rest beneath for facilitating the handling of the work and brings

out clearly the method of dogging and driving the axle in the machine. The dog, it will be observed, is in ring form and is attached to the body of the axle to clear the journal. The two-point driver is made with correspondingly long projections to extend past the journal and contact with the lugs on the dog. This lathe, like all other tools in the shop, is driven by an independent motor.

As rapidly as the axles have been inspected and turned, when required, they are classified by diameter and placed on the floor conveniently for the wheel borer. After the fitting of the wheels has been accomplished, the axles and wheels are assembled in the mounting press, Fig. 5. This press is located at the far end of the shop from the dismounting press. Like the latter; it has a cross-track for receiving the mounted units so that they may be rolled out of the shop through the horizontally swinging door that keeps the passageway closed except at the moment when wheels are rolling through.

The assembling and mounting press consists really of two distinct machines, the assembling section being air operated through mechanism controlled by the valves seen in the foreground of Fig. 5. Here two wheels will be noticed, one at either side, ready for the insertion of the axle, which is shown suspended from the pneumatic hoist. The two wheels are shown held in upright position by spring clamps. The wheel at the left is secured against a fixed head, while the one at the right is clamped to a head that travels longitudinally under the action of an air cylinder controlled by the fourway cock attached to the stand halfway between the wheels, where the operator may readily guide the axle and attend to the operation of the machine.

Both heads on this assembling press consist of ½-in. steel plate placed in upright position and mounted on a pair of 5-in. I-beams. This press starts the wheels true on their bearings on the axle and proves a most convenient and effective piece of apparatus for assembling preparatory to the forcing of the wheels into position.

The hydraulic mounting press, seen at the rear in Fig. 5, is located at a sufficient distance from the assembling apparatus to permit five pairs of wheels to stand in the intervening space. The mounting press is fitted with special jaws on the outboard housing. The ram head carries a distance piece of C-section, open along one side, so that after the wheels have been rolled into the press and properly mounted upon the axles, the open block may be rotated on its seat on the press ram and the wheels and axles rolled freely out of the press, ready to be run out of the shop. The removal of the work from the press is further facilitated by a pneumatic plunger in the outboard housing, which forces the wheels and axle bodily into definite line with the track. This air plunger also makes it easy to admit a filler block to lift the near wheel off the housing when it is necessary to force the other wheel a little farther onto the axle.

For removing and replacing the tires of wheels there is a Mahr fuel-oil heater that enables one man, with the aid of a jib crane, to handle all this work. The horizontal heater is lined with firebrick in a cast-iron body, and one lever controls the operation of all covers. Following the heating of one tire, the apparatus is automatically lighted from the heat of the bricks. As the tire expands from the heating action of the flame, the wheel falls through to a truck below, which is then pulled out and later returned empty for the next wheel. While a new tire is heated and placed on the wheel, another wheel is being made ready for heating, so that the process is practically continuous. The operation of completing the wheel requires about 6 min. only.

In a day of 9 hr. an average of 125 tires, say 40 in., can be removed, and fully half that number of new tires can be heated in the one machine.

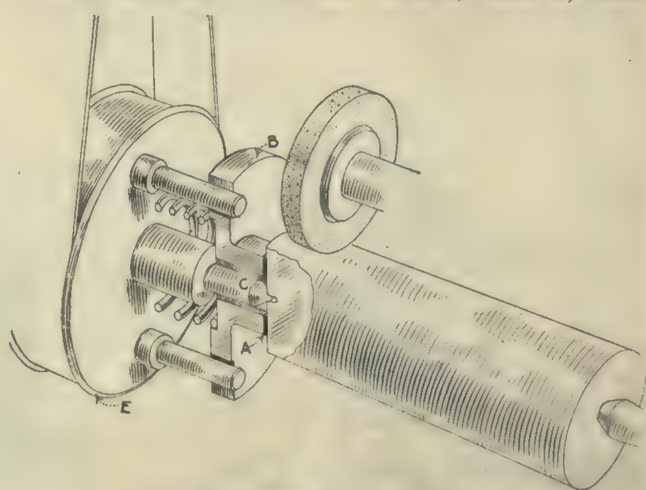
Grinding Cylindrical Bars

By George C. Lawrence

Having some small straight cylindrical pieces, similar to that shown in the illustration, to be ground, it occurred to me that it might be possible to drive them by friction, so that the grinding wheel could make a full traverse, overlapping the proper distance at the end of its stroke without interference from a dog.

A ring of emery cloth or paper *A* was cut to fit and glued to the member *B*, which is fitted with a brass bushing, bored a sliding fit on the dead center *C*. The spring fits into recesses turned in *B* and in the pulley *E*, keeping it clear of the center.

As arranged, this device is practicable only for light cuts—in this case, 0.0005 in. I have, however, taken



THE WAY THE WORK IS DRIVEN

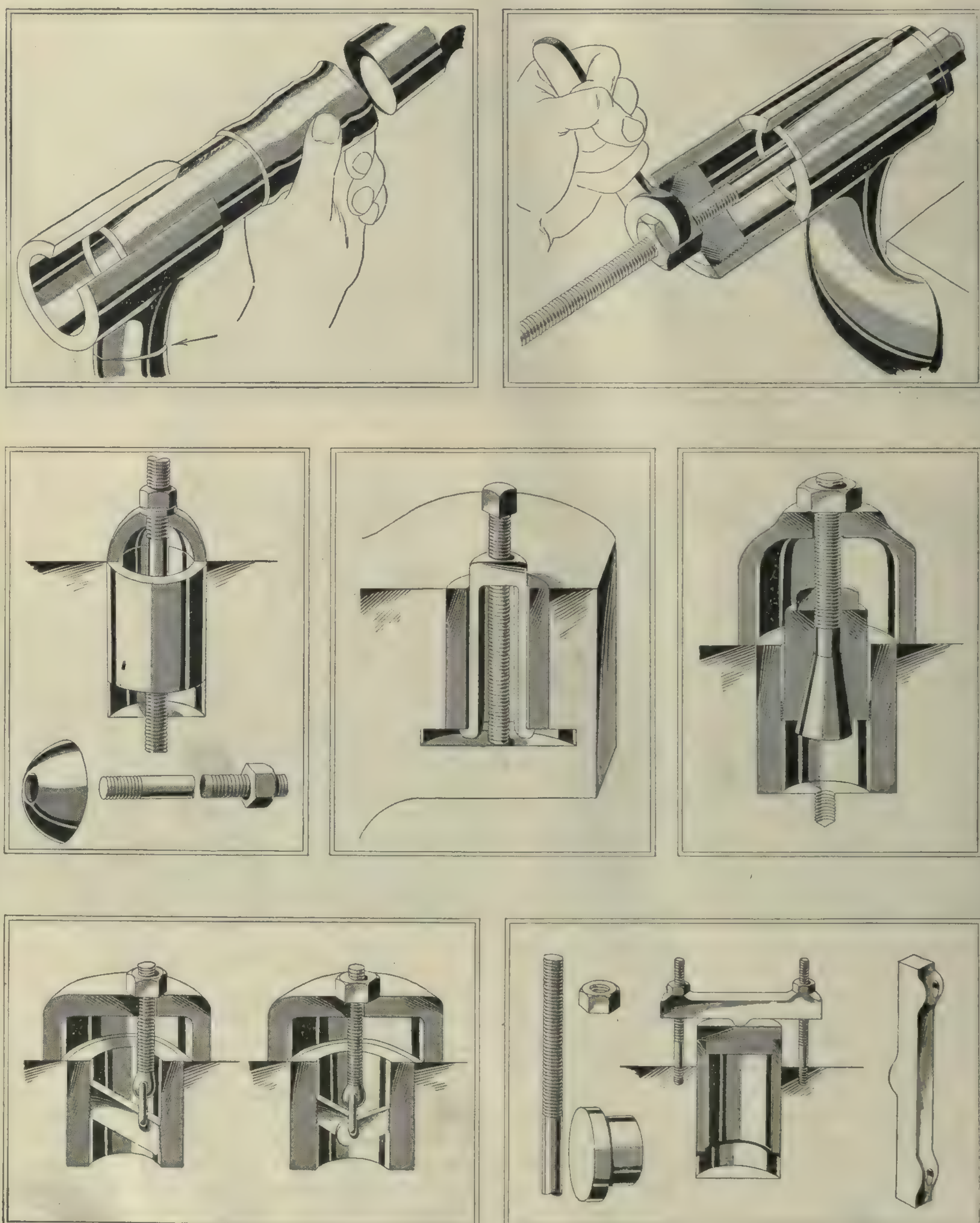
off as much as 0.001 in. with it. Over that, the wheel is apt to stop the revolving work. With a similar spring and friction and a ball thrust at the tail end, heavier cuts could be taken, but as yet I have had no occasion to try this.

American Watch Industry

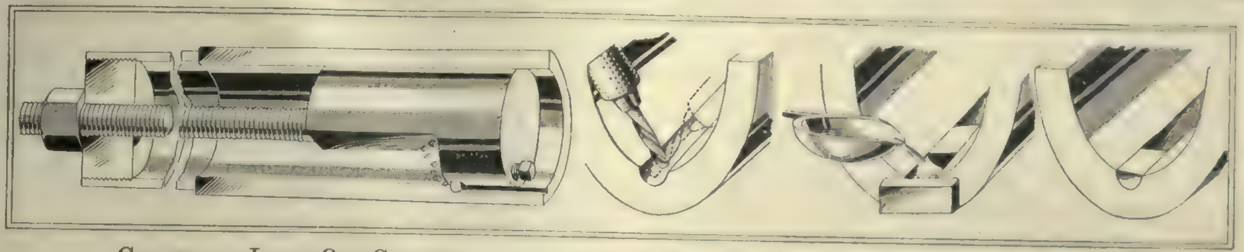
The 45 years during which the United States Census Bureau has separately listed American watch-making establishments have witnessed a centralization of the industry and a fivefold expansion in the value of the output. In 1869 there were in the United States 37 establishments making watches, watch parts and watch movements, employing 1816 wage earners, or an average working staff of less than 50. In 1914 there were but 15 such establishments, yet they employed 12,390 wage earners, or an average per establishment of 825. In 1869 the 37 establishments for which returns were made used materials that cost $412,783, and their combined output was valued at $2,819,080; in 1914 the 15 factories used materials that cost $2,670,000 and wrought these into watches, parts and movements worth $14,275,000.

From a Small-Shop Notebook

By John H. Van Deventer

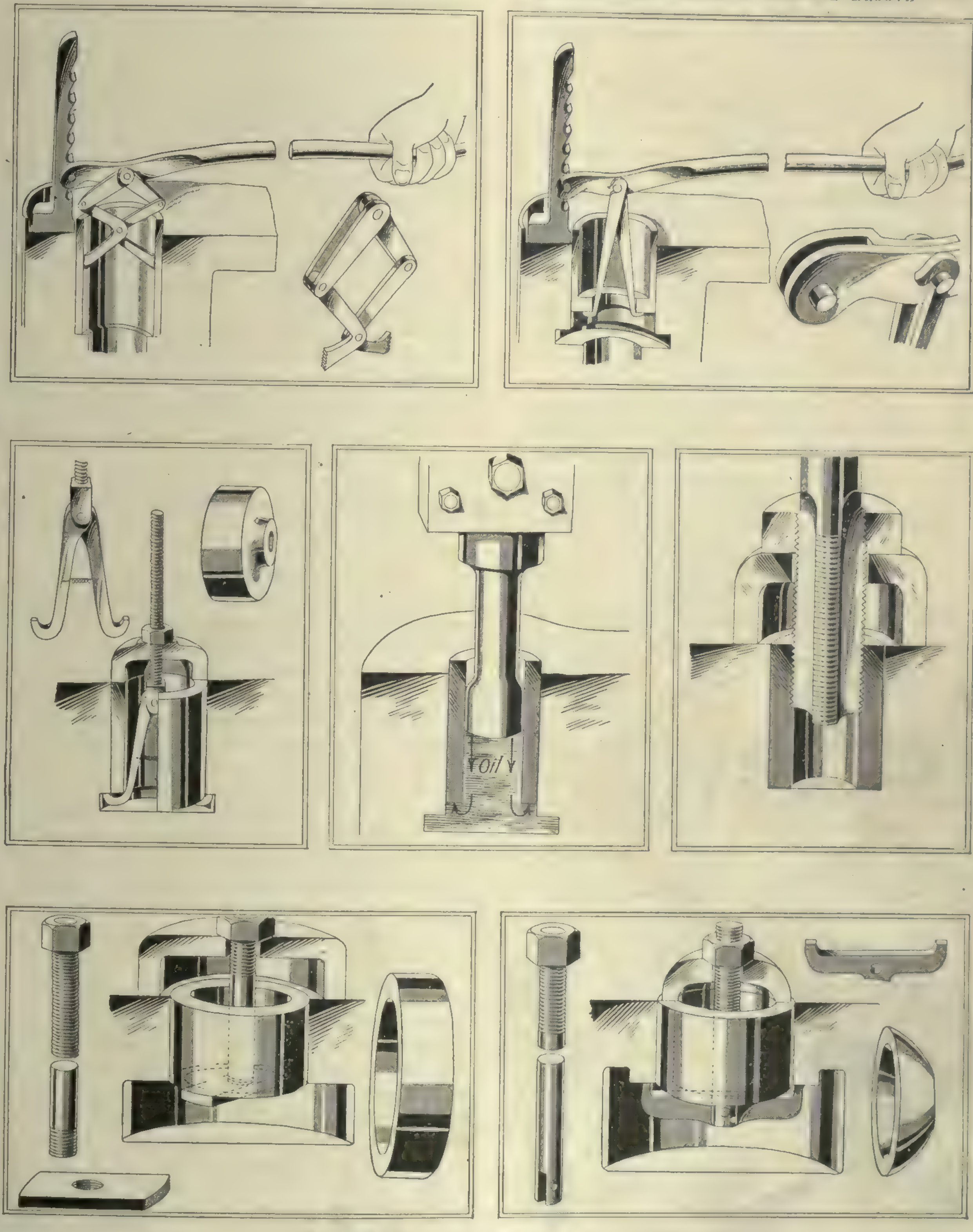


Various Methods of Driving and Pulling Bushings



CUTTING A LONG OIL GROOVE

PLUGGING THE ENDS OF THE OIL GROOVE



VARIOUS METHODS OF PULLING BUSHINGS

Recent British Hardness Tests of Engineering Materials

By I. W. Chubb

In Great Britain during the past few years a considerable measure of attention has been paid to the hardness of engineering materials, attention which has resulted in the suggestion that the term might almost be dropped, for it seems clear that hardness is not a definite property and that the various workshop and laboratory tests cannot give accordant results, because they do not measure the same property. As the outcome of a statement by a Scottish firm that they had "found difficulty in fixing a standard of hardness—for instance, in bearings where shafts or pins work at high speeds under heavy loads," a committee of the Institution of Mechanical Engineers instituted a series of tests which, after some consideration, resulted in the employment of a modified form of the Saniter method of determining wear by rolling abrasion. The results have recently been made known.

The material under test is secured in a chuck and rotated at high speed; surrounding it is a hardened-steel ring having a dead weight attached. For sliding abrasion, by means of a floating coupling the ring is caused to rotate, both ring and specimen revolving at the same number of revolutions per minute, with consequently a slip between the two depending on the difference in diameters. The wear due to abrasion is measured. Both the Brinell and scleroscope readings for the worn and unworn surfaces are also noted. The Brinell test is of course mainly one of compression, complicated perhaps by other actions. Similarly, the scleroscope reading shows the resiliency of the material, or specimen, under certain conditions. Sliding abrasion is clearly a matter dependent on the cohesion of the material. Why the three methods of testing should be expected to give results in agreement is perhaps not altogether clear. This, of course, does not necessarily criticize the use of the instruments named for purely practical workshop purposes.

The committee found no connection whatever between its own sliding-abrasion method of testing hardness and the Brinell method, although as regards ordinary carbon steels, with some exceptions, a high Brinell number agrees with a high sliding-abrasion resistance. In the case of the special steels this cannot be stated, and generally the committee concludes that "the Brinell hardness numbers of a miscellaneous selection of steels are not a safe guide in predicting their relative resistance to wear," a result which, they add, agrees generally with that of Robin, Nusbaumer and Saniter. In a measure, too, this must also apply to scleroscope results. The idea has been that a Brinell number is about six times the scleroscope number. A curve was therefore drawn endeavoring to connect the Brinell and scleroscope numbers. The ratio, even as stated by the committee, "appears to increase gradually from 5.5 for very soft material to about 8 for materials of over 700 on the Brinell scale."

In the recent English experiments the test piece was 1 in. in diameter, the ring had a bearing face on it 1/4 in. wide, the slip was 1/4 in. per revolution of the specimen, and the speed of rotation was 2220 r.p.m., the load being 410 lb. The materials tested included manganese steel as forged, as quenched in water at 950 deg. C. and as toughened, also various carbon steels as rolled and oil tempered, the carbon being mostly from 0.5 to 0.7 per cent., and also two mild steels. Further investigation is promised.

Dr. J. O. Arnold, of Sheffield, long since concluded that both Brinell and scleroscope tests were valueless as tests for cutting tools—that is, for "estimating the varying thermal stabilities of the hardenites which mainly determine lathe efficiency"—though the tests might be valuable means for rapidly determining approximately the elasticity of structural steels.

As to rolling abrasion, of which a few tests were made, for such hardened steels as were tested the resistance was "roughly proportional to the ball hardness number"; but the comparison is not safe, says the committee, "as cases frequently occur in which a considerable departure is found from this approximate relation." The rolling method is obviously suited for determining rail resistance, but in the rolling the surfaces are hardened; therefore, in the sliding-abrasion experiments an air blast was directed on the specimen, both to prevent the rerolling into the surface of abraded particles and also to keep the temperature constant.

Exactly what is meant by hardness does not appear yet to be settled. The softer the iron the more easily it is magnetized. Testing machines, based on this principle, have been built, but the results do not appear to have been sufficiently important to justify much publicity in regard to them.

Making Drawings for the Pattern Shop

By L. F. Neminger

In some drawing rooms detail drawings are dimensioned only in places where parts are to be machined. Casting sizes are omitted, so as not to confuse the men in the shop in their work with these drawings.

To furnish the pattern shop with a suitable drawing giving all pattern dimensions usually requires the making of a complete separate drawing. A convenient and time-saving method to produce a pattern drawing is to take the detail drawing and pin down a piece of tracing cloth over it. Trace on all the dimensions necessary for the pattern shop. It is not necessary to trace the outlines or other dimensions already given on the detail drawing. Carefully mark the two tracings with a cross, so that when pattern blueprints are to be made the two tracings can be pinned together, locating from the crosses on each tracing.

Industrial Workers in Japan

The law which is to be put in force in a few months' time in Japan, with a view to protecting the working class, has caused the Board of Industry to investigate the total number of men and women employed in industry at the present time. The following gives the official figures:

	In Works with Prime Mover	In Works Without Prime Mover
Number of works	14,578	17,139
Number of men employed	274,030	109,927
Number of women employed	469,013	95,291
Total number	733,043	205,222
Total per works, average	51	12.1

The Anti-Metric Case

By F. A. Halsey*

SYNOPSIS—The anti-metric party is composed chiefly of manufacturers. The pro-metric forces are made up principally of scientists and pseudo-scientists. The anti-metric case is founded on the necessities of measuring things to make them to required sizes.

Why is the interested public divided into two hostile camps, and why are the pro-metric forces made up chiefly of scientific men and the anti-metric forces chiefly of manufacturers? It is because of the fundamental difference in the use of weight and measure by the two parties. This use by the scientific man lies in determining the magnitude of things—in measuring things as they are—while the use by manufacturers lies in making things to required sizes. In the scientific use we have the thing of which we find the measure; in the industrial use we have the measure to which we make the thing, and between those who measure existing things and those who make new things to predetermined measure is the line of cleavage.

When measuring things, the dimension is the thing required—the unknown; but when making things, the dimension is the thing given—the known. These two uses of weight and measure are as opposite as multiplication and division, involution and evolution, differentiation and integration, analysis and synthesis. As soon expect the multiplication table to solve all problems in division, a table of squares to be also a complete table of square roots, as expect the scientific or analytical use of weight and measure to suffice for an understanding of the constructor's or synthetic use or to equip the user of the former for an understanding of the latter.

When making things, the dimension is decided upon beforehand and is thus a matter of deliberate choice. When measuring things, there is no choice—we must be prepared to find and to measure any possible dimension; but when making things, the power of choice enables us to eliminate undesirable and confine ourselves to desirable dimensions, and of the indefinite number of possible sizes we use surprisingly few. Thus, between 1 in. and 2 in. we have but eight diameters of standard screw threads, while of shafting we have but four and of pipe but three. The selection of the few sizes that shall, from the many that might, be used is a basic feature of all manufacturing.

It is because the scientific man must be prepared to measure all possible dimensions that he prefers decimal divisions. It is not that they give physical dimensions better than others, but that they are expressed in the same terms as decimal arithmetic, in which his calculations are made and which his measurements enter at the beginning as primary data. The constructor's sizes, on the contrary, do not enter his calculations at the beginning as data, but come at the end as results. In any event the constructor must use the commercial size nearest the result of his calculations. Broadly, the choice lies between the nearest eighth or the nearest tenth. The metric constructor uses the nearest tenth, because he must; but all others having free choice have, from the beginning of time, chosen the divisions obtained by successive halving. They have done this because such sizes are better for their purpose and in spite of the fact that they are badly expressed in decimal arithmetic.[1]

A perfect illustration of all this is found in the practice of the civil engineer, who on his tapes and leveling staffs divides his foot decimally for purposes of measurement and calculation, but never for purposes of construction. So far from this practice being an illustration of the advantage of decimal divisions, as has often been claimed, it is an illustration of their limitations and of the result of free choice of what is best in construction

An explanation of the superiority of binary sizes for constructive purposes and of the reasons for their universal choice would alone make material for an article, and I do not feel justified in asking for the necessary space—the more so because the scientific man, having no such choice to make and perhaps learning of it now for the first time, has no knowledge of the requirements and is not a competent judge of the argument. He should, however, recognize that, if there is anything in natural selection, decimal sizes have no case.

Here I may properly mention our system of coinage. For purposes of calculation (bookkeeping, interest and discount, etc.) our currency is truly decimal, but how do we divide the dollar for purposes of coinage? Thus:

5 cents make 1 nickel
2 nickels make 1 dime
2½ dimes make 1 quarter
2 quarters make 1 half-dollar
2 half-dollars make 1 dollar

The decimal character of this table is not conspicuous. On the contrary, every denomination that can be divided by 2 without a remainder is so divided. Does the reader need any further illustration of the fact that decimal division is not of universal application?

Fig. 1 shows an English and a metric scale in contact. The lines upon the English scale give the dimensions to which things have always been made in English-speaking countries, and reduced to its lowest terms, the proposition before us is that these sizes shall be abandoned and those shown on the metric scale be substituted for them.

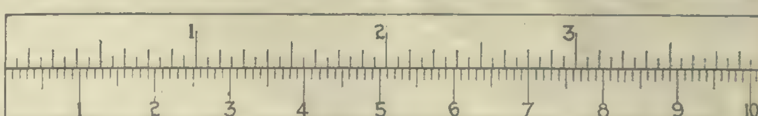


FIG. 1. THE MEANING OF THE INDUSTRIAL CHANGE

Now, please note: In the scientific use of weight and measure the only physical change involved in a change of systems is a change in measuring instruments, while in the industrial use there is also involved a change in the thing measured—which is to say, a change in everything made by human hands. The reader should see at once that here is a change of staggering magnitude and one on which laboratory use of weight and measure throws no light. Instead of denouncing as ignorant and prejudiced those who, knowing its meaning, are appalled

*Editor emeritus, "American Machinist."

[1]This is the fault of the arithmetic, not of the sizes.

at this vast change, the laboratory man should see that he is the one who does not know, and he should give pause to his enthusiasm for forcing this thing on those who do know and who must pay the bills.

The Meaning of the Industrial Change

How serious is this change? Consider the couplings of railway air-brake hose. These couplings have been standardized by the Westinghouse Air Brake Co. and by reason of this and of standardized draft couplers, railroad cars of all American lines go from railroad to railroad, from the Atlantic to the Pacific, from the Great Lakes to the Gulf, because they interchange as a matter of course. The attempt to change these couplings would lead to confusion worse confounded. Moreover, the new couplings doing their work no better than the old, the change would accomplish no useful purpose and hence will not be made. It is not a matter of willingness to change nor of getting people to learn and to think in the new units. It is not a matter of the life or the repair of individual couplings nor of the "cost of dies, patterns, gages, jigs, etc." (Dr. Collins). The obstacle to the change is physical and insurmountable and lies in the simple necessity for continuity between old and new couplings. Every standard of this kind has a value that is incalculable and that has no relation to the cost of the thing itself nor of the "dies, patterns, gages, jigs, etc.," with which it is made, just as the value of the coupling standard is measured by the saving in transshipment due to the interchange of cars and not by the cost of the couplings nor of the tools used in their production. Destroy these coupling standards and one can scarcely picture the increased cost and confusion of transportation.

It is in these standards that we, as a nation, lead. We have no end of them, and because of them our manufacturing industries are great. The rest of the world has scarcely learned their value. The example selected is not chosen because the difficulty of the change here is greater than elsewhere, but because it is so plain as to be obvious after the slightest reflection. It is the direct outgrowth of the selection of sizes that shall be used, a selection that has no place in the scientific uses of weight and measure, of the importance of which the scientific man has no knowledge and on which he, by that fact, has no right to express an opinion. The overwhelming difficulties of these changes, growing out of the simple necessity for continuity of sizes between old and new constructions, pervade every application of measures of length in the constructive arts, take the subject from the realm of choice and make the change impossible.

The Metric-Equivalent Subterfuge

Until recent years the metric party have ignored this difficulty. Repeated insistence upon it as the prime reason for the objections of manufacturers to the change has now compelled the metricites to take notice of it; and they suggest, as a means of getting around it, the continued use of existing sizes expressed in millimeters and fractions thereof—a suggestion that is too amateurish to merit discussion, were it not offered seriously and repeatedly.

In this they show again an abysmal ignorance of the difference between measuring things and making things to measure. Referring again to Fig. 1, the base units of the two scales being incommensurate, the two sets of lines seem fairly to play a game of hide and seek in their efforts to elude one another. Since they do not agree, it follows that, if the sizes shown by the lines of one scale are to be expressed in units of the other, draftsmen and mechanics will be required to use a set of sizes that are not given by the lines on the scales from which they are taken. That is to say, instead of taking from the scales the sizes shown by their lines, intermediate sizes are to be taken by estimation. Worse yet, the set of sizes that, as expressed on English scales, fairly memorizes itself, becomes, when expressed in metric units, a series of such character that the memorizing of it is impossible, and yet this must be done if this scheme is carried out.

The impossibility of memorizing this series of equivalents will be apparent from a glance at the following table:

METRIC EQUIVALENTS OF ENGLISH SIZES

In.	Mm.	In.	Mm.
1	25.4	2	50.8
1⅛	38.57	2⅛	53.97
1¼	31.75	2¼	57.15
1⅜	34.92	2¾	60.32
1½	38.10	2½	63.5
1⅝	41.27	2⅝	66.67
1¾	44.45	2¾	69.85
1⅞	47.62	2⅞	73.02
		3	76.2

The combinations of figures do not repeat themselves, each added inch adding a new set of combinations, which is to say that the table has no end. One might as well attempt to memorize a table of logarithms. The metric party will tell us that this table is to be used "during the transition period only"; but the transition period is not yet past in France, and it will not be past in the United States until all existing mechanical standards are abandoned.

Is it reasonable to suppose that eight threads per inch will ever be translated into eight threads per 25.4 mm., or that six diametral pitch will be thought of as meaning six teeth per 25.4 mm. diameter? Will 6-in. shafting ever be thought of as 152.4-mm. shafting or 12-in. I-beams and pipe as 304.8-mm. beams and pipe?

Let the reader turn to the metric scale of Fig. 2 and by it attempt to lay down, as a draftsman would have to do, a few such sizes as $\frac{7}{16}$, 1⅜ and 3¼ in. or any others that he may select. Explanation is unnecessary. If the reader will but try it, the simple childishness of the scheme will be apparent.[2] And yet it is to this pitiful thing that the metric case has been reduced. The preservation of mechanical standards is admitted to be a necessity. If they are to be continued and the metric system is to be used in connection with them, this plan must be made to work, and made to work it cannot be.

FIG. 2. METRIC SCALE FOR LAYING OFF ENGLISH DIMENSIONS

Cannot the metric party see that, if the plan were workable, it would have been adopted years ago in metric countries? Such countries would not, as they all in fact do, measure screw threads, pipe and lumber in inches, were it possible thus to express the sizes of one system in the units of another.

[2]The object of the plan is to retire the inch from men's thoughts as well as from the drafting board. The use of a table of equivalents is therefore inadmissible.

Standardized things will not, because they cannot, be changed, and the effect of the adoption of the system here will thus be, as it has been elsewhere, a partial change. When confronted with this, the metric party answer that a partial change will bring a partial benefit. On the contrary, a partial change will bring a state of confusion, complexity and disorder compared with which the worst picture drawn by metric writers of our present conditions fades into insignificance. Such partial change will involve the constant, daily use of the incommensurate ratios between English and metric units, which are far worse than the worst of our present ratios.

The ratios between English units are seldom used in reduction, because different units are used for different purposes, as I have explained in the preceding article, but the inch and millimeter, the pound and kilogram, the quart and liter are used for the same purposes, and conversions between them would be a constant necessity. In other words, the system would make calculations more, instead of less, complex; and at the very point where it is urged in order to make matters better than now, it would in fact make them worse. We now have the ratio,

3 *feet make* 1 *yard*,

which is held up as an example of all that is bad and as the cause of complexity of calculations; but how about the ratio,

3.28083 *feet make* 1 *meter*,

which a partial change will force us all to use? As matters now stand, conversions between English and metric units are far more burdensome than conversions between English units, and conditions today are but a warning shadow of what the metric program would bring.

Consult the pages upon pages of English-metric and metric-English equivalents with which all engineers' reference books are burdened. What are they? Simply an added and incommensurate set of ratios which no one can memorize, forced into use by the conjoint use of the two systems and differing in no way, except badness, from the ratios between English units which the metric party are so fond of deriding. What shall be said of the logic that holds the English ratios up to scorn and ridicule and then accepts these infinitely worse and far more numerous ratios as a step in the path of progress? Words fail. The burden of the tables is measured not by their extent, but by the amount of their use, and every added injection of the metric system into our commercial and industrial life adds to their use and to their burden.

The metric party will answer of course that, when the metric system is universal, the tables will no longer be needed, this like all other arguments for the system resting on the tacit assumption that the old units are to disappear. Our case is based upon the fact that they have not disappeared elsewhere and cannot disappear in this country; and note right here that, if the old units are to persist, not only this, but every other, argument for the system inverts itself and becomes an argument against it. Instead of uniformity we will have diversity of units; instead of fewer and simpler, more and more complex ratios; instead of simpler, more complex calculations and so on to the end.

Does the reader consider this picture overdrawn? Then let him read the following description of the manner in which a German manufacturer determines the cost of a simple piece of cotton tape as wide as one's finger:

> The reed is gaged by the number of dents per French line. The yarn counts in both warp and filling are English, based on the 840-yd. standard. The picks of filling are given as so many per French inch. The weight of the warp yarn is calculated in metric grams from the English counts and extended at a price in marks per English pound. The length of filling yarn is calculated per 100 m. of cloth from the picks per French inch and the width in French lines. The weight of the filling in grams is then calculated from the English yarn count and the length in meters. This weight in grams is then extended at a price in marks per English pound.

Or the following showing how the values of a lead ore carrying also gold and silver are determined in Mexican smelters[3]:

> When the ore contains 5 per cent. or more of lead, it is paid for at 1c. U. S. currency per pound when soft Spanish lead is quoted in London at £13 sterling per ton of 2,240 lb. For each advance of 1s. 3d. in the London quotation 1c. U. S. currency per 100 lb. for lead contents will be added or deducted. The ore, however, is weighed and deliveries made in kilos, and assays are reported for metric tons of 1,000 kilos. The silver is paid for at 90½ per cent. of the New York quotation, which is in U. S. currency, per troy ounce. The gold, however, is paid for at $0.6269 U. S. currency per gram. Freight and treatment charges are $24.50 Mexican currency per ton of 2,000 lb. avoirdupois.

We see here the metric system in the second—and if history furnishes any guide, the permanent—stage of its adoption. The easy changes have been made, but the difficult ones have not been; and the resulting mixture of old and new units leads to this welter of confusion. Should we ever reach that stage, we shall have with us those who have made the easy changes, and they will assure us how easy it all is—for some of these changes are easy, as easy as the traditional first downward step from the path of rectitude. We shall also have the metric party, emboldened and strengthened by their initial success, charging these conditions to the English system for not getting out of the way instead of to the metric intruder that caused them and pointing out its will-o'-the-wisp to urge us deeper and deeper into the mire. And once in that mire, we shall stay there; for with the metric units once anchored in our industries, the same necessity for continuity that keeps the English will also keep the metric units there. The metric bourn is one from which no nation can return.

The Error in the Meter and Its Consequences

It is well known and universally acknowledged that the attempt to derive the meter from a measurement of an arc of a meridian of the earth's surface was a failure. The actual base meter is the distance between two lines ruled on a standard bar, of which all other meters are, directly or indirectly, copies. With the error of the survey proven, the meter had no longer an excuse for existence. It then became an arbitrary unit like the yard and in neither kind nor degree better than the yard, while the effect of its continuance was the introduction of another base unit, of which the world already had too many. The discovery of the error was made before the adoption of the meter had made much progress and when it could easily have been changed; and in view of the established position of the yard, the surveyed value should have been abandoned as the result of a well-meant but abortive attempt to establish a natural unit.

After the error had been discovered and the significance of the surveyed value destroyed, Sir Joseph Whitworth,

[3]These are but samples. An entire number of this journal could be filled with illustrations of this kind. Mexico has been repeatedly held up as a shining example of the quickness with which the change can be made.

realizing the consequences of incommensurate ratios, urged that the length of the meter be changed to 40 in. (an increase of about 5/8 in.).

This small change would have made the decimeter exactly equal to 4 in. and 25 mm. exactly equal to 1 in., the incommensurate ratios disappearing. The suggestion fell upon deaf ears. The system had already assumed its present character as a sort of religion. The meter had taken on a sacrosanct character, and a change in its value was looked upon as sacrilege. For no better reason than this—the simple worship of a fetish—the most sane and useful suggestion ever made in connection with the system, and one from the man of all men best abe to speak with authority and best deserving a hearing, came to nothing. The incommensurate ratios were fastened upon the world, and the irony of it is that this was done in the name of simplified ratios. One might here paraphrase the saying of Madame Roland regarding the crimes committed in the name of liberty.

The most ardent advocate of the system, as a system, if he be not purblind, cannot fail to see that the introduction of a new incommensurate base unit, having in itself no element of superiority, had no justification and was certain to lead to confusion and complexity instead of to clarity and simplicity. And those who did it have their reward, for they but added another obstacle to the adoption of their system.

To sum the matter up: When we consult history instead of imagination, facts instead of hopes, we find that a change in weights and measures, so far from being in human affairs an easy matter is, next to language itself, about the most difficult. Instead of its having been completed by most of the nations of the earth, it has been completed by none and effectively begun by but few. The supposed advantages of the system are predicated upon its complete adoption and are a hundred-fold negatived by its inevitable partial adoption.

Finally, we who know the industrial use of weight and measure know that while "nothing is so easy as to introduce a new unit of measure, nothing is so difficult as to get rid of an old one" and that the adoption of the system means nothing more than the superposition of the new upon the old, with a complete reversal of every metric claim. So far from leading to a haven of rest, the metric path leads instead straight to the Slough of Despond.

This is why we fight; this is why we win; and this is why we will always win.

Foundry at Rheims After Bombardment

VIEWS OF AN IRON FOUNDRY AT RHEIMS, FRANCE, AFTER BOMBARDMENT AND FIRE

Fig. 1—View taken directly after the bombardment of Sept. 19, 1914. Fig. 2—View from the side of the core oven, December, 1916. Fig. 3—How the machines fared, taken December, 1916. Fig. 4—General view taken in December, 1916

Making Bronze Bushings in Quantities

By Ethan Viall

SYNOPSIS—Highly specialized, though simple methods used in making bronze bushings. Molding, machining and inspecting are all shown. One reason for the success of this specialization lies in the use of little kinks that cannot be described readily, as they can only be acquired by long experience.

Only a few years ago most firms that used bushings to any extent machined their own, and in many cases made their own castings too. The automobile trade called for bushings in such quantities, however, that it gave rise to a number of firms that make a specialty of bushings alone. Where the use would permit of soft metal, or metal of a comparatively low melting point, the bushings are usually made by the die-casting process. With brass or bronze bushings, however, another process must be used, as so far no successful method of die-casting these has been evolved. One of the firms making a specialty of brass and bronze bushings is the Sterling Specialty Co., of Newcomerstown, Ohio. This concern has an unusually well-equipped factory and makes bushings in any desired length and from ¾ to 7 in. in diameter. It has its own foundry, and bushings are made to conform to whatever formula may be furnished by a user, or metal mixtures are made after its own formulas to meet the requirements where the user does not want to specify his own.

Molding and Core Work

The molding for the small and medium bushings is done on Mumford machines, as shown in Fig. 1. The flasks average about 20 pieces each for the medium sizes, and each molding machine averages about 80 flasks. Fig. 2 shows a row of flasks at the right before the cope is put on, and at the left a row all weighted and ready to pour. A close-up view, showing the way the cores are laid in, is given in Fig. 3. As a general rule, the castings are made long enough for two bushings. This is considered more economical than to cast them singly, as is sometimes done, as on a majority of the work it simplifies the machining. However, no one method is adhered to strictly, as the nature of the work governs the handling. A stack of the castings, just as they were removed from the molds, is shown in Fig. 4.

Cores are made in small iron molds, as shown in Fig. 5. Between the girls lies a lot of cores ready to be placed in the drying oven. A better view of one of the molds

FIG. 1. MOLDING MACHINE, SHOWING PATTERN

FIG. 2. ROWS OF BUSHING MOLDS

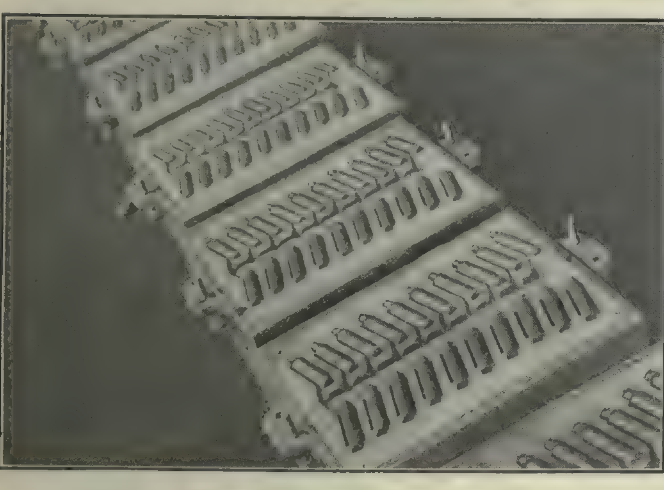


FIG. 3. METHOD OF PLACING THE CORES

FIG. 4. STACK OF BUSHING CASTINGS

is shown in Fig. 6. These molds are of the split type, and the one shown is for four cores. A C-clamp holds the two halves of the mold together as the girl fills it and pounds down the mixture with a mallet. Cores are baked about 35 min., and a girl will average about 1800 cores a day on the more common sizes that are here made.

FIG. 5. MAKING THE CORES

FIG. 6. TYPE OF CORE MOLD USED

FIG. 7. FIRST OPERATION ON BUSHINGS

FIG. 8. SECOND MACHINING OPERATION

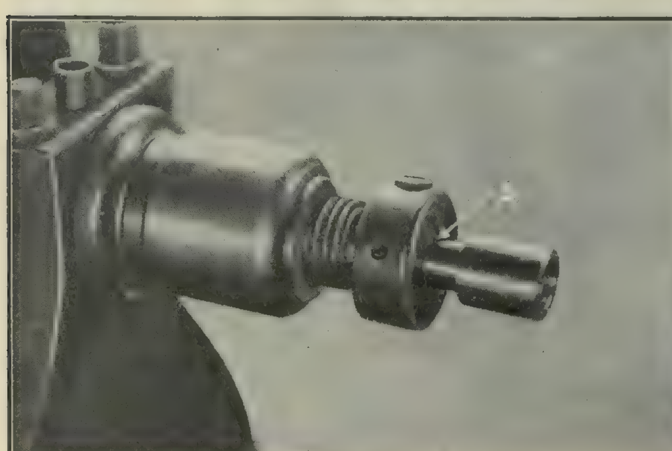


FIG. 9. ROUNDING INSIDE EDGE

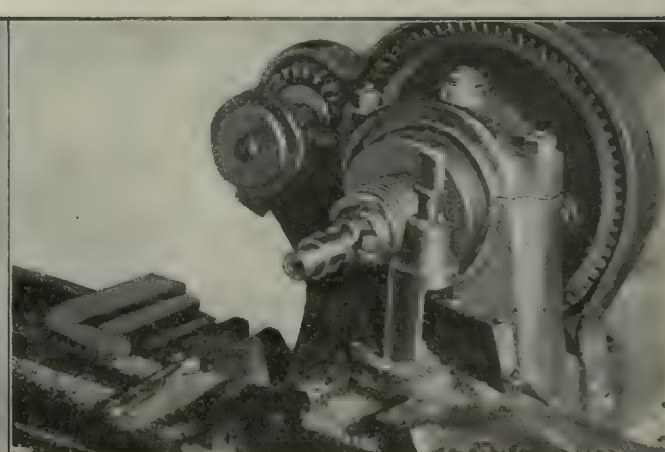


FIG. 10. ONE OF THE RE-TURNING OPERATIONS

The common sizes are all machined in about the same way. The first operation consists in chucking a bushing, center drilling with a flat drill, drilling out, reaming and machining the outside with a box tool, as shown in Fig. 7. This machines half of the bushing, as shown at *A*. One of the bushings previous to chucking is shown at *B*. On this work each operator will average about 2800 pieces per day.

In the second operation, the piece is chucked by the machined end, as shown in Fig. 8, and the other end machined. The work is similar to the first, except that a roughing and a finishing box tool are used to machine the outside, after which the bushing is cut in half, forming two bushings like the one shown at *A*.

Where the bushings are cut in two, as just described, the inside edge is rounded as shown in Fig. 9. The oper-

ator picks up a bushing and slips it over the pilot and against the tool *A*. Handling the work in this way, a girl will round the inside edges of a large number in a remarkably short time.

The bushings are made to any required degree of accuracy. In some cases, the inside is carefully reamed to size, and then the bushings are placed on a plug mandrel, as shown in Fig. 10, and the outside turned to size. In other cases, the inside is broached to size with the type of broach shown in Fig. 11. In the broach shown, the teeth are $\frac{9}{32}$-in. pitch and increase about 0.0015 in. per tooth. These broaches are pushed through in a small press and produce accurate and smooth holes.

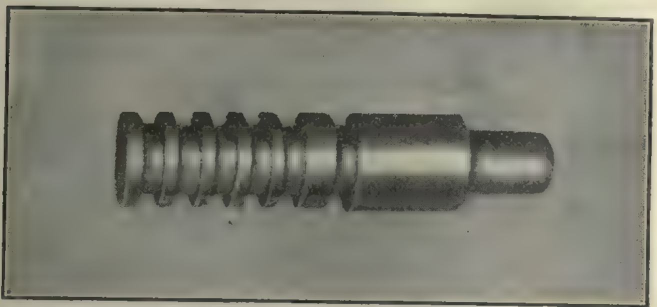


FIG. 11. TYPE OF BROACH USED

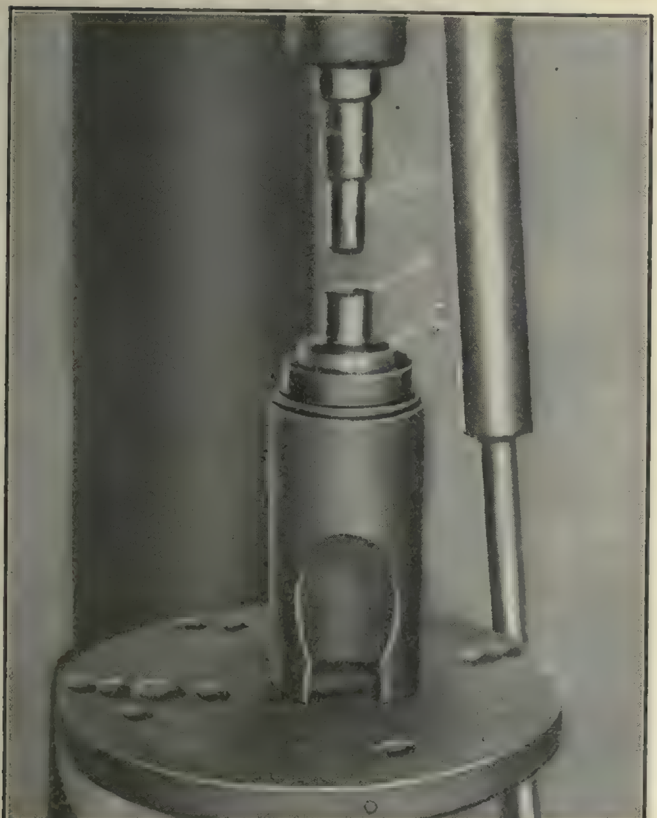


FIG. 12. AN OUTSIDE SHAVING OPERATION

A method of rapidly sizing the outside of machined bushings is shown in Fig. 12. This is a shaving operation and gives extremely accurate results. A bushing is placed at *A* and then the piloted ram *B* is brought down and the bushing is forced through the shaving die *C* and drops into the hollow cylinder beneath.

Following these operations are the various inspections, care being taken to make sure that the bushings are of the degree of accuracy called for on the order.

Oils and Greases in Common Use

By R. Gray

To those engaged in manufacturing the question arises, Which kind or quality of oil should be used?

When a general idea has been formed, the differences of gravity, flash and burning points, viscosity, etc., are discussed. To many these terms are a source of bewilderment, as they are understood but little and their meaning conveys nothing of the general effect one might expect in practice.

In the case of lubricating oils, an oil is used primarily to reduce friction; but all oils do not have the same effect nor, if efficiency is desired, can they be used under the same working conditions without regard to their physical properties.

Animal, vegetable and mineral oils are the three principal classes into which oils may be divided. Animal oils are obtained by rendering animal fat.

Vegetable oils, as the name implies, are obtained from vegetable matter, and the method of extraction may be by means of solvents, pressure or distillation, or a combination of these. Mineral oils are obtained chiefly by distilling crude oil.

Animal and vegetable oils differ from mineral oils in that the latter will volatilize, whereas the former do not undergo volatilization without decomposition. They are glycerides, or fatty acids. The vegetable oils include the various nut, seed, grain and fruit oils. A large percentage of these oils, when exposed to the air, oxidize, or dry, and form thin films, thereby increasing friction. These drying oils are used for paints. Vegetable and animal oils that do not possess the quality of drying are used for lubrication. Mineral oils, however, are cheaper and are used to a greater extent. These oils include benzine and gasoline, and also what are known as engine and cylinder stocks.

Oils may be classified as lubricating, lighting and paint oils, as shown in Table 1.

TABLE 1. CLASSIFICATION OF OILS

Use	Composition	Classification
Air compressor	Paraffine and mineral or mineral	Lubricating
Common engine	Paraffine and mineral or mineral	Lubricating
Power-house	Paraffine and mineral or mineral	Lubricating
Common valve	Paraffine and mineral or mineral	Lubricating
Power-house valve	Paraffine and mineral or mineral	Lubricating
Coach	Paraffine and mineral or mineral	Lubricating
Car	Paraffine and mineral or mineral	Lubricating
Dynamo	Paraffine and mineral or mineral	Lubricating
Triple valve	Paraffine and mineral or mineral	Lubricating
Superheater	Mineral	Lubricating
Transil	Mineral	Lubricating
Whale	Animal	Lubricating
Lard	Animal	Lubricating
Signal	Coal oil and mineral	Lighting
Mineral seal	Coal oil and mineral	Lighting
Headlight	Coal oil or kerosene	Lighting
Switch and semaphore	Coal oil	Lighting
Linseed	Vegetable	Paint oil
Benzine	Mineral distillate	Paint oil
Gasoline	Mineral distillate	Paint oil
Turpentine	Vegetable	Paint oil

The oils of each classification are compared with each other by gravity, flash and fire tests, viscosity, color and cold test. Sometimes the amount of sulphur, free acid, etc., is determined, and the oil is put through a test to obtain its saponification value; it may also undergo a gumming test.

The gravity of an oil is its density, or weight; that is, it represents the weight of a volume of liquid compared with the weight of an equal volume of water.

The viscosity is the time it takes a given quantity of oil at a given temperature to flow through an opening of fixed size.

The flash and fire tests are important, as oils are required to work where high temperatures prevail; for example, gasoline engines use explosive mixtures that give, under pressure, temperatures of from 1500 to 2400 deg. F., when ignition occurs. The flash test shows at what temperature the vapors coming from the heated oil will first flash, or ignite and go out again, when a small flame is brought near the surface of the oil.

The color test is not an infallible guide, as the oil may have been filtered or subjected to an acid treatment. It is of value for detecting adulteration; for example, if mineral oil is present, the "bloom," or fluorescence, is visible.

The cold test is the temperature at which an oil congeals or will just flow. This is important whenever oils are exposed to freezing temperatures. Winter oil would be a little lighter, a little less thick (viscous) and with lower flash, burning and freezing points. There may also be some difference in the amount of lead soap present.

A large railway corporation uses the oils designated in Table 2.

TABLE 2. LIST OF OILS STOCKED BY A RAILROAD

Kind of Oil	Purpose
Electrical Department	
Dynamo	Motors
Gredag	Grease cups and crane motors
Transil	Starting boxes
Machine Shop	
Power-house	Shafting and air compressors
Perfection or power-house valve	Air tools
Dynamo	Motors and fans
Car oil	Cranes and outside machinery
Headlight	Cleaning
Lard	Automatic machinery and tools
Grease	Air compressors
Foundry	
Engine	Cranes in wheel foundry
Dynamo	Cranes and blowers
Gredag	Cranes
Frog	
Engine	Machinery
Dynamo	Rail saw and motors
Valve	Air tools
Bolt	
Vaseline	Ball bearings on shafts
Lard	Automatic machines
Dynamo thinned with coal	Automatic machines
Blacksmith Shop	
Valve	Steam hammers
Planing Mill	
Dynamo	Shafting machines and motors

Carrying such a varied stock as this presents quite a difficulty and expense. If the shops had been familiar with a little theory, probably more engine oil would have been used for the machinery instead of dynamo and valve oil, and when a mixture of both is used on hot machinery a special oil of about the same price as engine could have been obtained.

The only difference between valve oil and air tool oil lies in its viscosity and gravity, so possibly a special air tool lubricant, either an oil or grease, could have been used at less cost.

Results of tests and specifications are a help in making comparisons, and some figures taken from actual practice are given in Tables 3 and 4.

As a general rule superheater cylinder oils are the heaviest, having the highest gravity, flash and viscosity; cylinder, engine, gas engine, dynamo and the lighter oils follow in corresponding order.

It will be noted that the flash and burning points, viscosity, etc., vary with the service demanded.

The heavier the machine and the slower the speed the greater the viscosity; also, when oils are subjected to a high temperature the higher the flash test and when subjected to low temperatures the lower the cold test which the oils must pass.

On heavy, slow service greases may be used instead of oils. On slow-moving spindles, say 5000 r.p.m., when lubricating ball bearings a good grease will give satisfaction; but when the speed is increased to 12,000 r.p.m.

TABLE 3. ANALYSES OF OILS

Kind	Gravity, Deg. Bé	Flash	Burn	Viscosity	Fatty Oil	Cold Test	Remarks
			Engine				
Specification.	29.0	325	440	180.0	10.0	30	
	24.5	433	475	234.0	None	....	
	29.4	416	472	82.3%	None	....	
	25.7	388	446	84.3%	....	....	
	27.5	444	517	74.9%	1.6	....	
	26.4	388	458	176.0	....	....	Too light, ran hot on this particular work
	25.0	584	666	184	3.64	28	
			Superheater Cylinder				
	25.0	560	630	155	9.0	39	Good for tempering oil
	23.5	594	670	205	10.0	40	
	24.8	620	690	232	7.96	....	Made in Germany
			Cylinder				
Specification.	26.0	560	620	185.0	....	30	
	27.0	557	600	61.9%	9.6	....	
	25.6	532	600	60.9%	9.3	....	
	27.3	478	558	58.4%	12.0	....	
	26.3	532	595	60.2%	9.9	....	
	20.3	471	491	138.0	5.4	....	No good
			Gas Engine				
Specification.	25.0	580	...	203	....	....	
	29.5	430	485	195	....	30	
			Dynamo				
Specification.	30.0	410	450	180.0	3	30	
	31.0	395	465	78.2%	....	....	
	25.9	412	454	164.0	....	....	
			Car				
Summer.....	22.9	339	387	165	29	....	
Winter......	23.0	264	...	.....	....	....	
			Transil				
	32.7	372	406	126	....	....	Should be free from moisture acids, alkali or sulphur
			Long Time Burning				
						Deg. F.	
Specification.	47	120	140	.....	....	— 5	
	49	115	...	.....	....	—17	
			Headlight				
Specification.	46	95		.....	....	—10	
	47	116	130	.....	....	—18	
			Lard				
	82	550	...	215	....	....	

a light oil is satisfactory, for if a heavy oil or grease were used the coëfficient of friction would be increased instead of reduced.

It is not always possible to get at the true value of oils by gravity, etc., because adulteration is sometimes resorted

TABLE 4. ANALYSES OF GREASES

Kind	Mineral Oil or Vaseline	Lime as Soap	Moisture	Acid	Drop Point, Deg. F.	Graphite	Remarks
Grand	58.29	22.57	8.7	0.22	194	9.55	
Special.....	55.74	19.76	8.83	0.020	297	14.80	
Ball bearing	88.7	2.04	5.09	4.34	196	.....	Mineral oil contains 12 per cent. of castor or rope oil
Ball bearing	89.16	0.59	0.66	7.74	212	.....	Mineral oil contains 1½% of fatty oil
Cup......	74.97	2.06	2.61	....	...	.....	Locomotive

to. The principal trouble is that the adulterants are susceptible to decomposing or oxidizing influences, resulting in friction or clogging of the lubrication system.

Factories in Australia

The valuation of the capital sunk in Australian factories in the shape of land and buildings, plants and machinery has nearly doubled in the last 10 years. Ten years ago the land and buildings were more valuable than the plants, but the reverse is now the case. Wages during 1914 amounted to $165,463,083. The value of land and buildings in 1914 was $190,269,351, while the value of plants and machinery was $201,531,118.

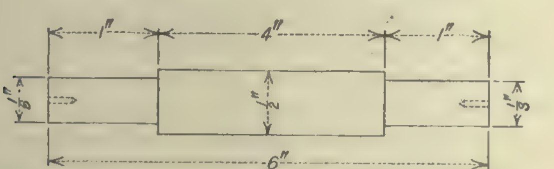
Drafting Room Versus Shop

By Charles M. Horton

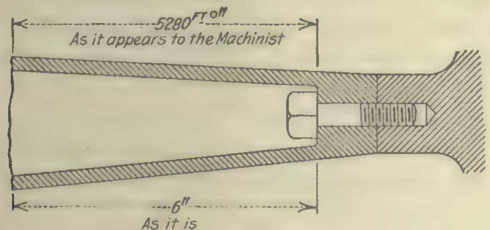
SYNOPSIS—A frank admission of the far too common strife between the drafting room and the shop and an explanation of its cause. Misunderstanding is the principal source of the trouble. A little about the draftsman's viewpoint and his work that may help to a better comprehension of him and his difficulties.

Beginning with the days of colored drawings, when the color "blue" meant steel, and "yellow" brass, and "gray" cast iron (remember, Oldtimer?) down to this very now, when it is the practice to make drawings with soft pencil upon tracing paper and then blueprint them direct, there has been unbroken strife between the shop and the drafting room. "'Tis true, 'tis pity; and pity 'tis 'tis true." Precisely *why* 'tis true cannot be lightly dismissed with a quotation—not even one from the immortal William himself. Shakespeare no doubt had full cognizance, however, of the jealousy among "the trades," since human beings have been human beings from the day the first monkey decided to aspirations beyond his neighbor and walked upright.

"Bill, what d'you s'pose that fool draftsman meant by this?"



And again: "Jim, how in h— is a man going to get a wrench in there?"



Or: "How is this thing going to go together?"

Common questions all! And who in the game has not heard one of them, or all of them, at some time? And there is a querulous note in the questions—the undercurrent of impatient fault finding. It is always there and always, apparently, justified.

For when an aged machinist, with two pairs of spectacles on his nose, with white hair rumpled, with back bent sharply over a blueprint, cannot decipher a dimension, or when a young, vigorous and enthusiastic machinist just out of his time fails to see how he is going to screw up a nut, or when a middle-aged journeyman scratches his bean over the problem of fitting a $2\frac{5}{16}$-in. collar over a $2\frac{7}{16}$-in. shaft—I say, when these difficulties present themselves, as they do frequently in the shop, there is just cause for complaint and, in the vernacular of the shop, h— to pay.

There is much to be said on both sides. One side already has spoken. It has spoken in no mistakable language and long and lustily—your machinist is never a shrinking violet. He speaks for himself.

Now let us look at the thing from the viewpoint of the long-suffering draftsman—one of the race of folk who walk soberly and apparently superciliously down through the shop, followed by many looks of disdain, contempt and occasionally pity from the machinists in that department. "There he goes now! Let's get him over here. Let's have it out with the white shirt and collar."

And while the draftsman is over there, a little nervous, but eminently anxious to explain, suppose we ourselves horn in on the thing, listen and lend a helpful voice to the otherwise raspy discussion

The Aged Machinist and the Unreadable Figures

We will consider first the complaint of Bill's friend—cannot read that dimension. He cannot read it with two pairs of spectacles and a perseverance engendered through 40 years of reading shop dimensions. Therefore, he feels—and is—justified in uttering provoked speech, "What do you s'pose that fool draftsman meant by this?"

The drawing is a detail of a small shaft, turned down on each end and with each end itself tapped out for a capscrew that is to support an end-thrust disk. You have seen hundreds of these little parts. The whole shaft can be held in the palm of your hand. It is small—the shaft, the drawing, the size of the sheet, everything. The dimensions are small, too, mind you—ask Bill's friend. No good excuse for it, really, under the circumstances, but there it is. And now let's see.

From the very nature of his being, the draftsman has a very acute sense of proportion—one of the characteristics of an artist. In eight cases out of ten, whether he be a graduate from a technical school or one who slipped into the drawing room through the side door, your draftsman is a man who initially entered upon the work because of an inborn desire to make pictures. Having this desire—this artistic urge, therefore—he also possesses a strong sense of the fitness of things, "of the true, the good and the beautiful."

Now, wait! I have elected to show you the real draftsman—that slender human who wanders into your drafting room looking for a job and whose list of places and references appalls you from its very length. He is the natural born draftsman. He is a quiet individual with a reticent manner; and possessing as he does a true sense of proportion, when he makes a detail of a small part on a small standard sheet, unless given orders to the contrary, he will unconsciously make his picture in proportion—small views, small arrow-heads, small figures—everything in keeping. It is the artistic sense within him that does it. And because his vision has been narrowed down through years of service and close application, the figures are clear to him. When the question is raised concerning them in the shop, he usually is the most surprised and chagrined man you can find.

Figures on drawings should be readable, of course. There is nothing else so valuable as a workman's eye-

sight; it must not be injured. Nor will your real draftsman ever consciously do anything that might cause injury.

Draftsmen have troubles not clearly understood outside of drafting rooms. They have to see a machine on all sides from one side, as it were. They stand still and walk around it, so to speak. It is not easy. As a matter of fact, it requires a pretty acute order of imagination to embrace fully, by the simple process of gazing at a general assembly, the import of the working parts of a design. Also, draftsmen have to look through it, too—levers and cams and gears oftentimes in profusion, each performing its individual task and performing it in a space clear and free from every other part—and not a single part, at the moment of gazing, in operation; indeed, assembled drawings of machines are never easy to understand.

Machinists do not comprehend this. It is a matter difficult for them to understand, since they themselves always have the parts of the machine in their hand—tangible somethings that require no imagination to see and whose uses readily suggest themselves. This lack of understanding, perhaps, as much as anything, accounts for their disdain of draftsmen as a race. Machinists do not have to worry about clearances. (Clearances, clearances! Draftsmen's souls have been lost in thy name!) It never occurs to them, or rarely, that when a part neatly clears by a hair another part of a working unit, the draftsman lost the color out of at least one of his own hairs in bringing this neat clearance about.

The Un-get-at-able Nut and the Unmade Socket Wrench

"Jim, how in h— is a man going to get a wrench in there?" Let us take this seeming fault from its beginning. It is not always an error. A special machine is in the wind. The establishment is a small jobbing shop. The initial chewing is over with—the inventor has explained his wants, the ideas of the president and the secretary and the treasurer and the superintendent have been aired, and the job finally finds its way into the drafting room. Steve Winthrop, the designer, gets his instructions. He is off—hurray! The machine is a complicated affair for the baling of tin cans.

Steve Winthrop is a narrow-chested, hollow-stomached individual with a long, lean face and a steady eye. Steve was not always narrow chested or hollow stomached. Steve had won athletic honors in his college days. But 15 years of bending over drafting boards have taken their toll. Steve has been in the game 15 long years, and today he knows his business if anyone knows it. Steve started out in life to get a broad engineering experience. And he got what he went after. Only, after some 15 years of jumping about the country from job to job, which was his idea of broadening himself in engineering, he has discovered that he is still a draftsman, whereas his classmates with but few exceptions are holding down $5000 jobs—have beaten him out by remaining with one organization, absorbing the intricacies of one line of product and going upward on the wings of this knowledge. Steve in consequence is a little sore. He knows that with his experience he would make a crackerjack consulting mechanical engineer.

But he knows also, too late, that his years of quiet plugging with drawing pencil on paper have weakened him for successful conflict with the aggressive outside world—and no other body of men is more removed from the aggressive outside world than are draftsmen. The way to bulge into a consulting business is to bulge in, profit by your mistakes—and they will be many—and keep your shingle over your door. Steve thought to get the experience first and practice later—and, as I have said, he is sore.

Steve designs the baling machine. He mulls over the drawing perhaps six months. He sees a great many things from a great many angles—performs miracles, after a fashion. Then he superintends the making of the detail drawings and here cleans up stray ends of his design. Somewhere in the construction he deems it advisable, in strict concordance with good machine design, to place a few bolts and nuts, which will necessitate the use of socket wrenches. Steve dutifully points this out to his superiors when he makes the design. They pass upon it, and the finished drawings are then sent out into the shop, where the patterns are made, the castings produced, and the job is finally taken to the erecting floor. The nuts under discussion called for a special socket wrench. Steve well understood this, and his superiors apparently had understood it. But somehow in the rush and turmoil of events the matter has been forgotten. It remains forgotten—the special wrench has never been made—until Jim's helper, the young machinist just out of his time, makes the discovery that he has no wrench that will perform the work. Then he lifts the long wail. In his eyes, naturally, as in the eyes of his associates, Steve the draftsman is a fool.

This shop opinion is not exactly right, is not what you would call justice, is it? Yet, after all, it is simply based on an ignorance of what Steve and his ilk do in the day's work every working day of their lives.

Many good machinists secrectly believe that they can make drawings the equal of those turned out by the best draftsman that ever strutted through a machine shop—with a little practice. This belief is natural; in many cases it is a just belief. In many cases, though, it is a belief based upon an erroneous idea of what constitutes a draftsman and the nature of his work. "Why," I have heard machinists say, "all a feller needs is a little practice twirling a compass, a little brushing up on arithmetic, and the chance!" Sure! And the most difficult of these is the chance. I will say that there is more truth than wisdom in this. But also, I will say that there is more to drafting than the mere twirling successfully of a compass and a good working knowledge of Euclid.

Among other things, there are required an infinite patience, not only with the tools themselves but with one's superiors; a willingness to be haunted o' nights that a certain cam will give required results, or a lever in its work clear the frame, or an odd-shaped piece transcribing an odd-shaped curve pass through its cycle correctly and as drawn; and lastly, and more than all else, a Job-like stoicism that will resignedly see a man in overalls in the same establishment step out and upward via the erecting route to a position of comparative ease and big compensation, while you yourself continue on the board because the chief cannot secure a man who knows the work as well as you do.

"Once a draftsman always a draftsman" is a true adage. Given positive knowledge of the inside, few machinists would care to make the change, and every last

one of them would refrain from harsh criticism upon discovering petty errors on drawings. Raise the point—sure! But with a little less rasp in your voice, my brothers!

The reason for the long-standing strife between shop and drafting room is simple to understand. It is a very human reason. It lies in the fact that one department catches the errors made by the other. Draftsmen do not get sore when their fellow draftsmen point out discrepancies in their work. Perhaps this is true because of the understanding that exists among draftsmen relative to their own general difficulties. But it certainly does start the blood boiling in a draftsman when a grinning machinist points out an error in a drawing. If the man only would not grin; or if he must grin, then show by some sympathetic gleam in his eyes that he understands the nature of the draftsman's work and difficulties! He has one on you, and he is proud of it, and he does not care who knows it. But it is not a feeling of brotherhood.

The Big Shaft and the Little Collar—a Mistake

"How is this thing going to go together?" It is the last of the three commonly heard questions directed at the draftsman in the shop. Precisely how the thing is going to go together is difficult to say. Obviously, it is a "buhl," as one Russian draftsman used to say whenever called to account for a mistake. It is one of those errors that repeatedly creep into a man's work as he completes his drawing, regardless of how clever and capable and careful he is as a draftsman. It is an error in figures. An error in figures is one of the most common mistakes that occur in drafting rooms—and the most dangerous. Also, it is the most subtle, the most insidious, the most mysterious of mental accidents. A draftsman may, and generally does, have the correct figure in his mind when he essays to put it down. Somewhere between the act of dipping his pen in the ink and that of setting his hand to the tracing, to establish for all time that figure on the drawing—Sip!—something happens, the mental figure backs up and without reason becomes something else. The mistake is made.

The Results of Draftsmen's Mistakes

Results are far reaching. If the draftsman does not detect his mistake when checking his work finally before handing it over to the regular checker—and every draftsman ought to do that—and if the regular checker also fails to catch the error, the thing then rests calmly and easefully in the laps of the gods. Usually these gods take form in the shape of a frowning man in overalls and jumper, with a steel rule in one hand and a pair of calipers in the other. Then, once more, the draftsman is dragged over the coals, if not actually fired—all depending upon the seriousness of the loss. Once more, the old, old strife is given fresh impetus. Nor can anything be said in excuse for the draftsman who makes a mistake in figures, save that he is human and that for every error he registers he also registers a hundred successes and that, finally, all he has to guide him is his hand and his eyes—never a jig nor a gage nor an automatic machine built to reduce mistakes to a minimum. That long-heralded mistake-preventing drafting machine has not as yet made its eagerly expected appearance. When it comes, draftsmen will all gladly heave a horse sigh of relief.

A body of sensitive men, as a rule conscientious, always alert, quick as an aspen to sense complaint, ever striving toward perfection in their work—draftsmen, I do solemnly say, state and declare, are the nerves of the manufacturing business. Inventors and engineers, granted, are the soul; mechanics, the body of the organization. The nerves of our own bodies seem to lie halfway between soul and body and do verily form that mystic connecting link between them. Draftsmen, from the nature of their work, together with their location in the plant, are the veritable nerves of the organization. Any physician will tell you to conserve your nerves as much as possible. Any observer aware of the true conditions in the manufacturing world today will tell you, for the good both of the body of your organization and the soul, to conserve your draftsmen. That, among other things, means to cut out the shop strife—all sources of irritation—even as a skilled surgeon, remembering his first law, will remove the cause.

I remember holding a position at one time in a small experimental shop in New York. I was the sole draftsman. Up to the time of my coming, all drafting, if one could call it that, had been done by the foreman of the shop—a big, flat-footed mechanic, quick as lightning in his opinions and with a temper as hot. My coming evidently worried him. He had been having his own way for years; had taken his instructions from the engineers, with a piece of chalk on the bench; had then gone ahead in his own way and gotten the machine out as he deemed best—barring certain firm instructions from the engineers, who themselves were practical men with but little knowledge of drafting or its principles.

I sent out my first design. Almost immediately there came a howl from the shop. I was wanted by the flat-footed foreman. I went. He wanted to make some changes. This was wrong, that could be lighter, and the other thing could be made easier. The interview resolved itself into a verbal scrap, with the engineers attentive and interested referees. We finally compromised, and the machine was made according to drawing. But from that day to the day I left, that man was my bitterest enemy. Why? For two very clear reasons: One was that his pride had been hurt. The other was that my way of making things often made his work more difficult. Yet my way in the end saved the company thousands of dollars—because I did not grope, in designing the machine, for the easiest way of making the parts. What I sought in making the parts was the cheapest way consistent with a few well-known principles—and one of them was attainable materials. The foreman had been making his parts out of stock on hand; lacking one thing, he would calmly use the next nearest at hand, regardless of its suitability for some other and more important part.

The incident was one more added to my collection of the strifes that existed—and still exist—between draftsmen and machinists. Because neither side understands the other, or is trying to understand the other, the end is not yet.

A Recent Report of Brig.-Gen. Henry G. Sharpe in regard to the recent mobilization along the Mexican border contains some interesting facts. It will be remembered that there was considerable criticism because Pullman cars were not furnished for all the troops, but this would have required about five times as many Pullman cars as there are in existence. During the entire troop movement there was only one accident, and this was not serious.

Cutting Round Bar Stock on a Punch Press

By Edward L. Robenolt

This fixture shown was designed for use on a P-4 Ferracute punch press for cutting roller bearing rods. The fixture was driven from a small pulley on the countershaft and, as the drawing shows, was designed to take four bars at once, which means four finished pieces for each stroke of the punch press. The details of shearing dies and guide bushings are for $\frac{5}{16}$-in. bar stock, but the device can be used for other sizes.

The fixture is not an expensive one to make up and is not greatly subject to wear. It will produce a large amount of work—from 240 to 280 finished pieces a minute—at a small operating expense. If the size of the punch press admits, the fixture may be arranged to take a larger number of bars than the one here shown in detail, and in this case the output will be proportionately larger.

The fixture should be driven just fast enough to insure all bars being up to the stop before being cut. The springs shown are to give friction on the rollers, which slide on the bars. After the bars have reached the stop, they are held until the press is on the upstroke, when the bars are again free to feed forward. The shearing dies, which are the only parts that require much renewing, are easily made.

The press can be run from 60 to 70 strokes per minute, depending on how quickly the bars slide forward.

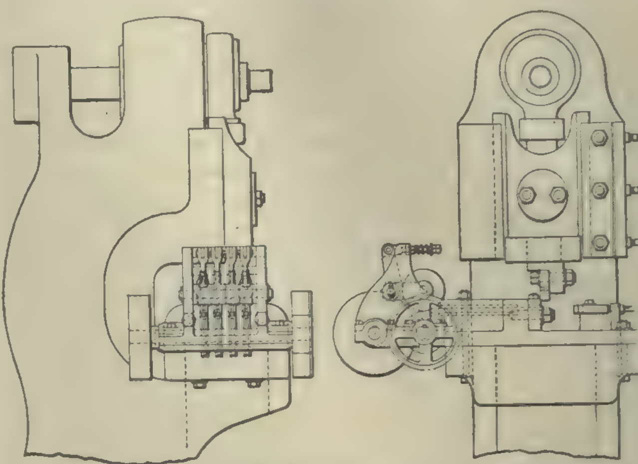


FIG. 1. FIXTURE FOR CUTTING BAR STOCK

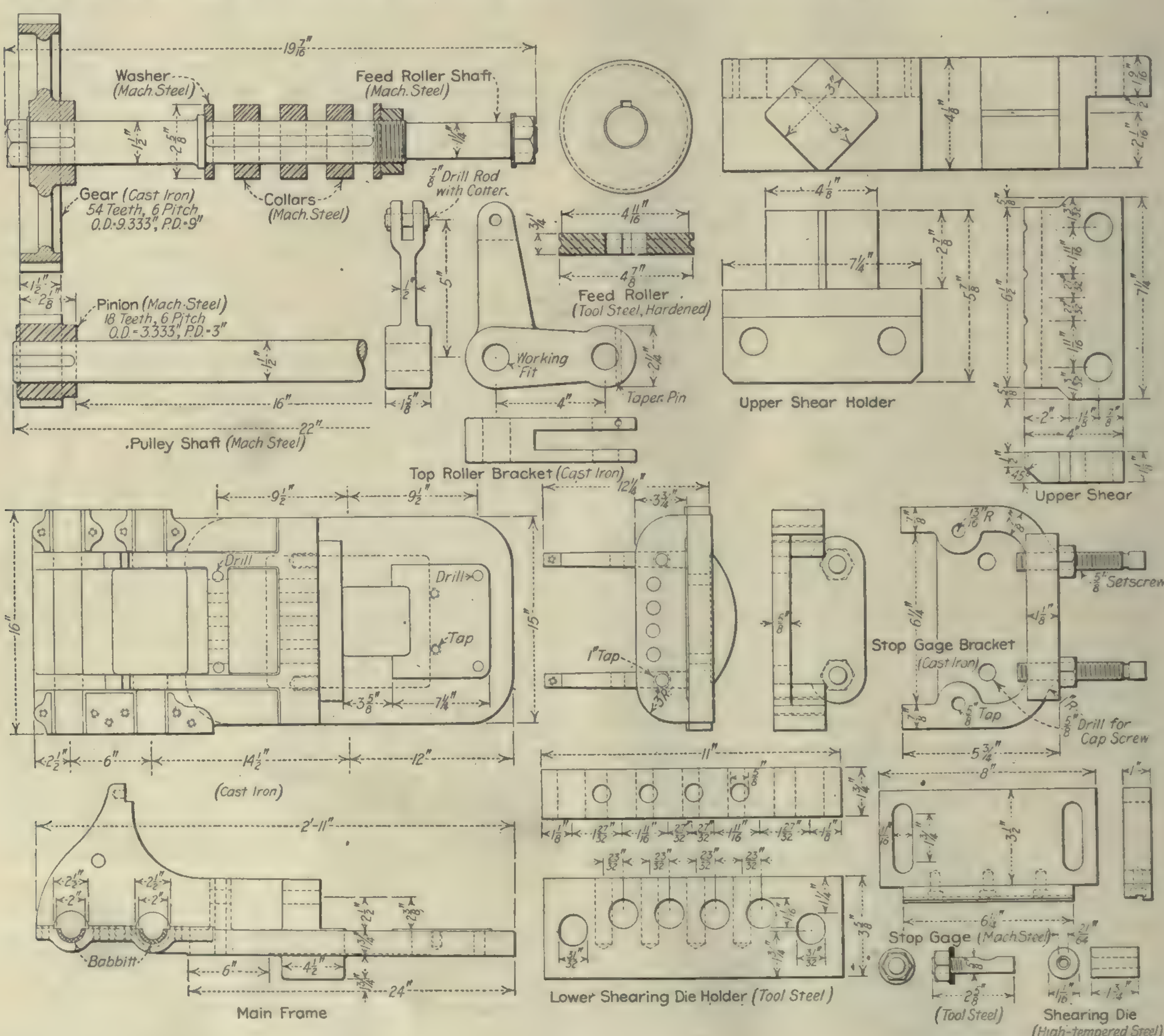


FIG. 2. DETAILS OF A FIXTURE FOR CUTTING ROUND BAR STOCK ON A PUNCH PRESS

Can Profits Be Shared?

By Entropy

SYNOPSIS—Some of the problems to be met in considering the plans of increasing the interest of men in the shop by dividing a portion of the earnings with them. Frequent divisions desirable to hold interest. Who shall share and how shall each receive his just proportion?

When I was a small boy, my father took me on a trip into the backwoods of Vermont. We saw a man driving a horse over whose head had been rigged a fishpole. From the end of the fishpole there dangled a bunch of hay that was just out of reach. The idea, apparently, was to entice the horse out of a slow walk by the lure of the hay. As I remember it, the results were not satisfactory. The horse may have tried, but by the time we saw it, it had given up the chase.

Profit sharing is one of those perfectly obvious things that seem sound in principle but which do not seem to work out any better in practice than the bunch of hay. Every man who works for a concern that is making large profits would like a share. If he gets it, he is likely to find that what looks like a large sum in one heap looks diminutive when divided by the number who have helped to pile it up. The employer who is making large profits feels that if by dividing a portion of them among his employees he can keep them with him for long periods, it will pay increased dividends that will more than compensate for his apparent generosity. Pure altruism gives the whole plant to the employees plus the guiding brain that makes its success possible, but it is not business.

There are a number of things which must be faced in starting any scheme of profit sharing that usually do not receive the attention they later demand. One of these is that any system to succeed must be workable through all sorts of conditions. It should be as applicable to a new concern as to one that has already piled up a surplus. That is, the men who share the profits must have no guarantee of their amount. The firm that offers as a bonus a percentage of the pay that a man has received is not sharing profits, it is raising wages. Wages once raised become a right in the minds of the workers, and it is dangerous to cut them.

Profit sharing, then, must be on the basis of a division of a certain definite proportion of the profits earned during a given period. If there is a lean year and no profit is made, the stockholders may be paid out of the accumulated surplus; but if employees are paid, it is merely a loan against the future earnings, not a legitimate share of the profits. It is better that everyone should know and feel the fact that the company is not making money, if it is not. That is the real value of profit sharing, to make men see that profits depend on them; therefore, profits should be figured as often as possible—at least once a month—even if they are not paid as often as that. The fact that employees are not in business for themselves implies in many cases that they have not the far-sightedness or the thrift that keeps a man content to wait for deferred payments. They want it now. In states where weekly payments of wages are made, and the option is given of having weekly or monthly payments, it is surprising how far up the line men prefer weekly payments.

Frequent division of profits means more bookkeeping than if the division were only required annually. That costs money, but it is a growing custom that pays in other ways in many industries. The actual physical inventory that is necessary may be taken only once a year, but a perpetual inventory is almost a present day necessity.

Once the decision has been made to divide a proportion of the actual net profits among the workmen, and to do it at frequent intervals so as to keep up the interest, the next thing is to decide who is to share them. It is customary to limit the participants to those that have been in the employ of the company at least six months or a year, or longer, according to the taste of the individual that is making the plans. It is also customary to limit the division to those that the management suspects of being able to understand it. One thing seldom done is to divide according to the effort that men have made to create profits. The drone gets as much as the worker, except so far as his laziness has been discounted in the rate of pay offered. This is wrong, but it is the easiest way.

In an ordinary corporation all that the stockholders usually put in is money, or its equivalent. The earning power of one dollar is very much like the earning power of another. If one of the stockholders works for the company, he goes on the pay roll. He then draws money in a dual way, part as interest and reward for risk on the money that he has put in and part for services rendered. If he does not earn the latter, his colleagues freeze him out and hire some one who can.

But in present day shops a man's fellow workmen have no voice in judging his value, and have no influence, at least legitimately, on his leaving. The consequence is that if a workman is at all good at covering his tracks he can stay on and on and under any of the common profit-sharing systems draw as much money as the next man. Distribution according to piecework earnings is also dangerous, for even when drawing large wages a man may be working against the real interest of the company. It is oftentimes necessary that some work in a shop be done at a loss in order that a greater profit may be made elsewhere, so it is necessary that the basis of profit sharing shall be one that takes into consideration, not merely the rates received by the individual, but also the attitude he has taken toward the business as a whole. It is therefore necessary that there shall be a rating of men that shall be somewhat independent of the actual wage rate.

Who Shall Share the Profits?

Who shall be made sharers of profits? Not the yard laborer who comes today and throws down his shovel tomorrow? Certainly not! Most assuredly, the men higher up in the organization—heads of departments and others who are potential competitors. But these are the very men whose nature demands that they shall work with their best efforts. They do not need this spur, and if opportunity comes to them to connect with some com-

petitor, they will weigh advantages carefully and with their eyes wide open to the difference between a steady salary guaranteed by a responsible house and the questionable advantage of sharing profits with others, whom they may not recognize as their equals.

The men to whom this system should make the greatest appeal are those a little farther down the line in the organization, the men whose training has cost the company a considerable sum, yet who can and will leave to work for a competitor for a small increase in wages. These are the machinists and the better grade workmen in other industries. They are not always well educated and are suspicious of every such move on the part of their employer. If the latter attempts to make his profit-sharing scheme appear to be in any part philanthropy, they will surely sense an attempt at exploitation. Put before this type of worker in its true light, as an inducement for him to stick to his job, it will hold him only after he has seen that his predecessors have received what he considers fair treatment.

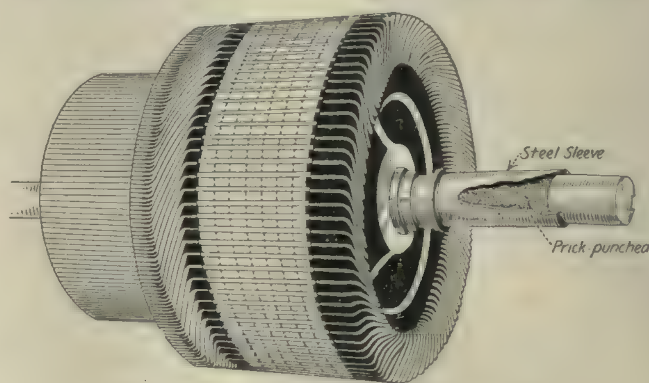
The greatest difficulty of all, and the one ever present, is that few businesses pay large profits. By profit I mean net earnings after allowing the stockholders the going rate of interest on their money and a reasonable additional dividend to cover insurance against loss, and also allowing for reasonable salaries to the executives. There are many apparently prosperous businesses that are owned by the manager, whose combined drawing account and dividends do not amount to what he could easily command as a salary. He thinks he is independent and will declare that he never would submit to the exactions of a superior, while as a matter of fact he is daily submitting to more dictation from customers, the people from whom he buys on credit, and his bankers, than he would find as a subordinate in a larger concern. If profit sharing became prevalent, and was appreciated by the men themselves, it would be difficult for non-sharing concerns to hire men at all; and the latter would be forced out of business. However, any method of handling business that would make for stronger and safer credit would be to the advantage of every one.

Schemes providing for the purchase of stock are not strictly profit sharing. They merely offer to employees certain advantages in the way of investment. They do nothing to increase the staying qualities of the employee, for they either have strings attached so that the employee resells his stock to the company if he leaves, or else the stock purchased is such a minute share of the whole issue that it would be futile for the holder to attend a stockholders' meeting. The ordinary purchaser of small amounts of stock buys as an investment, usually at some one's recommendation, and lays away the certificate. He knows nothing and cares less about the management, unless the time comes for a reorganization, in which case he simply hands his stock over to a committee and takes what is given him in return. In other words, he takes no further interest and has no more say in the management than if he had no financial interest in the concern.

True profit sharing should be a taking of the employee into the company on a basis of partnership. Some believe that the old relationship of master and servant has outlived its usefulness. They would put every man they could into business for himself as one of a large number of coöperators, each drawing a fair share of the profits of the company. Whether this can be done while the wage system is still in vogue is hard to tell. The wage becomes a sort of advance payment made to the workman as a matter of convenience to him, and as a portion of his share of the profits that it is reasonably likely will be forthcoming. Such a view of the matter would require a complete overhauling of our ideas of the relations between employer and employee, so as to place this relation on a basis of mutual trust.

Repairing an Old Motor Shaft

It being impossible to buy a new 10-hp. 110-volt direct-current motor and obtain an immediate delivery, a second-hand motor of the same size was purchased. This old machine was in pretty bad condition; both bearings and the shaft at the pulley end were badly worn. If the



HOW WORN SHAFT WAS REPAIRED

part of the shaft in the bearing had been made larger than in the pulley, it could have been turned to a smaller diameter and the bearing bushed and reamed to fit it. However, the bore of the bearing and pulley were of the same size; therefore, if the shaft was turned to a new surface, it would have to be turned the entire length, as the bearing was of the one-piece type. This would require the pulley to be bushed, weakening the shaft, which was not any too strong to start with. The method of overcoming this condition was as follows: A piece of machinery steel ⅜ in. larger in diameter and ½ in. longer than the bearing was reamed to a slightly smaller diameter than the shaft. The worn part of the shaft where this sleeve was to fit was prick-punched around the small part, as shown in the figure, and the sleeve was heated and forced into place by a hand press. The sleeve was then turned down until it was ⅛ in. larger than the original shaft. This permitted the old bearing to be used by reboring and reaming. The bearing for the commutator end was bored out and a bronze bushing forced in. To make sure that it would not work loose, the bushing was soldered in place with an all-tin solder, then bored and reamed.—R. L. Hervey in *Power*.

Automobiles Prohibited

From Jan. 1, 1917, the importation into India of foreign automobiles, motorcycles and parts thereof is prohibited.

It is understood that this prohibition is occasioned by the shortage of gasoline in British India and that no shipment exported from the United States or other foreign country after Jan. 1 will be admitted.

United States Munitions*

The Springfield Model 1903 Service Rifle

Extractor—II; Extractor Collar, Ejector and Ejector Pin

SYNOPSIS—This article completes the extractor, which is a rather bothersome piece to handle, and also shows the various operations on the extractor collar, the ejector and the pin which holds it in place. These are all comparatively simple operations but require considerable care. They involve the use of a number of machines, mostly small except for the forging and grinding.

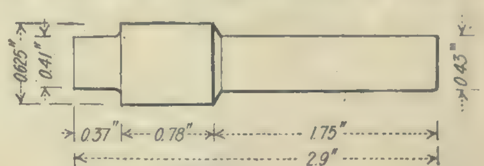
The long, thin shape of the extractor makes it a difficult piece to hold as the sides are quite narrow and do not give a good surface for gripping in the special vise jaws provided. The difficulty is overcome, however, by so designing the jigs and holding fixtures that the piece is held in place against proper supports which prevent springing or side slipping. Being so held, with reference to the portion of the extractor which bears against the bolt body, the machining is done accurately and rapidly and the various operations are performed in their proper sequence.

A good example of one of these operations is seen in Fig. 1021 where the extractor is being held while the upper end is beveled with the cutter shown. Then come the milling and profiling, in Figs. 1030, 1034 and 1039, thus completing the recess for the ears of the extractor collar. The thread transformation, Figs. 1029, 1033 and 1038, shows just how this undercutting is worked out.

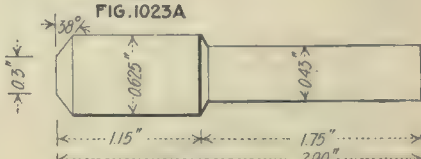
The position of this slot with relation to the fit on the bolt body is very neatly measured by means of the gage in Fig. 1041-A. Here the button *A*, which fits into the slot easily, is controlled by the micrometer screw with the graduated dial *B*. Moving this screw measures the bottom and top of the slot, the readings being easily taken from the position of the pointer against the dial.

The width and thickness of the slot are gaged by the two button gages shown in Fig. 1041-B, the larger-diameter button being the thinner and the thick button the smallest.

FIG. 1020



6 Teeth
FIG. 1023A



8 Teeth, R.H.
FIG. 1023B

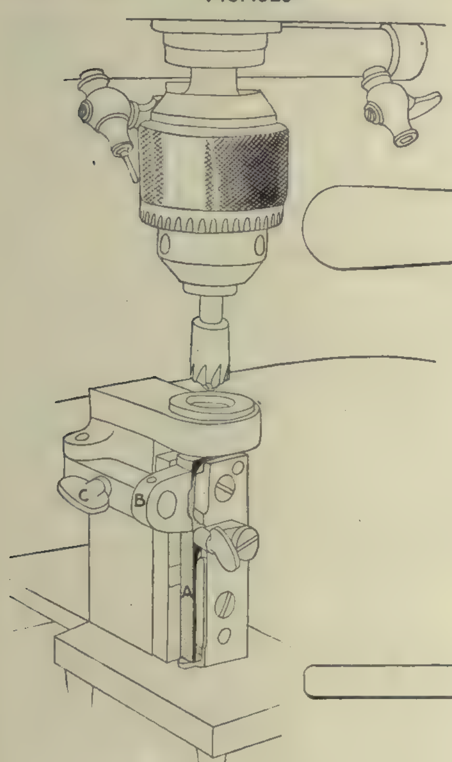


FIG. 1021

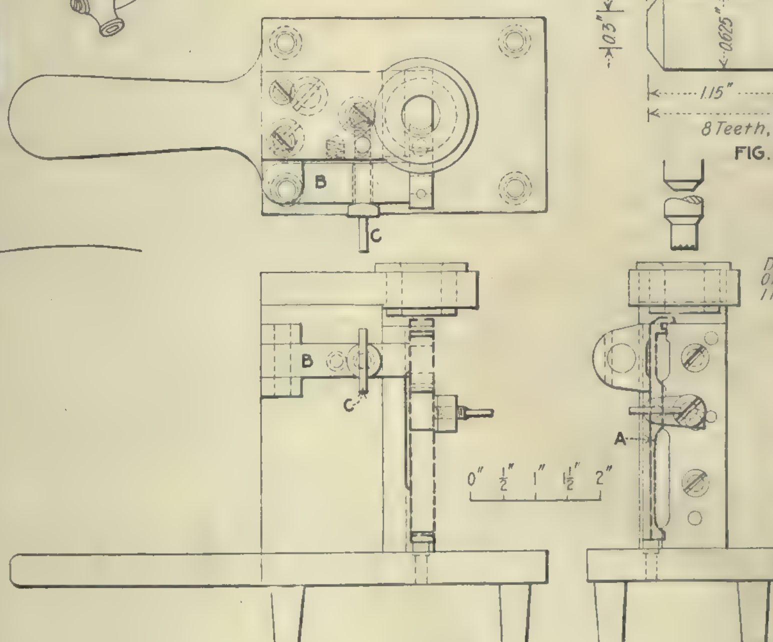


FIG. 1022

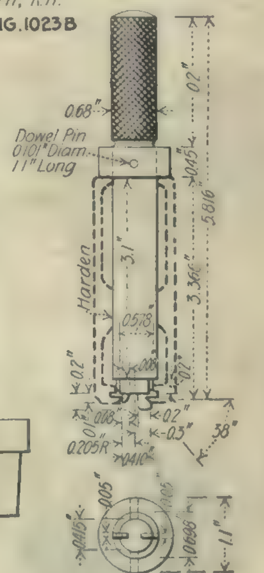


FIG. 1024

OPERATION 16

OPERATION 16. JIG-MILLING HOOK AND BEVELS, FRONT END

Transformation—Fig. 1020. Machine Used—Dwight-Slate 16-in. three-spindle upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1021; details in Fig. 1022; work A is held by clamp B and thumbscrew C. Tool-Holding Devices—Drill chuck. Cutting Tools—Milling cutter, Fig. 1023; A, for hook; B, for front-end bevel. Number of Cuts—Two. Cut Data—250 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{8}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1024, contour and position. Production—80 per hr.

OPERATION 19. PROFILING CORNERS OF HOOK

Transformation—Fig. 1025. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Clamped to form upright position, Fig. 1026; details in Fig. 1027. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1028. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—None. Production—400 per hr.

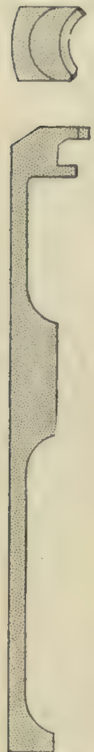


FIG. 1025

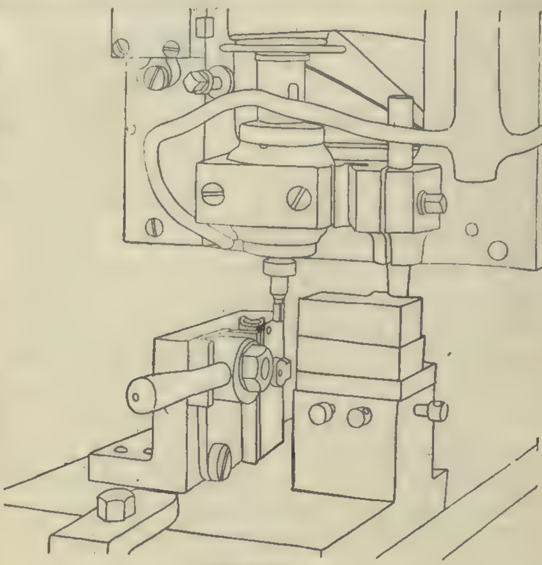


FIG. 1026

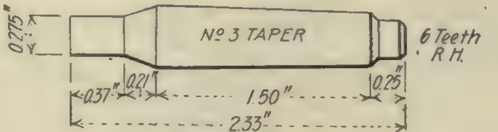


FIG. 1028

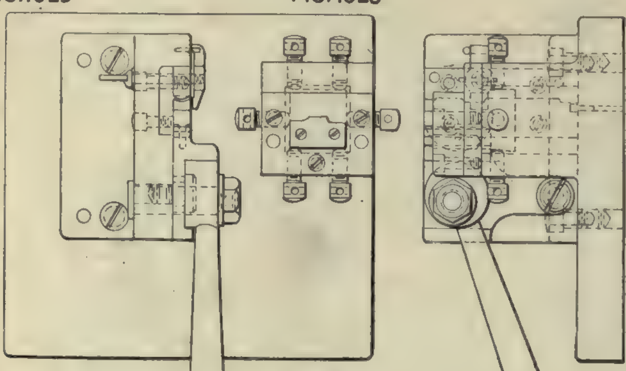


FIG. 1027

OPERATION 19


FIG. 1029

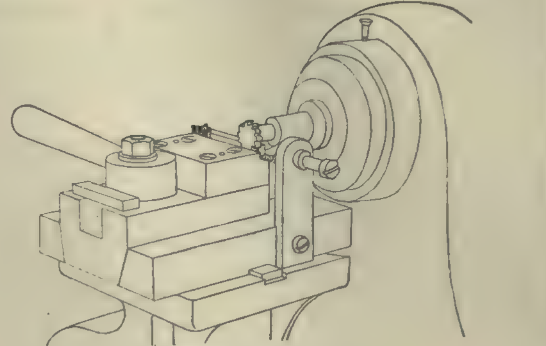


FIG. 1030

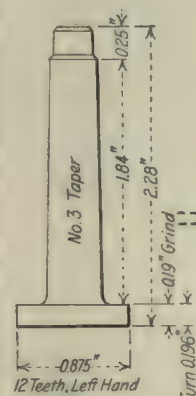
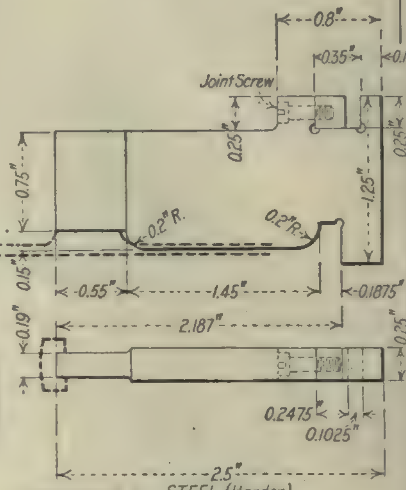


FIG. 1031



OPERATION 8

FIG. 1032

OPERATION 8. HAND-MILLING LUG SLOT, ROUGH

Transformation—Fig. 1029. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Work pushed to stop, clamped by vise jaws, Fig. 1030. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1031. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream.


FIG. 1033

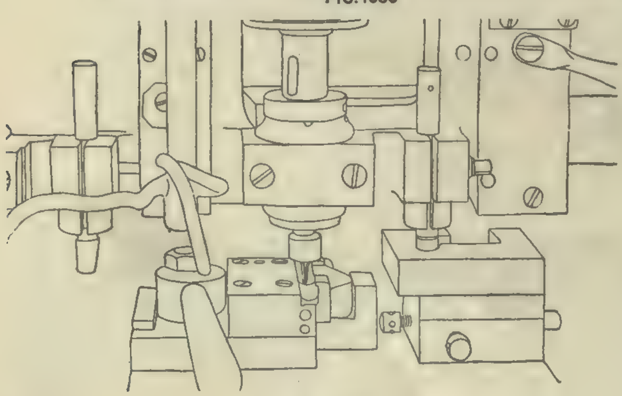


FIG. 1034

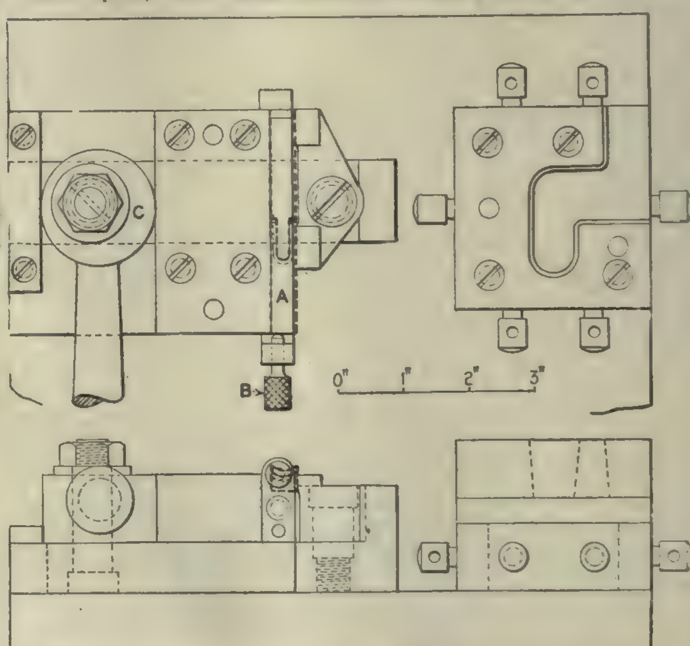


FIG. 1035

Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 1032, width of slot. Production—175 per hr.

OPERATION 9. PROFILING LUG SLOT TO FINISH

Transformation—Fig. 1033. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Work pushed against stop and clamped by vise jaws, Fig. 1034; Fig. 1035 shows details; work A is positioned by screw B and clamped by cam C. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1036. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1037, width and position of slot. Production—50 per hr.

Work-Holding Devices—Vise jaws with stop at forward end, Fig. 1039. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1040. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1041; A, micrometer; point A fits slot; dial B registers against stop C; B, go and not go for slot; C slides in slot. Production—40 per hr.

OPERATION 26. REAMING GAS HOLE

Machine Used—Bench lathe. Number of Operators per Machine—One. Work-Holding Devices—Held in hands. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer. Gages—None. Production—Grouped with operation 28.

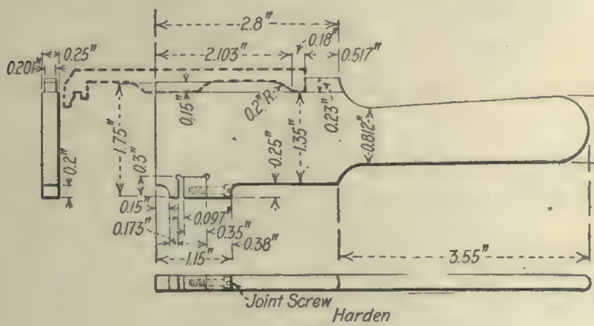


FIG. 1037

OPERATION 9

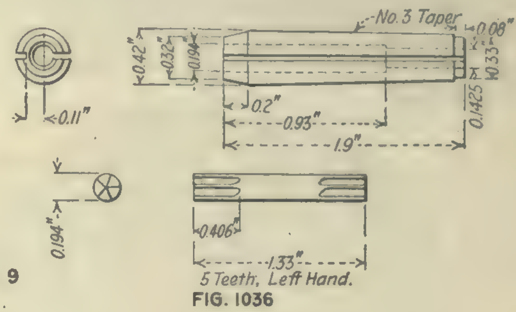


FIG. 1036

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 9

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 9. Apparatus and Equipment Used—File. Production—Grouped with operation 9.

OPERATION 10. PROFILING LUG SLOT, UNDERCUT

Transformation—Fig. 1038. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One.

OPERATION 27. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Brushing up and filing of corners. Apparatus and Equipment Used—File. Production—35 per hr.

OPERATION 28. BENDING FOR TENSION

Transformation—Fig. 1042. Number of Operators—One. Description of Operation—Making a little bend for tension. Apparatus and Equipment Used—Special vise, Fig. 1043. Production—350 per hr.

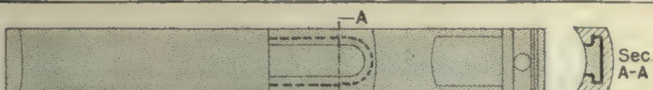


FIG. 1038

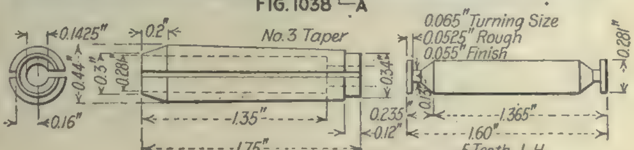


FIG. 1040

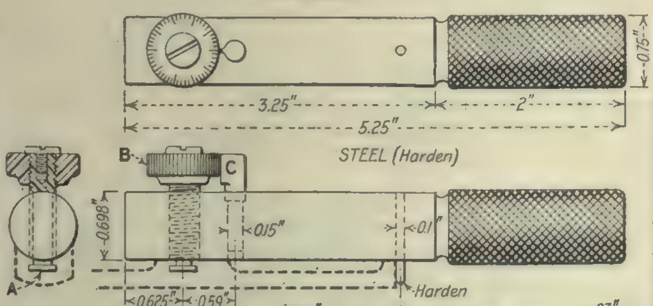


FIG. 1041 A

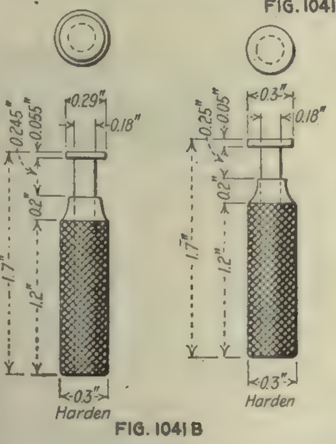


FIG. 1041 B

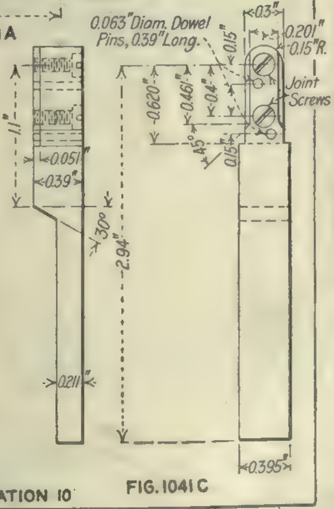


FIG. 1041 C

OPERATION 10

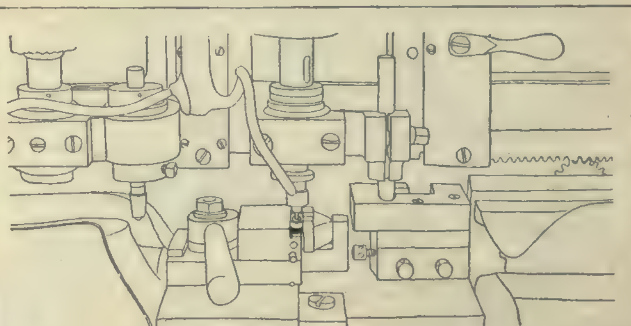


FIG. 1039

FIG. 1042

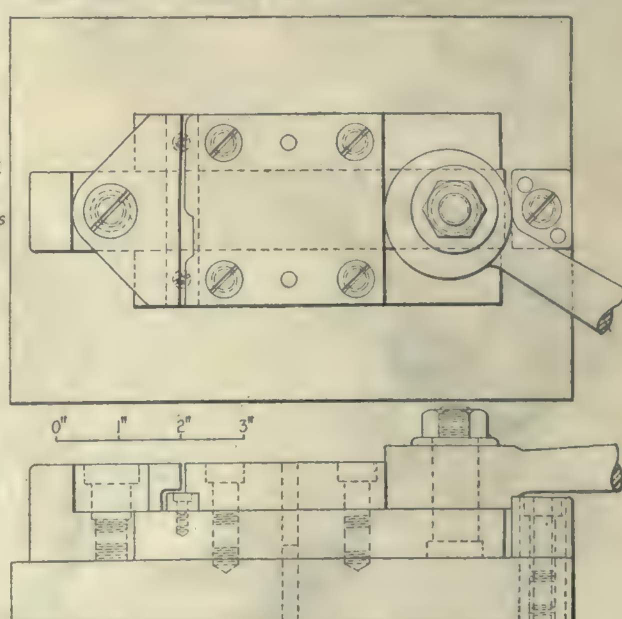


FIG. 1043

OPERATION 29. HARDENING AND TEMPERING

Number of Operators—One. Description of Operation—Heat in open oil fire to 1,450 deg. F.; temper drawn in lead bath to 900 deg. F. Apparatus and Equipment Used—Rockwell oil-burning furnaces, cast-iron pots for lead. Production—100 per hr. per fire.

OPERATION 30. STRAIGHTENING TO CORRECT TEMPERING

Number of Operators—One. Description of Operation—Bent by hand on lead block with brass hammer. Apparatus and Equipment Used—Lead block and brass hammer.

OPERATION 31. POLISHING OUTER SURFACE

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Polishing jack and wheel. Production—70 per hr.

OPERATION 32. BROWNING

Number of Operators—One. Description of Operation—Brown same as barrels. Apparatus and Equipment Used—Same as for barrels.

Extractor Collar

The extractor collar, shown in detail in Fig. 1044, fits around the bolt body and holds the extractor by means of the ears, permitting the bolt to turn while the extractor is held in its slot in the receiver. It is made of Class D steel 0.40 in. square and is drop-forged in single pieces. It is ground on each side, bored and milled on the outside to fit the bolt body and extractor. It is bent in position on the bolt in bolt operation 54 as was illustrated in Fig. 748. Its small size makes it difficult to hold and the fact that it must be finished all over adds to the difficulties of holding it for machining. This consists mostly of grinding and milling operations, with a liberal amount of burring.

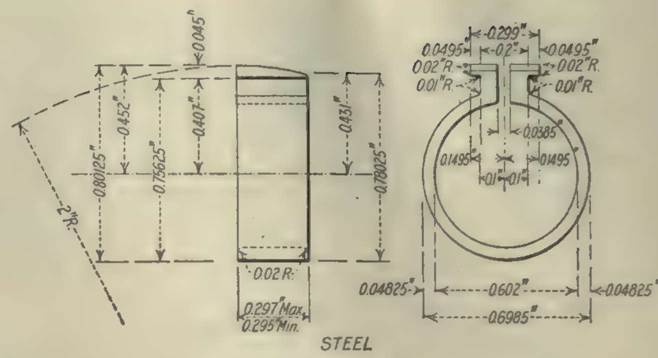


FIG. 1044

OPERATIONS ON THE EXTRACTOR COLLAR

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
1	Grinding front and rear ends
2	Drilling and reaming
AA	Countersinking both sides
4	Milling right side
CC	Removing burrs left by operation 4
5	Milling left side (operations 4, CC, 5 and DD are grouped)
DD	Removing burrs left by operation 5
6	Slotting
7	Spreading and filing inner corners of ears
8	Assembling with bolt

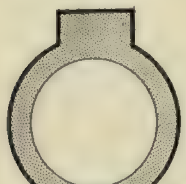


FIG. 1045

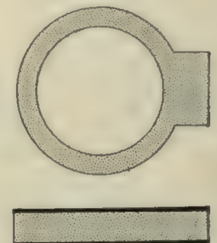


FIG. 1046

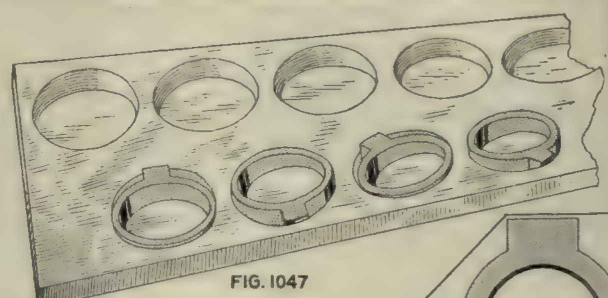


FIG. 1047

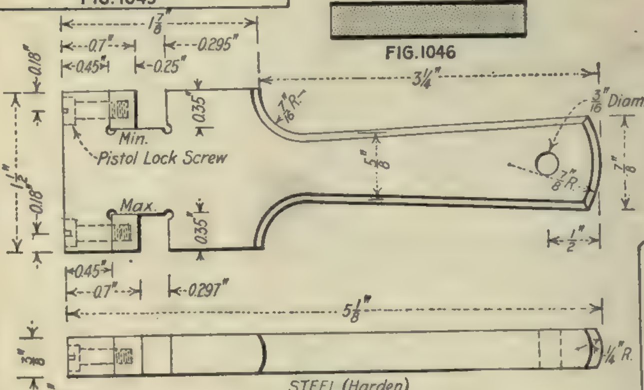


FIG. 1048
OPERATION 1

FIG. 1049

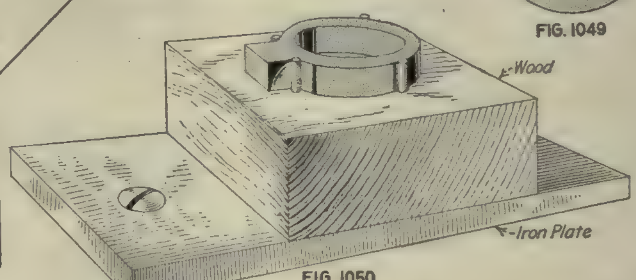


FIG. 1050

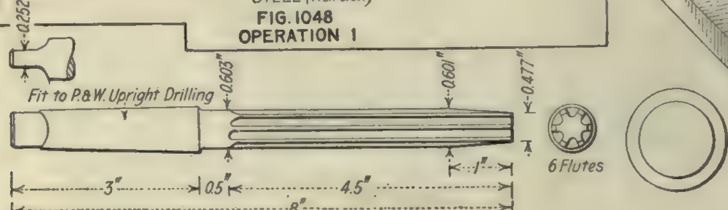


FIG. 1051

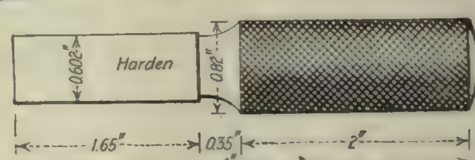


FIG. 1052

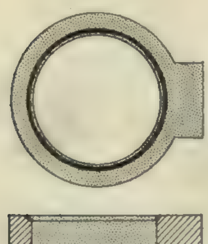


FIG. 1053

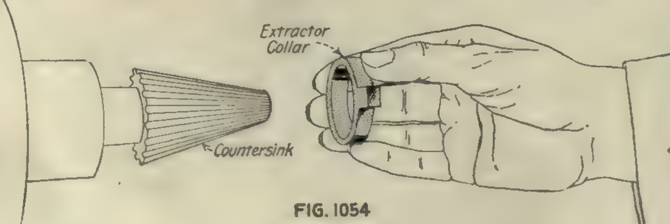


FIG. 1054
OPERATION 2

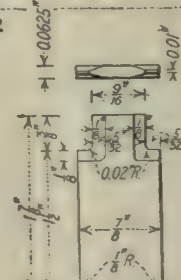


FIG. 1055

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1045. Number of Operators—One. Description of Operation—Blocking from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—200 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots with powdered charcoal and heated to 850 deg. C. (1,562 deg. F.); left overnight to cool. Apparatus and Equipment Used—Iron pots, powdered charcoal, Brown & Sharpe annealing furnaces.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and left in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water, for 10 or 12 min. Apparatus and Equipment Used—Wire baskets, pickling tanks (wooden) and pulley block.

Cut Data—350 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ⅛-in. stream. Gages—Fig. 1052. Production—30 per hr.

OPERATION AA. COUNTERSINKING BOTH SIDES

Transformation—Fig. 1053. Number of Operators—One. Description of Operation—Rounding corners on both sides of collar. Apparatus and Equipment Used—Speed lathe and countersink, Fig. 1054. Gages—Contour, Fig. 1055. Production—350 pieces per hr.

OPERATIONS 4 AND 5. MILLING RIGHT AND LEFT SIDES

Transformation—Fig. 1056. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—In stud clamped with vise jaws, Fig. 1057. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1058. Number of Cuts—Two. Cut Data—60 r.p.m; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 1059; A, inside and outside diameters; B, width of ears; C, width under ears. Production—35 per hr.

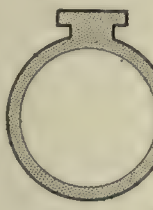


FIG. 1056

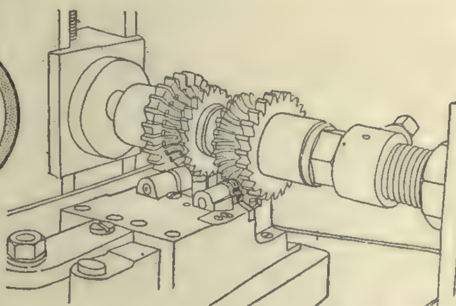


FIG. 1057

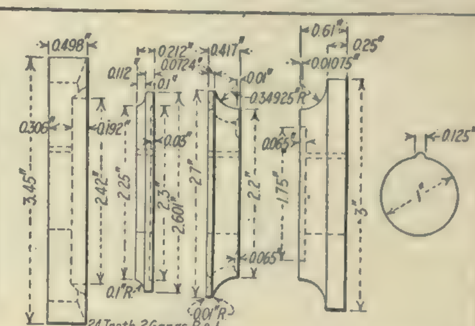


FIG. 1058

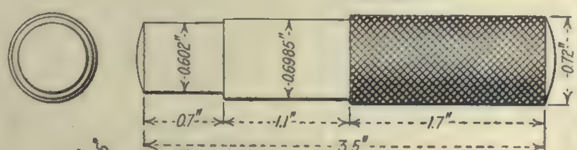


FIG. 1059 A

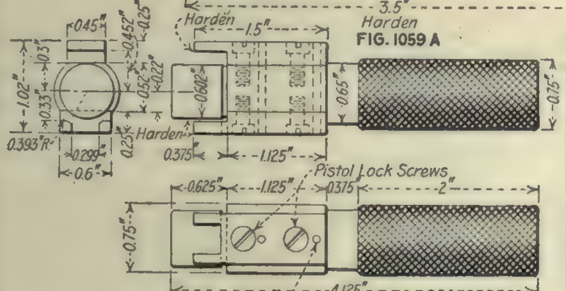
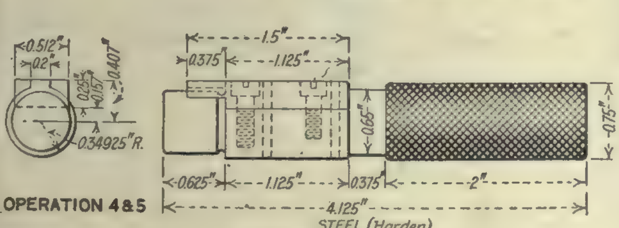


FIG. 1059 B



OPERATION 4 & 5

FIG. 1059 C

FIG. 1060

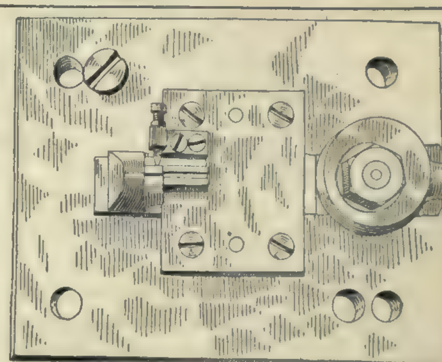


FIG. 1061

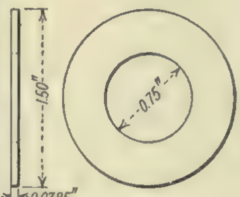
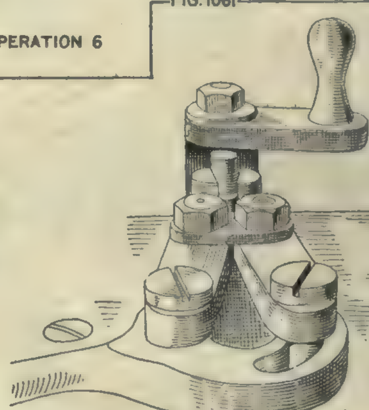


FIG. 1062

OPERATION 6

FIG. 1063



OPERATION 8

FIG. 1063 A

OPERATION C. TRIMMING

Machine Used—Bliss back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe, by setscrew. Stripping Mechanism—Punched down through die. Production—600 per hr.

OPERATION 1. GRINDING FRONT AND REAR ENDS

Transformation—Fig. 1046. Machine Used—Pratt & Whitney vertical grinder, 36-in. table. Number of Operators per Machine—One. Work-Holding Devices—Magnetic chuck, with frame to hold work Fig. 1047. Cutting Tools—Cup grinding wheel. Number of Cuts—20. Cut Data—1,500 r.p.m.; 15-in. per min. feed. Gages—Fig. 1048, thickness. Production—200 per hr.

OPERATION 2. DRILLING AND REAMING

Transformation—Fig. 1049. Machine Used—Pratt & Whitney automatic, 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—In jig clamped by finger clamp, Fig. 1050. Tool-Holding Devices—Taper shank. Cutting Tools—Fig. 1051. Number of Cuts—One.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operations 4 and 5.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operation 5.

OPERATION 6. SLOTTING

Transformation—Fig. 1060. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Work is held on stud and clamped by vise jaws; the stop locates work, Fig. 1061. Tool-Holding Devices—Taper shank. Cutting Tools—Slitting saw, Fig. 1062. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—500 pieces. Gages—None. Production—300 per hr.

OPERATION 7. SPREADING AND FILING INNER CORNERS OF EARS

Number of Operators—One. Description of Operation—Spreading collar for assembling with bolt. Apparatus and Equipment Used—Spreading fixture, Fig. 1063-A. Production—350 pieces per hr.

OPERATION 8. ASSEMBLING WITH BOLT

Transformation—Fig. 1063. Number of Operators—One. Description of Operation—Heated to a cherry red closed together on the bolt. Apparatus and Equipment Used—Furnace and fixture (see Fig. 748); Rockwell oil furnace.

Ejector

The ejector, as shown in detail in Fig. 1064, throws the cartridge case out of the receiver after it has been drawn back by the extractor. It is made of Class D material 0.26 in. square and is drop-forged to shape. It has three important points—the point *A*, the heel *B* and the pin hole *C*. It is hinged on the ejector pin in its recess on the left side of the receiver, ejection being accomplished by the slot lug of the bolt coming in contact with the heel when the bolt is drawn to the rear.

Although a small piece, its manufacture is even more difficult on that account as it is not an easy piece to handle. The dimensions and angles are held within very close limits as it plays an important part in a small space. It is rather difficult to hold for some of the operations but the hole, which is the first machining operation, serves for holding as well as for locating in subsequent operations. This hole is used in all future operations and is also the gaging point as can be seen by following the illustrations.

Milling the sides, as in Fig. 1078, is a case where the use of two cutters balances the thrust of one against the other and makes it much easier to hold the piece than if a single cutter were used.

Some of the gages and the way in which they are used are shown in Figs. 1076, 1080 and 1094, the pins being used to locate the piece in each case. Fig. 1075 shows how the gangs of cutters give the desired shape to both sides of the ejector and also insure the correct outline.

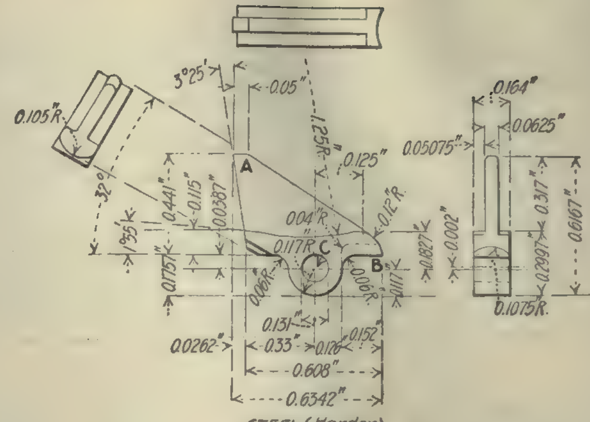


FIG. 1064

OPERATIONS ON EJECTOR

Operation	
A	Blanking
B	Pressing to thickness
B-1	Pickling
3	Drilling pin hole
4	Reaming pin hole
5 and 6	Milling edges; front, rear and both sides
7	Straddle-milling tongue
AA	Removing burrs left by operation 7 (operation BB occurs in operation CC)
9	Profiling right edge of tongue
10	Hand-milling left front corner
CC	Removing burrs from pin hole (reamer)
8	Jig-miller rear end
16	Reaming and countersinking ejector-pin hole
11	Polishing upper and lower sides of bearing and front end
18	Filing, general cornering
13	Casehardening

OPERATION A. BLANKING

Transformation—Fig. 1065. Machine Used—Perkins No. 19, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held by setscrew in shoe. Stripping Mechanism—Steel stripper screwed to face of die. Lubricant—Stock oil with cutting oil. Production—600 pieces per hr. Note—Blanking two at a time.

OPERATION B. PRESSING

Machine Used—Perkins No. 19, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Die plate screwed to shoe; shoe bolted to bed of press. Production—600 pieces per hr. Note—Pressing burrs and trying to straighten up corners.

FIG. 1065

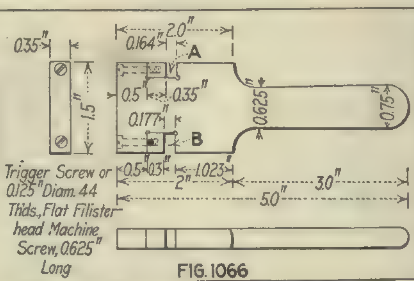


FIG. 1066

OPERATION A

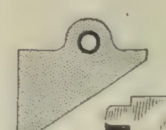


FIG. 1067

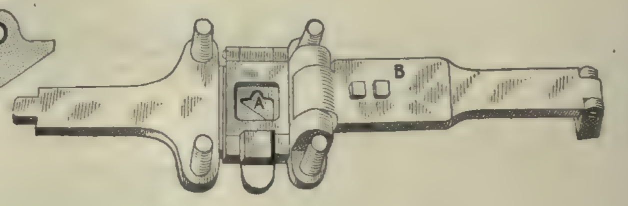


FIG. 1068

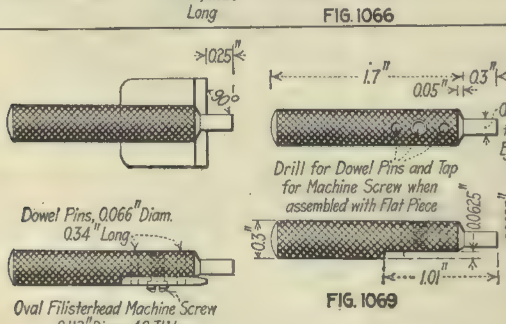
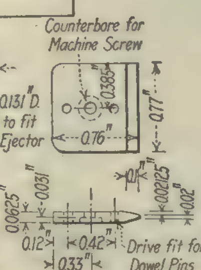


FIG. 1069



OPERATION 3

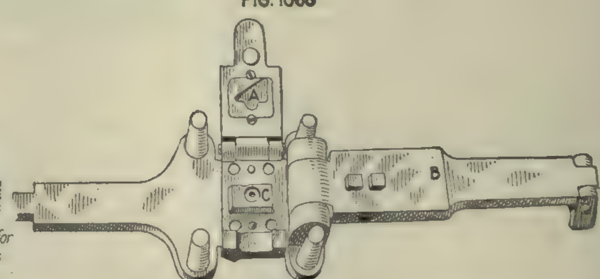


FIG. 1068-A

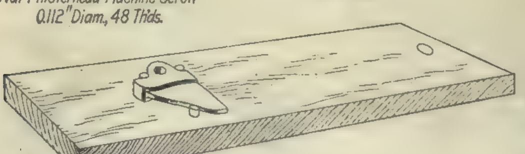


FIG. 1070

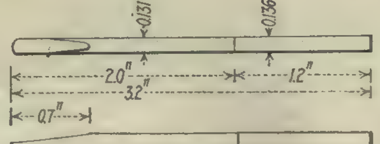


FIG. 1071

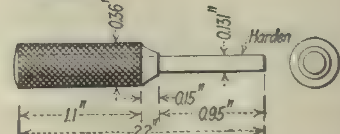


FIG. 1072

OPERATION 4

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Put into the pickling solution, consisting of 1 part sulphuric acid and 9 parts water, and left for 10 or 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and pulley block.

OPERATION 3. DRILLING PIN HOLE

Transformation—Fig. 1067. Machine Used—Sigourney Tool Co. three-spindle 12-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1068; work held in leaf A, which is locked in place by arm B; bushing at C. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—600 pieces. Gages—Fig. 1069, diameter of hole and location. Production—125 per hr.

OPERATION 4. REAMING PIN HOLE

Transformation—Same as Fig. 1067. Machine Used—Sigourney Tool Co. three-spindle 12-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Held in block, block held in hand, Fig. 1070. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer, Fig. 1071. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—600 pieces. Gages—Fig. 1072. Production—350 per hr.

OPERATIONS 5 AND 6. MILLING EDGES, FRONT. REAR AND BOTH SIDES

Transformation—Fig. 1073. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin clamped by vise jaws, Fig. 1074; this holds work in two positions, A and B. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 1075, gang of milling cutters. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1076; ejector fits over pin, and three slides A, B and C measure the three sides. Production 45 per hr. Note—Work held on pin.

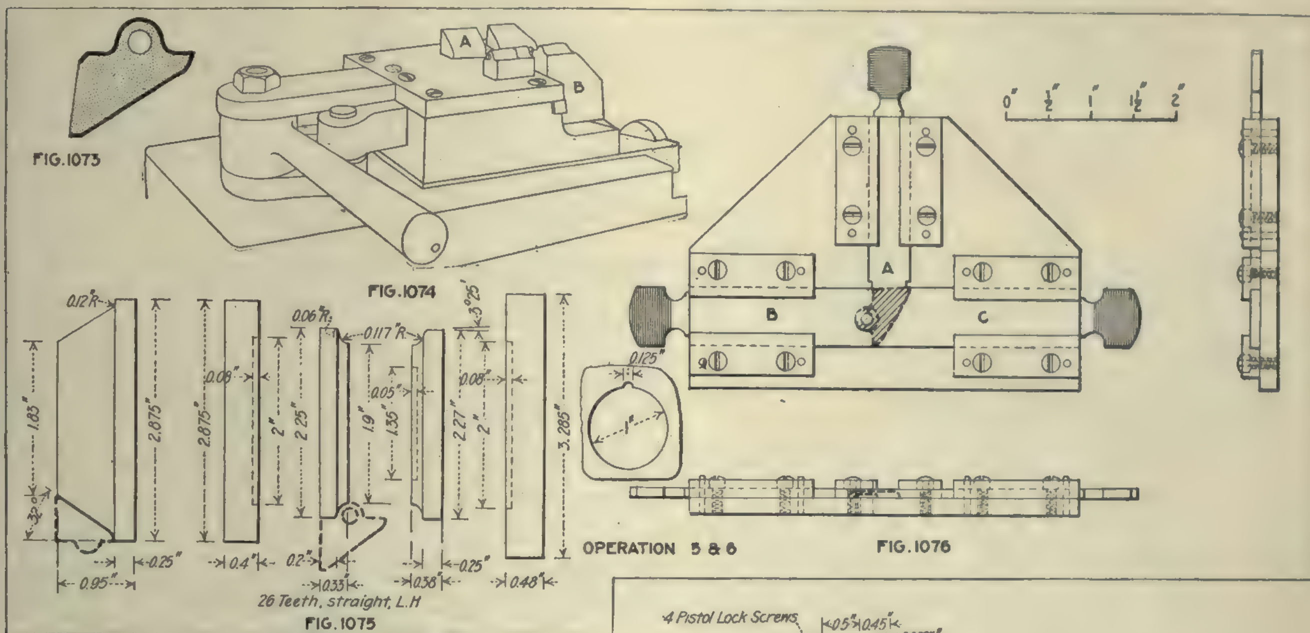


FIG. 1073 FIG. 1074 FIG. 1075 FIG. 1076

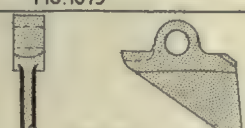


FIG. 1077

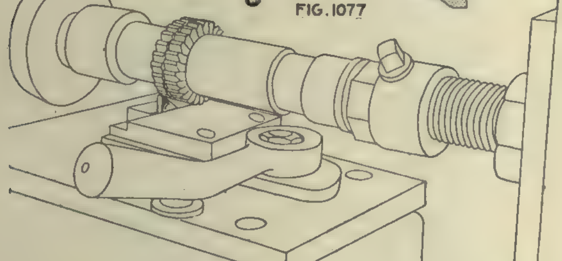


FIG. 1078

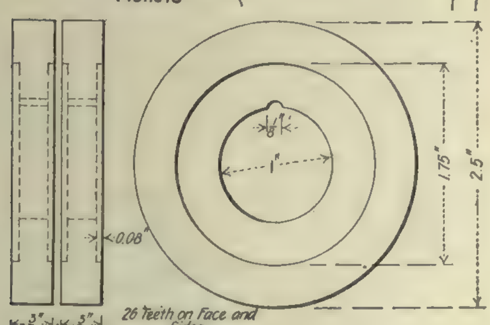


FIG. 1079

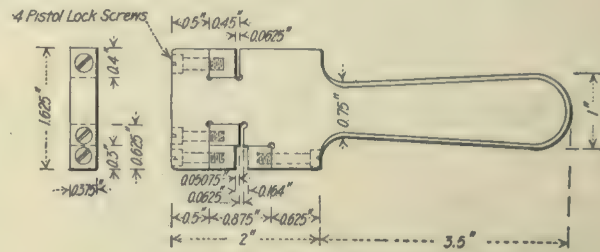


FIG. 1080A

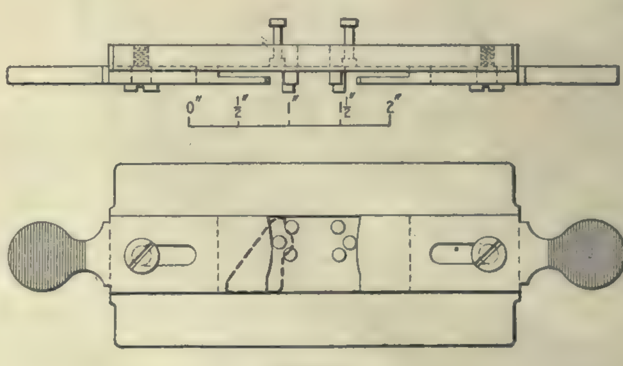


FIG. 1080B

OPERATION 7

OPERATION 7. STRADDLE-MILLING TONGUE

Transformation—Fig. 1077. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1078. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, Fig. 1079. Number of Cuts—One. Cut Data—80 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1080; A, width of tongue and body; B, radius of side of tongue. Production—40 per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7.

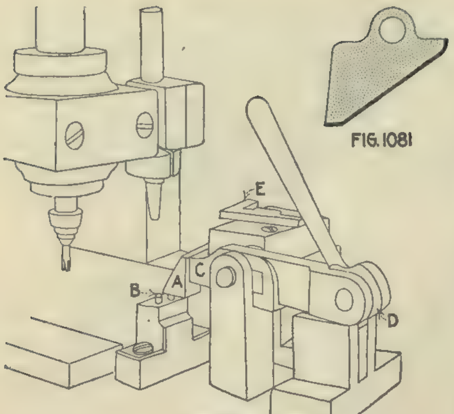


FIG. 1081

FIG. 1082

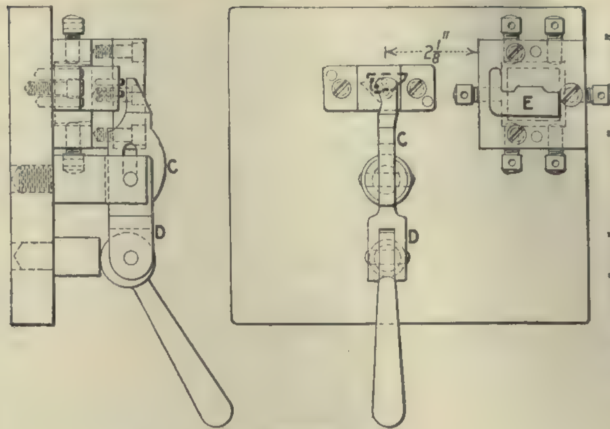


FIG. 1083

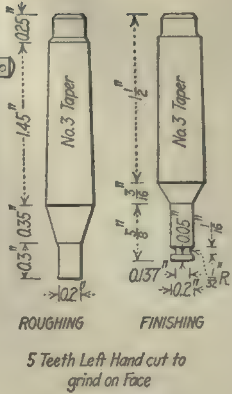


FIG. 1084

OPERATION 9

OPERATION 9. PROFILING RIGHT EDGE OF TONGUE

Transformation—Fig. 1081. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on pin clamped with finger clamp, Fig. 1082; details in Fig. 1083; work located on pin A against stop B; clamp C and cam D hold in place; profile form at E. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters, Fig. 1084. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1076, slide C. Production—80 per hr.

OPERATION 10. HAND-MILLING LEFT FRONT CORNER

Transformation—Fig. 1085. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 1086; details in Fig. 1087; corner A is rounded as fixture rotates; work held on pin B, located by stop C. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1088. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Finger gage, Fig. 1089; held on pin A, located by pin B; finger C swings over the work. Production—325 per hr.

OPERATION CC. REMOVING BURRS FROM PIN HOLE (REAMER)

Number of Operators—One. Description of Operation—Removing burrs and reaming hole squeezed together by fixture in operation 10. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operation 8.

OPERATION 8. JIG-MILLING REAR END

Transformation—Fig. 1090. Machine Used—Sigourney Tool Co. three-spindle 12-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1091; work A is held on pin B, and clamped by arm C; guide bushing at D; details in Fig. 1092. Tool-Holding Devices—Drill chuck. Cutting Tools—Milling cutter, Fig. 1093. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 1094, location of groove with relation to pin hole. Production—100 per hr.

OPERATION 16. REAMING AND COUNTERSINKING EJECTOR-PIN HOLE

Machine Used—Bench lathe. Number of Operators per Machine—One. Work-Holding Devices—In hand against the countersink. Tool-Holding Devices—In drill chuck in bench lathe. Cutting Tools—Fig. 1095, A and B. Cut Data—900 r.p.m. Coolant—None. Gages—Fig. 1096. Production—250 per hr.

OPERATION 11. POLISHING UPPER AND LOWER SIDES OF BEARING AND FRONT END

Number of Operators—One. Description of Operation—Polishing upper and lower sides of bearing and front end. Apparatus and Equipment Used—Polishing jack and wheel. Production—300 per hr.

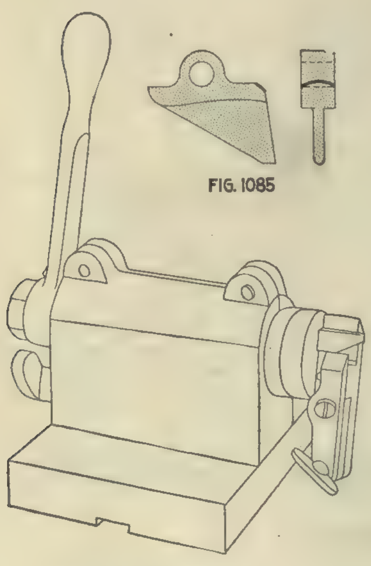
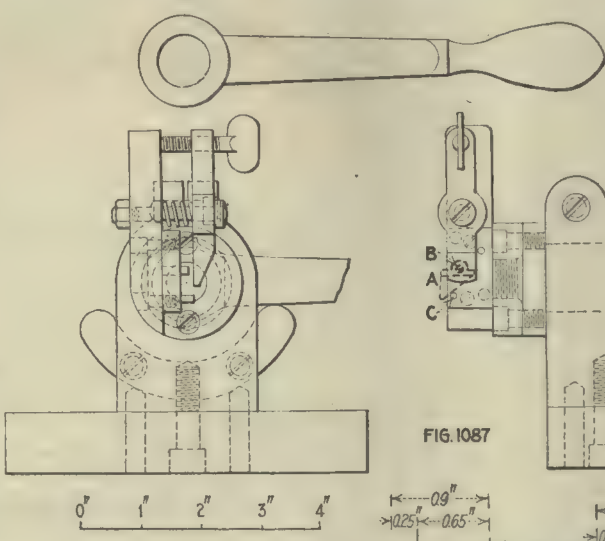


FIG. 1085

FIG. 1086



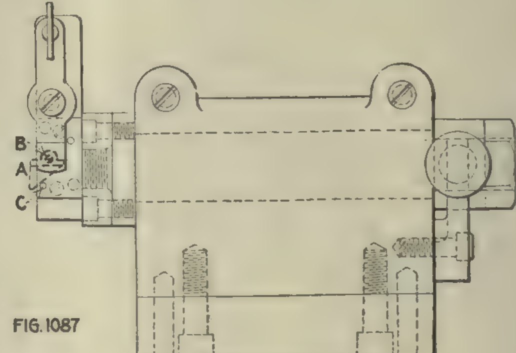


FIG. 1087

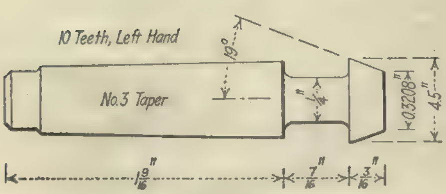


FIG. 1088

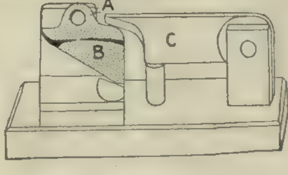


FIG. 1089

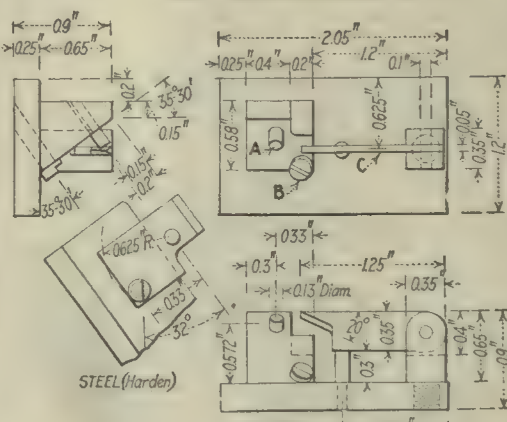


FIG. 1089

OPERATION 10

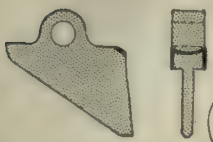


FIG. 1090

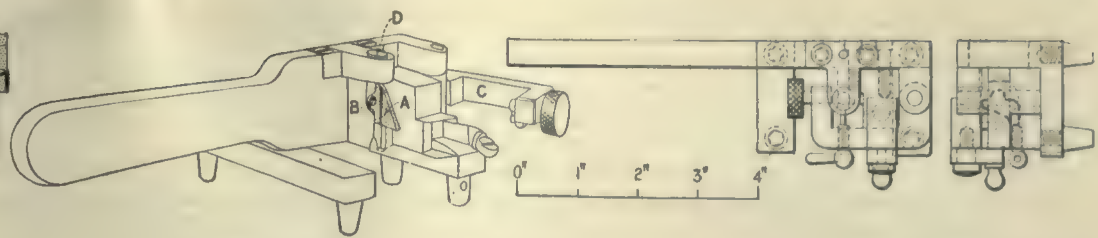


FIG. 1091

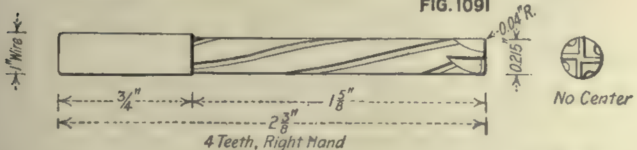


FIG. 1093

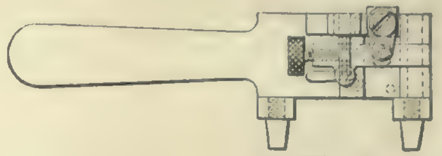
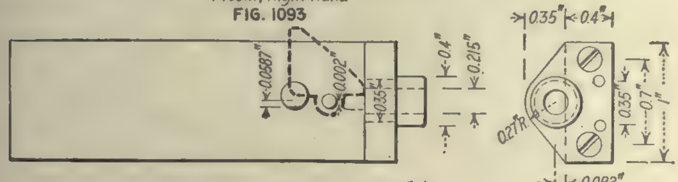


FIG. 1092



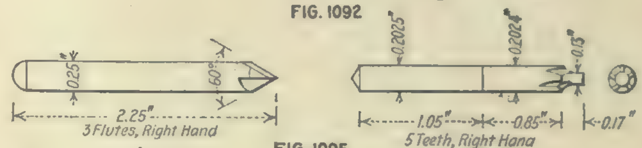


FIG. 1095

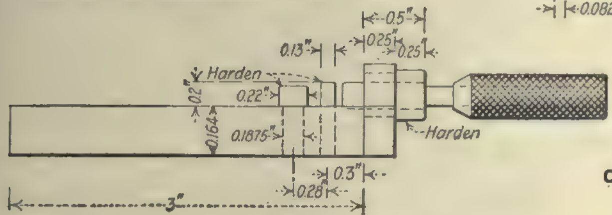


FIG. 1094

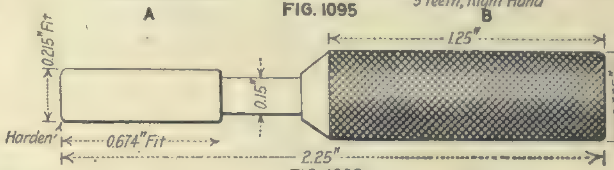


FIG. 1096

OPERATION 8

OPERATION 18. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—General filing and cornering. Apparatus and Equipment Used—File. Production—120 per hr.

OPERATION 13. CASEHARDENING

Number of Operators—One. Description of Operation—Caseharden in cyanide at 1,500 deg. F.; quench in oil. Apparatus and Equipment Used—Crucibles in oil-burning furnaces.

Ejector Pin

The ejector pin is an automatic-machine job and holds the ejector in place in the receiver. The head is slotted so as to be able to control the pin easily during the assembling, the head being spread to fit the hole tightly.

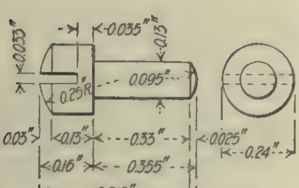


FIG. 1097

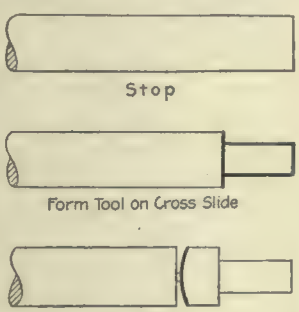


FIG. 1098

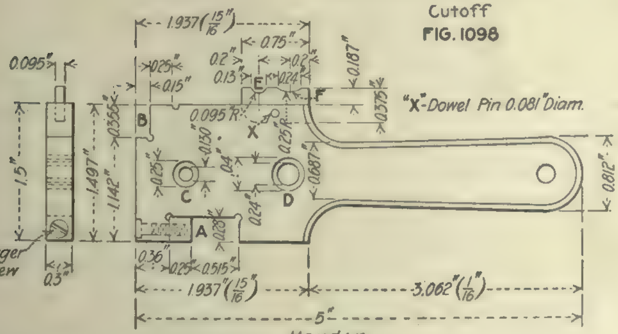


FIG. 1099

It is made of screw stock 0.245 in. in diameter and comes in 10-ft. lengths. The limit is —0.001 in. Full details are given in Figs. 1097, 1098 and 1099.

OPERATIONS ON THE EJECTOR PIN

Operation
1 Automatic
2 Slitting (hand and automatic)
3 Crowning
4 Spreading slot

OPERATION 1. AUTOMATIC

Machine Used—Brown & Sharpe automatic; tool layout, Fig. 1098. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Tool-Holding Devices—Holder on crossfeed carriage. Number of Cuts—Two. Cut Data—1,500 r.p.m. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—3,000 pieces. Gages—Fig. 1099; A, total length; B, length of body; C and D, diameters; E and F, radius of end and head. Production—125 per hr. Note—Size of stock, 0.245 in., slotted in Whitney hand miller; pins are blued in the usual way.

Brazing High-Speed Steel Tips to Machine-Steel Cutting Tools

By James Ellis*

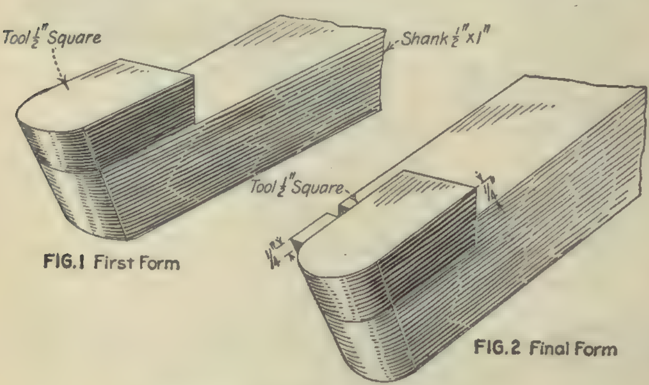
The great increase in the cost of high-speed steels in the past two years has caused much study of possible ways to use up all scrap and to economize in the use of new steel. There has been a great deal of comment in the *American Machinist* on this subject. Most of the articles have been concerned with the welding of tips to machine-steel shanks, although a few have been about brazed-tip tools. I have had some experience with tools of the latter class, and the results I have obtained may be of interest.

As a brazing medium I have used several kinds of brass, silver solder, such as is used on bandsaws, and copper, which has given the best results in that it requires a higher heat to melt and more nearly approaches the hardening heat of the high-speed steel than any of the others. As a flux I first used borax, but it was uncertain, probably due to the moisture in it. Bicarbonate of soda was tried and gave better results than borax, but it is best always to grind the bit and the iron shank clean at the points of contact before brazing.

*S. J. Ellis Machine Works.

The brazing is done in an ordinary forge, which is filled with hard coke; and the heat is brought up slowly. A brick or a piece of iron is placed in front of the fire to support the tool with only about 2 in. extending into the fire. It requires some time to get the copper melted, owing to the fact that all the heat must come up through the iron shank, as the tool cannot be turned during the heating. When the copper begins to run, the tool is removed from the fire, the bit is given a firm pressure and then plunged into oil after the tool begins to cool. When it can be handled, it is struck on the anvil to see if it is solid, after which it is ground. The use of wire to bind the parts together is unsuccessful.

As to the methods for preparing the tool, there are several. The first tools that we used were a piece of bar iron ground bright on the end where the tool was to be brazed and the bit brazed on, as shown in Fig. 1. The tool was 1½ in. high at the cutting end and was about right for ordinary work, but the shank was weak and would bend under heavy cuts; also, the bits would slide off sidewise. The final form was that shown in Fig. 2,



BRAZED-TIP CUTTING TOOL

the shank being ¾x1¼ in. and the tool ½ in. square, as before, with the seat planed down ¼ in., leaving a wall ¼ in. broad to take the thrust of the cut. The sheet copper was bent up on the sides and one end in order to braze the tool on three sides. This is important, as it insures the heat being absorbed by the shank, adding to the life of the tool.

This tool has given satisfaction on lathe work, both on roughing and finishing, but on heavy shaper and planer duty it breaks off. This is apparently not due to an imperfect braze, but to the sudden shock on entering the cut. The soft metal just below the bit at the extreme end of the tool gives way, and the entire bit is then torn off. It is possible that, if the shank were made of tool steel, this would not occur.

It seems to be a peculiarity of high-speed steel that the copper will not always unite with it, although it does with the iron. This is the cause of all the failures, for when the bit breaks off, it will always show spots where the copper had not united. While the brazed-tip tool has not the endurance of the electrically welded tool, it has possibilities, especially for the small shop. We are drawing out short solid tools to fit tool holders; and when the bits are used up to about an inch long, we braze them to an iron shank.

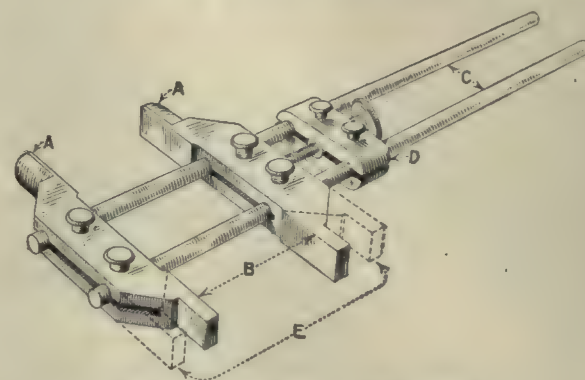
This method of using up the short ends of high-speed steel should prove to be of use in the small shop which is not equipped with welding apparatus.

Double-Ended Caliper Gage for Milling Jobs

By J. V. Souder

The illustration shows a caliper designed principally for taking measurements where the ordinary style of caliper cannot conveniently be used, as in measuring between slots in milling jobs, gage work, etc. The rigidity of this caliper makes it sensitive to a fraction of a thousandth.

It is made of tool steel, hardened, ground and lapped. After hardening, the heads *A* are clamped together and the holes lapped to fit drill rod of some convenient size. The heads *A* are then clamped individually by the screws



DOUBLE-ENDED CALIPER GAGE

to two pieces of drill rod, squared up on an angle plate, and the surfaces *B* ground. The sides were ground with the rods *C* resting on parallels in order that the sides might be parallel to these rods.

As the illustration shows, this is a double-ended caliper, one end for round internal work and the other for parallel surfaces. The parallel jaws were reduced to 0.050 each, requiring the addition of 0.100 to the micrometer reading in all cases where external measurements were made.

To grind the round jaws true is a little more difficult. It was done in this way: In the center of a bench-lathe faceplate a brass plug was driven. Two sides were milled equal to the width of the caliper. At right angles a slot was milled equal to the thickness of the parallel jaws, or $\frac{1}{10}$ in. (the plate indexed 180 deg. for both milling cuts). A small angle iron was pressed against one side of the plug and clamped to the plate. The parallel jaws were entered in the slot, squared, clamped to the angle iron, and the round jaws reduced to the desired diameter with a traverse grinder.

The heads *A* are slotted, as indicated in the figure, while the yoke *D* is made of two pieces with a piece of paper between them for clamping clearance while drilling and reaming the holes. For internal parallel measurements equal to or greater than the heads *A* they can be reversed, as the dotted lines show at *E*, making a deeper entering gage. All screws have knurled heads, also screwdriver slots.

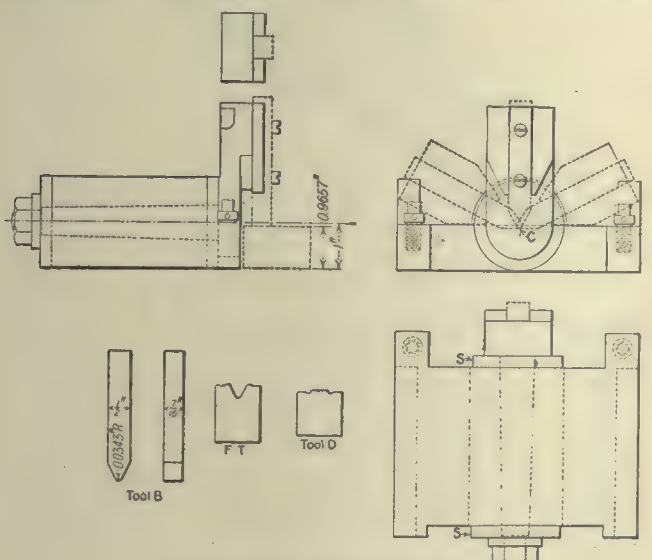
This gage will be found a valuable asset to any kit of tools, its size and general details depending upon the need and taste of the individual, while its capacity is governed only by the length of straight drill rod obtainable and the size of available micrometers.

Letters from Practical Men

Developing the Whitworth Form of Thread

A tool shop called upon to produce cutters for milling Whitworth thread chasers found it necessary to originate its master tools, and the following method was adopted. The results were highly satisfactory. Probably our English cousins have an easier way to achieve similar results and will tell us in the columns of the *American Machinist* how they do it.

Tables of thread dimensions in engineers' handbooks give us the necessary information as to angles, radii of circles, etc., so that the problem resolves itself into producing a form, as shown, having sides of 55 deg.



THE TOOLS AND THE LAP

included angle and tangent to circles of fixed diameter. Inasmuch as methods of making forming tools for formed cutters have been described in your columns, nothing but the master fly tools will be considered, and four pitch will be selected as an example. *B* illustrates what we will need first. Select a piece of good quality carbon tool steel; machine to proper size to allow for grinding; harden, temper and grind to sizes given.

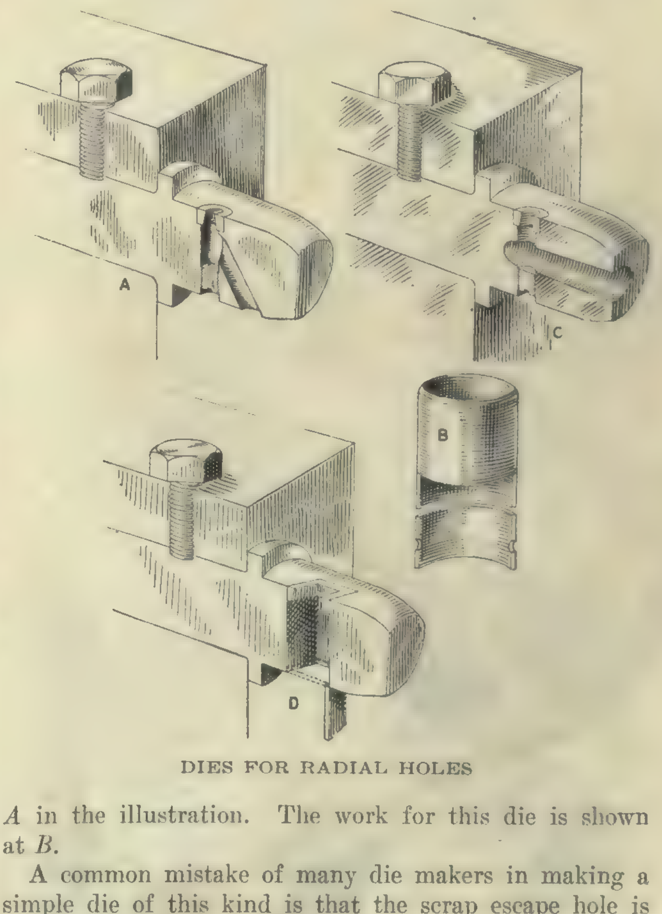
The straight surfaces can be ground in a surface grinder, and the circle as close as is practical free hand. The next operation is to lap the angle surfaces, making them 55 deg. included angle. For this operation the lapping fixture shown was made. It consists of a gray-iron frame and a steel spindle so made that it will hold the tool *B* and permit of its being revolved around the center *C* and present both angular surfaces and the circular portion to the lap in such a manner that no more than a predetermined amount can be removed.

In making the fixture the shoulders *S* were turned to exactly 2 in. in diameter and the base planed and scraped until it was even with the turning. When this had been done, we knew the exact distance from the center to the base; and to produce a lapped surface of a given radius it was only necessary to make the lap this given amount less than the distance from the center to the base of the fixture. The dotted lines represent a cast-iron lap in position under the tool ready to be used, and it is evident that by using care a part of a true circle will be produced and that the radius will equal the difference between the thickness of the lap and the height of the center, as already stated. With the tool *B* we can now produce the second fly tool *D*, making the distance from center to center of the circles equal the pitch, in this case 0.250. By now using fly tools *B* and *D*, forming tool *FT* can be provided, with the assurance that all dimensions will be right.

Cleveland, Ohio. R. W. GREEN.

Dies for Piercing Single Radial Holes in Shells

When the number of shells or other articles that require perforating is so small as not to warrant making a set of tools that will perforate the required number of holes simultaneously, the work can be perforated on a bench power press with a die similar to the one shown at



DIES FOR RADIAL HOLES

A in the illustration. The work for this die is shown at *B*.

A common mistake of many die makers in making a simple die of this kind is that the scrap escape hole is made vertical, whereas it should be made as shown at

either *A* or *C*. The reason for this is that when a scrap escape hole is vertical, the scrap punchings drop down and get caught in the holes already perforated in the shell while the operator is trying to turn the shell in position so that the holes will engage in the spacing-off finger (not shown). This often causes the shell to catch on the die in such a manner that the shell cannot be turned or pulled off without distorting it. By making the die as shown at *A* or *C* the scrap punchings will not come in contact with the holes in the shell. The perforating dies are made from steel bushings and can readily be removed by taking out the grub screws.

In cases where the perforated holes are large or irregular in shape, the punchings must drop through a vertical escape hole, as they would clog and not go through an angular escape hole, which would have to be made so large as to weaken the die holder. In order to prevent large punchings from catching in the holes in the shell, a shutter which acts as a trap by closing up the escape hole when the shell is slipped over the die is employed. This shutter is made of soft sheet steel and swings on a pin driven into the die holder. When the shell is removed from the die, the shutter swings open, allowing the punching to drop.

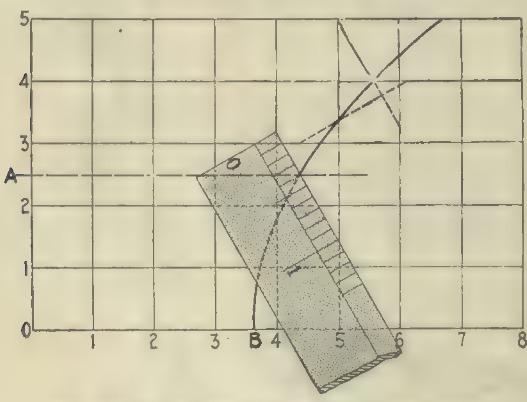
Nothing new is presented in the foregoing paragraphs, which merely describe some of those simple yet important kinks in the art of die making that are not so generally known and made use of as they should be.

Waterbury, Conn. CHARLES DOESCHER.

Reading Copied Charts

Recently I found it necessary to read coördinate values from curves that had been reduced for printing. The unit ordinates and abscissa were noted, but it was difficult to estimate intermediate values as the curve was not reduced to any particular scale. Several of the values were to be combined in quadrature, hence close estimates of curve values were desired.

I finally hit upon the following scheme of reading or plotting intermediate values upon squared paper when,



METHOD OF READING GRADUATIONS

for the sake of clearness, numerous cross-lines are not desired:

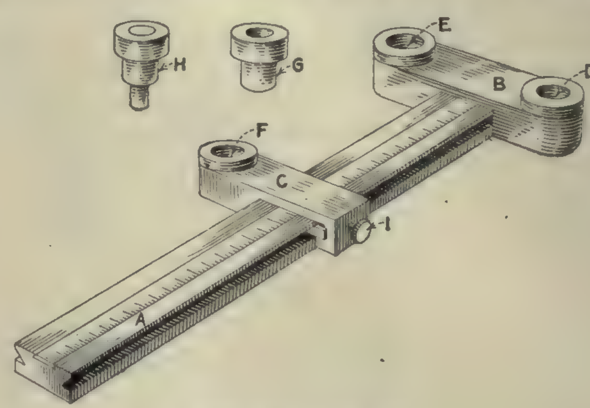
Using a graduated scale divided into eighths or tenths (or smaller if desired), zero mark of the scale is placed upon the next less noted ordinate or abscissa and the unity dimension upon the succeeding noted ordinate or abscissa. This divides the intervening space into equal divisions. A slight adjustment of the graduated scale will bring the required value of the curve so that it may be easily read on the scale. This fractional value is added to the noted ordinate at zero in the scale.

Example: As illustrated, *A* value of 2.5 gives *B* value of 4 + 4 = 4.4. Also *A* value of 4 reads *B* value of 5.565. Again, *B* value of 5 reads *A* value of 3.37.

Schenectady, N. Y. H. H. SIMMONS.

Laying Out and Drilling Jig

The accompanying illustration shows a handy little tool which I use for drilling and laying off work. It consists of a bar *A* with a T-head *B* at one end. The upper surface of *A* has a scale set in. A series of bushings are made to fit the holes *D, E* in *B* and *F* in the sliding head *C*. The closest these can be set is 1 in. center to



THE DRILLING JIG

center. The edges of the bar *A* are ½ in. from the centers of the holes *D, E* and *F*.

The bushings *G* and the plugs *H* are made to fit the holes *D, E* and *F*. These are in pairs, the plugs locating the head after a hole has been drilled.

In laying out a job the guide lines of the layout are spaced ½ in. either inside or outside the actual location of the holes. The edge of the bar *A* is matched up with this line, and the bushings disposed either to one side or the other, depending on whether the guide layout lines are inside or outside the true position of the given layout.

The sliding head *C* is applicable to either side of the bar *A*. Tightening the clamping screw *I* draws *C* down solid on the bar *A*. M. CARRY.

Chester Park, L. I.

A Bonus Announcement for 1917

The Kempsmith Manufacturing Co., Milwaukee, Wis., has recently announced an extra-payment plan that gives a 10 per cent. bonus to all shop employees staying with the company the entire year. The bonus will be paid in four installments of 2½ per cent. at the end of each quarter. Employees entering the service of the company between the first and fifteenth day of the first month of any quarter will receive the bonus for that quarter. This plan will mean an additional distribution of about $35,000 in wages.

Last Christmas all salaried employees who had been with the company for two years or more received a present of two weeks' salary.

Driving Two Rivets Where One Was Not Practicable

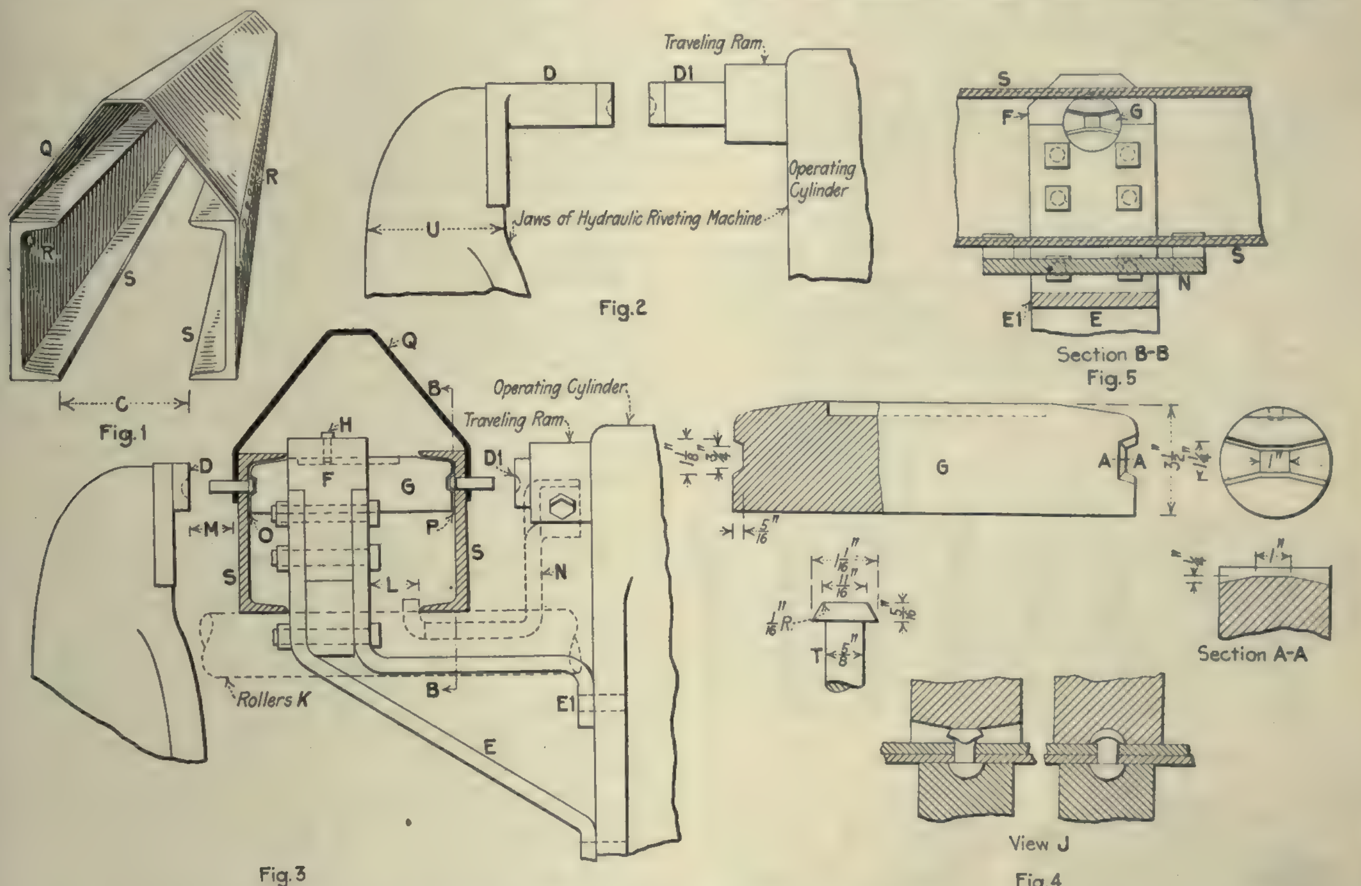
I had several hundred beams to make, consisting of two channels *S* and a hood plate *Q*, Fig. 1. These beams were over 40 ft. long. It was desired that *R* should be a good job of riveting. As the hydraulic-driven rivet makes a more efficient joint than the hand-driven one, I wished to put this job on a hydraulic riveter. While I had several of these machines at my disposal, it was impossible to do this work on any of them.

On the one I planned to use, Fig. 2, the dimension *C*, Fig. 1, was several inches less than was necessary to straddle the jaw of the machine at *U*, Fig. 2, which is the place where the bottom flanges of the channels would have to come to bring rivet holes in line with the driving ram. Of course, the tool holders *D* and *D-1* could be made to suit, but *U* would have to be enough less than *C* to permit the work to be slipped over the jaw and tool. As the design could not be changed so that channels would come on the outside of the plate, with the flanges out, it looked as if hand riveting would be necessary.

Then I got the idea that, on the same machine, it might be easy to drive two rivets where it was impossible to drive one—and it was. Fig. 3 shows the arrangement used. Two heavy bars *E* and *E-1*, bent as shown and clamped to a cast-iron block *F*, made a rigid bracket when bolted to the jaw of the machine which supported the driving ram. This bracket supported a sliding bar *G*, detailed in Fig. 4, which was grooved on the ends to allow the rivet heads to pass through. It was necessary to use a special flat-head rivet, shown at *T*, Fig. 4, the flat head having a bearing surface larger than the area of the rivet. This was necessary to prevent the rivet from backing up while being driven. The view *J* in Fig. 4 shows what would have happened if a standard or button-head rivet had been used. Of course, the outside heads were standard.

It was very important that the bar *G* should have no twisting movement, as the rivets, while being upset, must remain in perfect alignment with the heading tools *D* and *D-1*, Fig. 3. This horizontal shifting movement, without other motions, was secured by boring the cast-iron block *F* to a very close fit with the bar *G*. A setscrew *H* prevented the bar from turning. The operation of riveting with this arrangement was as follows:

The beam, having been assembled, bolted and reamed, was placed in the riveting machine. It was supported on the rollers *K*, Fig. 3, several of which were placed at each side of the machine and adjusted to bring the rivet holes in the beam to the proper height to match the tools on the machine. Several hot rivets were inserted in holes from the inside of the channels, and the beam was advanced until the extending ends of the first pair of rivets were in line with the heading tools *D* and *D-1*. Then the pressure was applied. The traveling ram forced the beam over against the other jaw of the machine, upsetting the rivets as it went, until *D* and *D-1* were tight against the hood plate *Q*. Notice that the space *L* was greater than the distance *M*, so as to prevent the channel from hitting the bracket bar *E-1*.



FIGS. 1 TO 5. DETAILS OF SPECIAL RIVETING JOB

Fig. 1—Special beam over 40 ft. long. Fig. 2—Hydraulic riveter selected for the work. Fig. 3—Arrangement for heading the two rivets simultaneously. Fig. 4—Details of sliding bar and rivet. Fig. 5—Section through riveting arrangement

On the return stroke of the ram the plate N drew the beam back in position for the advance to the next pair of rivets. The beam was easily rolled ahead, owing to a slight clearance at O and P caused by the springing of the hood plate Q. Of course, this space was closed up while the pressure was on. In Fig. 5 is a section through B-B, Fig. 3, showing how N clears the bracket while driving the rivets. C. M. ROGERS.

Mt. Vernon, Ill.

Roughing Out Blanking Dies

The most convenient method to employ when it is desired to cut out different shapes from heavy sheet steel, or to rough out blanking dies and such work, is to drill a series of holes spaced so that the drill will do most of the work, leaving a very thin bridge between the holes.

In order that the drill will do the work properly, it is necessary to first space the centers of the holes with a center punch. Most mechanics are familiar with the commercial style of spacing center punch that has a spring-actuated spacing leg for setting it for different spacings. There are also several homemade varieties, some more complicated than others. But for simplicity and convenience, the solid type of spacing center punch, Fig. 1, has few equals. I have had a set of four made, with the

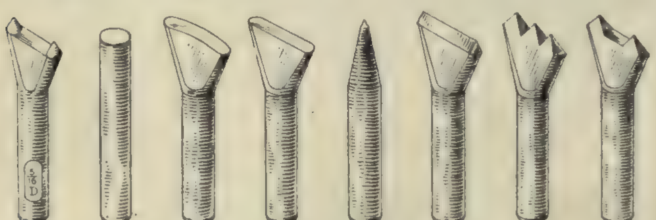


FIG. 1 A B C D E F G
FIG. 2

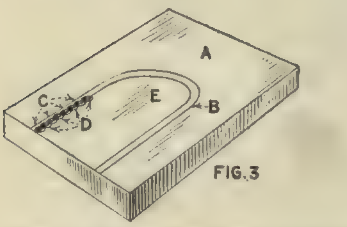


FIG. 3

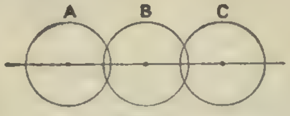


FIG. 4

FIGS. 1 TO 4. SPACING PUNCH AND THE DRILLED WORK
Fig. 1—Spacing punch. Fig. 2—Steps in making a spacing punch. Figs. 3 and 4—Method of drilling

punch points $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$ and $\frac{3}{8}$ in. apart. These four sizes cover all requirements for general tool and die work. Any mechanic can make a set of these spacing center punches in a short time.

To describe the various steps from a piece of drill rod to the finished article, we will take for an example a center punch with the spacing points $\frac{1}{4}$ in. apart. A piece of drill rod is cut to a convenient length and one end is rounded as at A, Fig. 2. The other end is flattened out as shown at B. All the other stages—from C to G—in making this type of center punch are self-explanatory. An 8-in. mill file and a $\frac{1}{4}$-in. square file are the tools to be used for beveling the flat sides and the edges, as at D and E, and also for filing the nicks. After this has been done, the center portion left by the square file, as shown at F, is filed down. The punch will then resemble G. The corners left on the two spacing points are now rounded off with a small file, and the punch is ready for hardening. If made of drill rod, it should be hardened, and then drawn to a dark straw color. A spacing center punch is used only to make a small impression for the regular heavy center punch to follow, so there is no danger of the spacing points breaking off in use. Where a set of spacing center punches of this type has been made, the punches should be stamped on the stem with the size of drill to be used with each punch, as shown in Fig. 1. The sizes can be stamped on after the punches have been hardened and tried out.

A kink worth remembering in drilling stock for parting is illustrated in Fig. 3. The piece E is to be removed from the sectional die block A by drilling. After a line has been scribed a safe distance from the finish contour of the die, in this case represented by the line B, the drill centers are laid out with a spacing center punch and the impression deepened with a regular punch. Every other hole C is now drilled clear through the block A all the way around. The holes D are then drilled the same way, and if the drilling has been properly done, the piece E can easily be removed by a few taps with a hammer. The reason for drilling every other hole is to prevent the drill from running off into the next hole. A glance at the layout in Fig. 4 will make clear the point here involved and will demonstrate that the only successful way of drilling holes A, B and C is to drill holes A and C first and leave hole B for the last. HUGO F. PUSEP.

Dayton, Ohio.

Why Was the Storekeeper Fired?

This is a true story, and I believe it could be duplicated in other shops, which is my excuse for sending it along.

The works had a system of keeping all stock tools in the general stores, the toolroom having a minimum and maximum working stock, drawing on the general store as required. One day the toolroom foreman sent through an order for two $1\frac{3}{32}$-in. twist drills. The boy returned with two $\frac{13}{32}$ drills. He was sent back and told to inform the storekeeper what was wanted. The boy then returned with the order and no drills.

At this point the chief foreman happened on the scene and took the storeman's side of the question, informing the toolroom foreman that the order should be distinct whenever there was a possibility of its reading two ways. The order was made plainer and again sent through, to be returned because the storekeeper discovered it had not been copied (a rule of the firm being that all orders must be copied). The chief being still on the scene, his advice was sought. As a result the chief himself wrote another order and signed it, the boy again being dispatched for the drills.

This story should end here, but some ten minutes later the chief happened to see the toolroom foreman coming from the stores and inquired the reason. He discovered two $\frac{13}{32}$ drills had again been sent out. The foreman took them back himself, and after threatening the storekeeper in various ways obtained the correct drills, but not until the storekeeper had torn up the chief's order and substituted one written by himself. Five minutes later the storekeeper was fired. Whether it was because he could not read or because he willfully disobeyed orders or because the drill hand had been waiting for nearly half an hour for one of these drills, I would not venture an opinion. F. P. TERRY.

Belfast, Ireland.

Discussion of Previous Question

Employment Bureaus for Classifying Workmen

The article by C. W. Johnson on page 64 brings up a subject that is being more and more considered in various states. New York already has a well-established labor bureau, that is doing good work in many lines. Work of this nature requires a grasp, not only of the details, but of the broad human principles involved. In this New York is exceedingly fortunate in its choice of Charles B. Barnes as director.

While I heartily agree with the need of an employment bureau, we must be careful not to introduce czar-like methods into its routine; and if we begin to classify men, we may easily tie them to a lower grade than they are capable of filling, or prevent them from advancing. This is not only unfair to them, but to the employer and to the community at large.

Men do not always change jobs in the hope of getting a "soft" place. In fact one of the first questions employers are learning to ask themselves is why men leave their employ at all. Is it not better to try to find the reasons and remedy them, instead of attempting to create classifications that may tend to prevent a man from changing jobs even with good cause?

Some shops make it a point to inquire carefully into the cause of every man's leaving, it being necessary for the man to give his reason to the employment superintendent before he can get his pay. If it is a case of incompatibility with the foreman he is given separation papers and transferred to another department, where he often makes good.

There are, of course, a certain percentage of men who are naturally wanderers; but the great majority, especially those with a family, do not change jobs for the mere fun of changing. Let us try to make the jobs more attractive as the first step, and then follow it up with any plan of just classification and distribution by means of employment bureaus, which have an important place to fill as distributors of labor and are beginning to do a much needed work. FRANK C. HUDSON.

New York City.

High-Speed Power Winder for Electric Coils

On page 824, Vol. 43, the *American Machinist* described a power winder made out of a grinder head. The remark that most coils are wound with the lathe was accurate indeed, and when high prices were offered for old lathes a substantial profit was made by replacing the lathe used for winding with an ingenious power winder made at hardly any cost, out of junk. Besides the direct gain derived from this one suggestion offered by the *American Machinist* there is also the great saving of labor and time, as the new power winder is from 10 to 12 times speedier than the lathe.

The winder runs 1000 r.p.m. and may be speeded up to double that amount. A boy is able to run 12,000 wire turns within half an hour, all operations, like inserting paper layers, etc., included. In 10 hr. 66,000

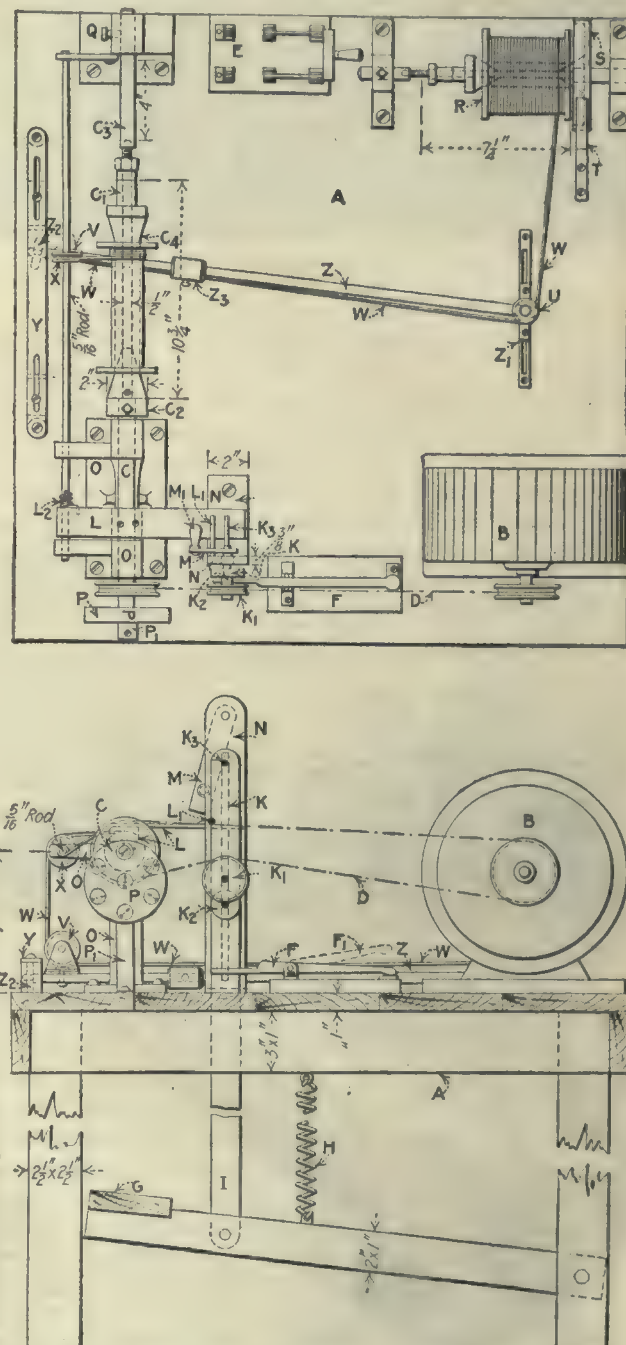


FIG. 1. THE COIL WINDER

ft. of wire, representing 120,000 turns, has been wound, this still being below the maximum output. The same job on the lathe might have taken over a week, and therefore many a reader might be interested in this machine.

The winder, as shown in the illustrations, consists of a wooden bench, *A*, Fig. 1, 31x30x36 in. high, on which a small motor *B* drives the coil shaft *C* by means of a round leather belt *D*. The motor can be run either way by a double-throw switch *E*. This switch is only used for reversing; but when winding, the motor is governed by a

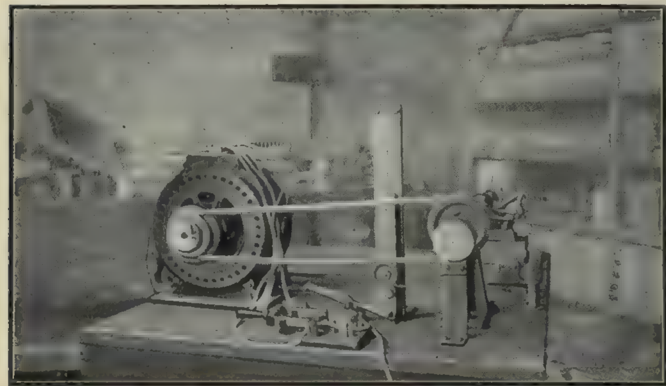


FIG. 2. END VIEW OF WINDER

single-pole switch *F*. By putting the foot on the pedal *G*, which is kept up by the spring *H*, the connecting link *I* pulls the slide *K* down and with it the pulley *K-1* and the pins *K-2* and *K-3*, which are fastened to the slide.

Bringing the pulley down slackens the belt, which loosens its grip on the coil-shaft pulley. The pin *K-2* strikes the switch *F* and opens it, stopping the motor. The pin *K-3* presses the brake *L* on the coil shaft, stop-

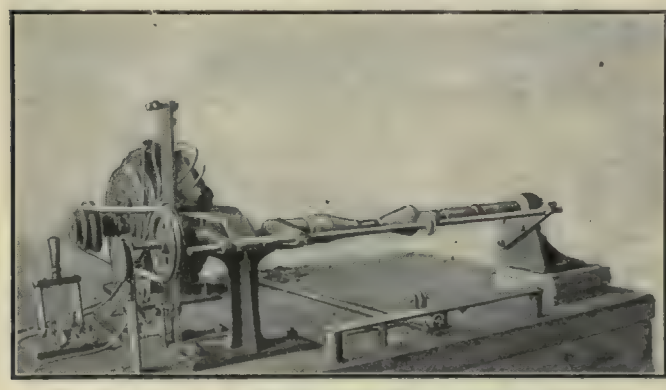


FIG. 3. FRONT VIEW OF WINDER

ping it immediately, and damage to the wire is prevented. By releasing the pedal the slide moves halfway up, and the pin *K-3* strikes against the catch *M* and moves it out of its way. While the slide is kept in this intermediate position, the switch *F* is still open, the belt has not yet been tightened by the pulley, but the brake *L* has enough play to be thrown against the pin *L-1* by the spring *L-2*, thus releasing the coil shaft.

The whole combination of actions is the result of one single movement, and within a fraction of a second the *belted* coil shaft running from 1000 to 2000 r.p.m. has been stopped and unbelted and can be revolved freely by hand to unwind a section of the wire or to insert paper layers. This and the adjustable circular wire float, described later on, are responsible for the surprising capacity of the winder.

To restart, remove the catch *M* by its handle *M-1;* the slide is pulled up by the spring on the pedal, the pulley tightens the belt, the switch closes and starts the motor, and the pin *K-3* keeps the catch *M* in the original angular position. The slide runs against a slotted upright *N*, made out of 2x2x3/8-in. flat iron, which also carries the pin *L-1* and the catch *M*.

The coil shaft *C* runs in a Y-bearing *O*. At the right it carries the belt pulley, and it drives the revolution counter *P* (made out of an old water meter), which rests on a foot *P-1*, made of flat iron. At the left the shaft carries the cone *C-2*, which is drilled for the 1/2-in. shaft *C-1*. This is fastened to the cone by a removable setscrew. The loose shaft *C-1* rests at the other end in a hole in the shaft *C-3*, which is held fast in the bracket *Q* by a setscrew. The shaft *C-1* is threaded at the left-hand end, and by means of the cone *C-4*, the spacers and the nut any coil up to 10 3/4 in. in length and with a core-hole diameter up to 2 in. can be secured satisfactorily between the two cones. Coils up to 4 in. long may be put in or removed by unscrewing the nut and by moving the shaft *C-3* back. For longer coils the shaft *C-1* has also to be taken out of the cone *C-2*, to do which the setscrew has to be loosened.

The arrangement for unwinding the wire spool *R* is practically the same, but is more limited, as the sizes of the commercial spools are standard. The only addition is a drum *S* on one of the cones, against which rubs a bent strip *T*, of springy phosphor bronze. The strip is fastened to the table, and by means of the screws the friction on the drum and, with that, the tension in the wire *W* can be regulated.

The wire runs from the spool along the pulleys *U*, *V* and *X* to the coil. The pulley *V* slides lightly over a 5/16-in. rod (which also serves as fulcrum to the brake), which rests in arms of the Y-bearing *O*. The pulley *V* swivels on the floating rod *Z*, and the pulley *U* is in the top of the pin that is also the fulcrum for *Z*. The tension in the wire lifts the float *Z* from the table and presses the wheel *Z-2*, at the end of the float, against the strip *Y*, which is elevated from the table to a distance slightly greater than the diameter of the wheel *Z-2*. In this way the rod *Z* and its pulley float by the tension and follow the pulley *X*, describing part of a circle. The pulley *X* follows the wire instantaneously in its rapid back and forward motion along the coil. The strip *Y* is provided with adjustable stops for the wheel *Z-2*, and the fulcrum of the float can be shifted to the center of any coil, along the slide *Z-1*. The weight *Z-3* on the float can be moved along the rod as a further regulation for a perfect floating of the wire. A general idea of the machine can be gained from Figs. 2 and 3.

By combining the good points of the power winder previously described in the *American Machinist* and of this one a unit can be formed that will prove to be an asset to any experimental machine shop. JAN SPAANDER.

Brooklyn, N. Y.

The Unending Struggle—Against Nature or Man?

The first editorial on page 37, on "The Unending Struggle," leaves several points unexplained. While it is true that we must continually repair structures, it hardly follows that we pay for all the great works that we use. If we did, it would leave only the repairs to be paid for by the next generation, when in reality it must pay the interest, if not the principal, on bond issues in addition to

repairs. It is the habit of nations, whether at peace or at war, to leave many debts for the next generation.

Neither do I see how we can call Nature hostile. Tilling the soil gives us ample crops, at least in our latitude. We were given wild horses to tame into beasts of burden, and cows and sheep are also the gifts of Nature, rather than due to any effort on the part of man.

No one will deny the continual battle to obtain food, clothing and shelter, but this is not due to the hostility of Nature half so much as to the hostility of our fellow man. If it be true that a day's work purchases more than ever before, many of us would like to know just how it works out with flour costing twice what it did a year or so ago and many other things in proportion. This reminds me of the three grades of prevarication—"lies, d— lies and statistics."

That labor-saving machinery injures labor may be a popular fallacy, but it would be hard to make the editor believe it a fallacy if a machine were devised to write editorials and get out a paper automatically. Such a machine would so reduce the cost of production that the publishers could give its readers a bigger and perhaps a better paper for the same price, and in so doing would benefit 25,000 readers while throwing only a few men out of a job. But the editor might get just as hungry as though no one was benefited, before finding another job.

No one questions that labor-saving machinery is a benefit, unless it is used (as is too often the case) solely to increase profits. And no workman will oppose it if he is assured of an equally good job at some other work. But when his means of livelihood is taken away—not only the surface, but clear down to the shoes on his feet and the clothes on his children's backs—it is difficult to make him think about the benefits to the country as a whole.

The only way the workman can appreciate the benefits of labor-saving machinery is so to manage our industries that none are deprived, even temporarily, of their opportunity to provide for themselves and their families. If labor-saving machinery benefits mankind, and it undoubtedly does, the community should in return be glad of the opportunity to give new work to those whose means of livelihood has been destroyed.

The unending struggle against Nature will be made much easier if all those who profit by labor-saving machinery will give the other fellow a square deal.

New York City. JOHN R. GODFREY.

What Is a Gage, a Die, a Jig, a Tool, a Fixture?

On page 649, Vol. 45, W. B. Greenleaf states that "the names jig and fixture are synonymous." On page 1000, Vol. 45, Wallace Taylor writes that "the usual distinction between a jig and a fixture is that a jig is a device for holding and controlling the work, while a fixture is a device for holding and controlling the tools."

Neither statement agrees with what I have found to be the practice of tool designers, during twelve years' experience as tool designer on jigs and fixtures and small tools, and four years as a machinist. The tool designing experience covered ten different designing rooms.

My experience has been that a jig is a device *not fixed* to a machine, for holding the work in position; generally for any, or all, of the following operations—drilling, reaming, tapping, counterboring, boring and spinning—and controlling it relative to the tool by guide bushings or other means.

A fixture is a device *fixed* to the machine for holding the work in position; generally for any, or all, of the following operations—milling, shaping, planing, slotting, grinding, boring and turning.

The distinction lies chiefly in the fact that one is fixed to the machine while the other is not.

Webster's New International Dictionary defines fixture as "a thing or person firmly established in place; that which is fixed or attached to something as a permanent appendage." The same authority defines jig, under metal working, as "a contrivance fastened to, or inclosing a piece of work, and having hard steel surfaces to guide a tool, as a drill; or to form a shield or templet to work to, as in filing." These dictionary definitions seem to harmonize better with the practice I have known than with the definitions which either Mr. Greenleaf or Mr. Taylor has given.

I have not come across a case of the term jig being applied to a center or a chuck or a vise or a mandrel.

Springfield, Mass. J. J. WOFFINGTON.

Red Tape in Navy Yards Somewhat Exaggerated

While no doubt exists that there is considerable red tape connected with navy-yard methods, I want to set right the article in *American Machinist,* page 18, by B. Davis. It conveys the idea that in order to obtain an air drill to use for a few minutes' work you are required to waste a whole working day. This is not true of any navy yard. It is an exaggeration of the method necessary in some yards for an enlisted man to obtain the loan of tools from the yard shops, for use on board ship. Almost all navy-yard shops have the employees' check system for keeping track of the portable tools, and the only time a typewritten form is used, as referred to by Mr. Davis, is when a tool is lent to one of a crew of a vessel in the yard undergoing repairs. I believe that I am acquainted with the so-called red-tape method that Mr. Davis writes of; and if one uses a little good sense, it takes only a short time to obtain the tools necessary for any ordinary small job.

All ships have their allowance of machine tools, portable tools, etc., for making repairs to their machinery. When at sea they get along very well with this equipment, but on arrival at the navy yard the ship's force has a good bit of work to do. This sometimes requires borrowing additional tools from the yard shops, such as air drills, hammers, etc. In order to obtain the loan of the tools it is necessary to make out a request to the shop concerned. This request is a typed form obtained from and signed by the chief engineer of the vessel desiring the loan of the tools. This request is presented at the toolroom of the shop; the tools are issued, and the person obtaining them signs a receipt attached to the request.

It seems to me that the simplicity of any method lies in being familiar with its operation. I rather think that at most navy yards the location of any particular building could be found in a trifle less than half a day.

Concord, N. H. C. H. WILLEY.

The New York Automobile Show of 1917

The seventeenth annual New York automobile show was the largest ever held, and those who remembered the first show were reminded of it by contrast, at every turn. The feature of the show from a mechanical viewpoint, was the Doble steam car, in which several leaves have been taken from the book of gasoline-car practice in the endeavor to again popularize steam as the motive power for automobiles. The boiler is in front, under the hood, and consists of a series of vertical water-tube sections made of welded steel tubing. About a third of these sections act as an economizer, the rest serving as the boiler, which operates normally at about 600 lb. pressure, although the safety valve does not blow until 1000 lb. is reached, this being about one-sixth the bursting pressure.

The fuel is kerosene, burnt in a combustion chamber lined with a special refractory material. A blower supplies air pressure which, with the aid of a carburetor, mixes the fuel and allows it to burn with no attention from the driver. The lubricating oil is fed into the feed water and is said to prevent scale as well as give perfect lubrication with a minimum of oil, 1 gal. being sufficient for 12,000 miles. The exhaust steam is condensed in the radiator and enables a run of 1500 miles on one tank of water. Although this was a heavy car, Mr. Doble claims 15 miles per gallon of kerosene in cross-country running. The engine has two cylinders, 5-in. bore by 4-in. stroke, which gives ample power.

Electric Transmissions

Two electric transmissions were exhibited, the Vesta Centrifugal-Electric being shown on a McFarlan six-cylinder car. This differs from the Owen-Magnetic both in construction and in operation, but the electrical transmission is believed by many to have a great future, owing to its many advantages over gear shifting with its fixed ratios. The idea of driving with no levers to shift, with one foot on the brake and the other on the accelerator, and to get all speeds from one mile an hour to the maximum whenever wanted and without the possibility of stalling the motor, seems to approach very near to the long-sought-for ideal.

Another novelty was the Bateman, or Frontmobile, which both drives and steers by the front wheels. This puts the whole mechanism under the hood and enables the car to be built as low as road clearance will allow. The advantages claimed are in pulling out of a hole or bad road much more easily than pushing, and freedom from skidding. There was also a good looking electric runabout at a moderate price.

The Franklin continues to have the only air-cooled motor, while the Metz is the only car with a disk or friction drive. Both these features, as well as a kerosene motor, were combined in a car from Los Angeles, Calif., that is entirely experimental as yet.

Body Styles Little Changed

In general appearance the cars have changed little during the year. Sloping windshields are increasing, as is also the clover-leaf type of body. Few of these, however, have room enough in the rear to be attractive, particularly to middle-aged people, and the passage between the front seats is too narrow for comfort in most cases. Permanent tops, which can be used either open or closed, are on the increase and various combinations are being tried. There is also an increase in the number of cars built from standard parts, particularly in the better class, with prices ranging from $1000 to $3000.

Details of motor and other mechanisms are being refined, largely from the point of get-at-ability, which is desirable from every point of view. The tendency to pile one piece of mechanism on top of another, necessitating taking them all off to get at the one on the bottom, is happily becoming a thing of the past. One noticeable little refinement on the Cadillac is a tank for condensing the alcohol evaporated in a hot radiator, not only saving it, but automatically putting it back in the radiator when it cools down. This ought to save many a frozen radiator in cold sections of the country and also overcome the necessity of frequently replenishing the supply of alcohol, which at present prices is a considerable expense.

Motor Types Changing Slightly

The use of six-, eight- and twelve-cylinder motors is increasing, although there is no sudden rush away from the fours, which still total about 36 per cent. of the whole. The valve-in-head type of motor increased over 6 per cent. during the year, while the sleeve-valve lost a trifle. Double valves, four to a cylinder, are now found in two stock-car models.

The greatest percentage of change is from the single to the double unit in starting and lighting sets. Next is an increase of 26 per cent. in the use of the vacuum feed, the gravity feed being now used by only 15 per cent. of the makers. The use of semi-elliptic rear springs increased 24 per cent., while battery ignition gained 16 per cent. over the magneto. The cone clutch also seems to be losing ground, with a decrease of 12 per cent. from the figures of last year.

The Accessory Exhibit

The accessory exhibit was particularly interesting, including several firms well known in the machine field, such as the Acieral Co. of America, the American Bronze Co., Baush Machine Tool Co., William Cramp & Sons, Curtis Pneumatic Machinery Co., Cutler-Hammer Manufacturing Co., Joseph Dixon Crucible Co., Doehler Die Casting Co., Peter A. Frasse & Co., General Electric Co., Ward Leonard Electric Co., Lumen Bearing Co., Sipp Machine Co., Veeder Manufacturing Co., and the Westinghouse Electric and Manufacturing Co.

The general opinion seems to be that a four-cylinder motor in a light chassis, with a sensible and fairly roomy body, is the ideal car for the average user. Nearly all the designers seem to be trying to eliminate unnecessary weight instead of assuming that it is necessary for easy riding. Some of the lighter cars seem to disprove the theory that weight is essential and indicate that it is just as much a question of balance and proper springs as of weight. The spring with more leaves of thinner steel will probably find its way into more cars next year. The only discordant note at the show was the exhibition of cars of companies which are trying to sell large amounts of stock by popular subscription.

Editorials

Adaptability, the Keynote of Success

Adaptability, or the lack of it, plays a more important part in the success or failure of a man or a business than we are apt to realize. A man may get on famously at his work as long as no new methods or machines are introduced but innovations are disastrous to him. High-speed steel upset the future of many a machinist and put him on the list of back numbers, because he could not adapt himself to the higher cutting speeds. In the same way many a business firm prospers as long as the conditions to which it is accustomed continue. The coming of the telegraph and the telephone sounded the death knell of more than one businessman who could not adapt himself to the more rapid methods of conducting business. The quill-pen type of man cannot survive in these days of the typewriter and the dictaphone.

Shopmen who are very successful at the lathe often fail utterly on other machines, and the same type of miller men does not make good when transferred to other work. And all because they have not the faculty of adapting themselves to new or different conditions, for the fundamental differences are slight between cutting with a stationary tool and cutting with a revolving tool; and failure under the changed conditions is due more to the result of the impression that different machines make on us than to any real differences existing between them. But this difference is sufficient to deter many from trying to run another kind of machine. Many a good operator has quit his job rather than tackle a new machine with which he was not familiar. This attitude is one of the obstacles that must be overcome by those who are trying to introduce new machinery into the shop. It causes antagonism which, while unwarranted, is perhaps perfectly natural under the circumstances.

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This fact alone should unite all builders and users of new machinery in an effort to overcome this tendency, as it is a decided hindrance to new business and adds many dollars to the selling cost. The burden rests on the user of the machines, who ultimately pays all these costs in addition to the builders' profits. The only solution of the problem lies in the education of workmen, or better still, boys who are to become workmen, to the point where they are not afraid of any new machine that comes into the shop; until they know that they can soon learn to run it, no matter how it looks or what it does. When we can teach boys and men that the fundamentals of all metal-cutting machines are the same, and have them understand it, we shall have gone a long way on the road toward helping both the employer and the employee—the former to get men for his various machines, and the latter to get work running any kind of machine that needs an operator.

This inability to assimilate new plans and methods, to pick one idea here and another there, seems to be due to two things—a failure to understand the fundamentals of the problems involved and a lack of imagination that can picture a change before actually working it out in wood or metal. The former can be remedied the more easily of the two, and much, we believe, can be accomplished by proper vocational guidance and training. This can help to establish an understanding of the fundamental principles underlying machinery of various kinds. With this understanding a man will know that the same mechanical principles govern the operation of the lathe, planer, miller and other machines and that he must simply realize how they are employed in each case, to be able to operate the machine.

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The vocational schools as well as trade and technical schools can do much to bring about the kind of knowledge that is much to be desired. And for this reason, if for no other, both makers and users of machinery should assist in their work or in anything tending toward this end. Both the trade school and the vocational school must bear in mind that it is not nearly so important that a boy be trained to be perfect on any one machine as that he know how to handle them all. Specialization, which means as near perfection as we mortals get in machine-shop work, can well be left to the experience of later years. Each shop has its own peculiar methods and requirements, which usually necessitate more or less breaking in, no matter how experienced the operator. And the time taken for this breaking-in process depends directly on the ability of the man to adapt himself to the different conditions. If he can also adapt himself to handle a different type of machine, he is that much more valuable to both himself and his employer. Such adaptability is an asset from two viewpoints—the man is more valuable to himself, and he is worth more to the shop.

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The lack of adaptability, however, is not confined to machine workers, but extends far up the line. It prevents foremen and superintendents from taking advantage of many of the good ideas that they see or read of from time to time. Unless a new device or method is shown applied to their particular kind of work, too many fail to see its application or that it can be of use to them. The superintendent of a lathe shop may admire the assembling frame used by builders of an automobile motor and never see that it can perhaps be applied equally well to assembling the apron of his lathe carriage. Or he may spend much time in maintaining milling cutters to a fairly exact width while he passes by the profiling method because he has seen it used in gun shops only. There are many similar instances that might easily be cited, if specific cases were needed; but this hardly seems to be the case.

All these observations have a direct bearing on the *American Machinist* and its contents. It is difficult, if not impossible, to secure articles that show just how to apply new methods to each particular branch of the machine business. But by showing the best practice in the

most modern shops we can point out the new ideas that can be adapted, either in whole or in part, to other lines of work. It is for this reason that we have shown so much from automobile shops. The size of their plants and the newness of their equipment make them in many ways excellent examples of modern methods. While all these methods are not applicable to other shops, many of the ideas can be readily transplanted, perhaps with a little careful pruning, to almost any shop that produces parts in large numbers, for it does not matter whether the product is automobiles or dish-washers, if the same types of parts are used in the make-up of each.

If your work requires the rapid removal of a large amount of stock, the machines and the methods used in making high-explosive and shrapnel shells have given many suggestions that can be utilized on entirely different kinds of work. The machines that have been built for the rapid drilling of the many holes in time fuses include features that can be used in more peaceful manufacture. If you have deep holes to drill or ream, or both, and particularly if you want these holes straight and smooth, you can take several leaves from the practice shown in making rifle barrels in the armory at Springfield. The use of the "scrape" reamer is not so well known as it deserves to be by those who desire very smooth holes in their work. Even the design of some parts of the rifle itself, such as the method of holding the firing-pin rod and the striker by means of the firing-pin sleeve, is full of suggestions that may well find a use in entirely different mechanisms.

So if you feel that there is too much of any one kind of article, whether on automobiles or munitions, try to see what parts of the methods shown can be applied to your own work. Perhaps a few of even the minor operations on the rifle may fit in with a part of your own product. Possibly the clamping and locating devices used on some of the jigs may be better than your own. Or the method of locating and gaging a piece from the same point, the use of a mandrel or block to gage from, may suggest a similar application or a better way in your own work on an entirely different piece. But in all cases bear in mind that we can hardly hope to show just your kind of piece. If, however, you will consider each article as containing possible suggestions for your individual work and seek to find and to apply these ideas, you will not care just what kind of shop they hail from. Conditions are constantly changing in the shop, as elsewhere, and the ability to meet new requirements is the real test of success. The man who can meet these requirements is on the sure route to the top of the ladder.

Health Insurance

There is a burden of illness upon wage earners. Employers, employees and social workers recognize that some of this is preventable and that so far as possible it should be alleviated.

Social workers seem to favor compulsory insurance under state law. It is time that every one should study the question far enough to make up his mind whether he is for or against its principles, for it will probably be made the subject of proposed legislation in several states this winter.

Whatever difference of opinion there may be in regard to these principles, there will be little disagreement as to the goal. This is threefold: To prevent disease so far as it may be prevented; to discover illness in its early stages and restore the patient rapidly and securely to normal health; to distribute in some way the sickness losses of those workers who are actually unable to bear them.

It is recognized that in so far as the first two are accomplished, the need of the last is reduced.

In any case health insurance will be far from a cure-all for the ills of wage earners. Illness is only one of several causes that bring about a reduction of earning power. Among the others must be recognized voluntary absence from work, intemperance, venereal diseases, mental deficiency, lack of vocational training and shiftlessness.

The enthusiastic supporters of health insurance through legislation fail to take into account the influence of these six items.

If, then, we can only hope to do away with a small part of poverty and loss of time through compulsory health insurance, is it wise to place this burden upon society? Is it not wiser to foster the fine spirit of American independence, thrift and foresight, which will have its influence upon all the things that tend to a lowering of the economic condition of workers?

The movement toward safeguarding from accidents, and workmen's compensation, has had its development because everyone realized that accidents were, to a very great degree, preventable. From the start the safety-first movement has hinged around prevention rather than cure.

But compulsory health insurance will be curative: it cannot be preventive. The coming of disease and illness cannot be foreseen, like the possibility of accident. Safeguards are impossible except those of a general nature, which affect the community as a whole or employees in the mass. For this reason the movement toward health insurance is on a far different basis from that of accident prevention.

From still another viewpoint there is a complete insufficiency of information in this country as to how such legislation ought to be worked out. We have no adequate records of illness among wage earners. A number of large manufacturing plants, however, have well established medical departments, and if time is permitted to take its course they will accumulate a mass of information which will be of the greatest value in determining basic facts in regard to illness, its causes and consequences. Because of this insufficient information, it seems wise to oppose at this time all the movements for compulsory health insurance which have been started. Let us wait until we know.

But employers must not forget their social responsibility and must do whatever is necessary to conserve the welfare of their employees. Industrial hygiene, medical service, convalescent care and real preventive work have all been established in many plants to a greater or less degree. The opportunity and duty in front of each employer is to aid in developing services in connection with his own working people on a basis of true coöperation. This act will alleviate the burden of illness and at the same time collect information for a basis of future action.

Shop Equipment News

Adjustable Filing Machine

The filing machine shown in the illustration has recently been placed on the market by the Noble & Westbrook Manufacturing Co., Hartford, Conn. It is provided with an adjustable chuck that will handle standard straight files. The stroke is adjustable, 1½ or 2½ in.

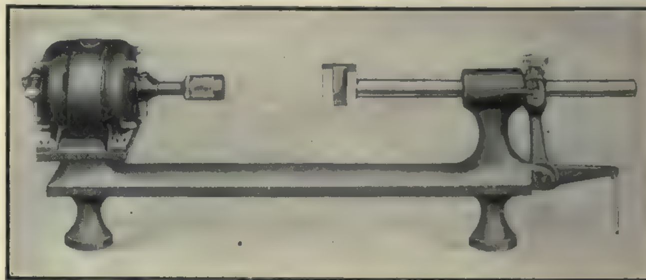
FILING MACHINE

The table is solid, but the head can be set at any angle and is provided with graduations for indicating this angle. An adjustable hardened roller bearing is provided to prevent file breakage. All bearings are of phosphor bronze, and the working parts are placed above the file in order to protect them from the filings.

Tapping Machine

In the illustration is shown a machine that has recently been placed on the market by F. S. Trumbull, Bridgeport, Conn., which is known as the Trumbull lightning tapping machine.

The machine is made in three sizes to tap holes up to ¼ in. in diameter, but is not recommended for work over ⅛ in. thick. A long shank string tap is used, which is easily removed and emptied as soon as it is filled with the finished parts. The machine consists essentially of a small electric motor on whose shaft is mounted a Gronkvist automatic collapsible chuck. The fixture for holding the work on the tail spindle is fitted with two coil springs that force the work onto the tap after it is placed in position. A foot pedal is used to back off the spindle.



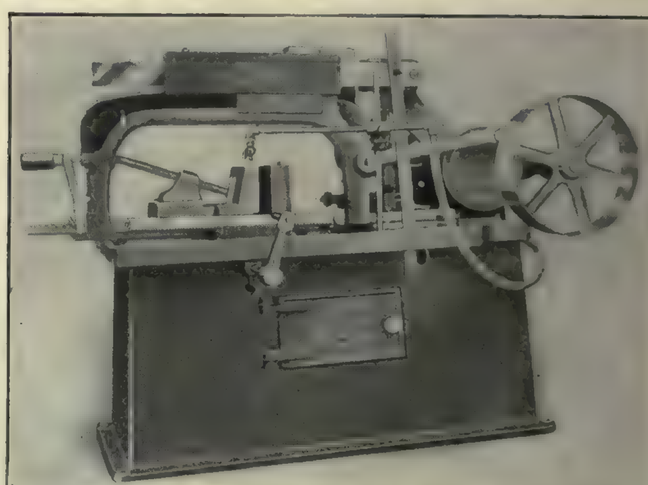
TAPPING MACHINE FOR THIN WORK

The machines are equipped with a switch that automatically stops the machine when the operator's foot is removed from the starting pedal.

Power Hacksaw

The W. Robertson Machinery and Foundry Co., Buffalo, N. Y., has recently put on the market the heavy-duty power hacksaw shown in the accompanying illustration.

The machine has a capacity of 8x8 in. and uses saw blades from 10 to 17 in. long. The cutting is done on the draw stroke, and the lift on the return is accomplished by means of a two-cylinder plunger pump operated from the crankshaft and submerged in oil in the base of the machine. An adjustment is provided for changing the lift on the return stroke from zero to ⅜ in. The cooling liquid is held in the hollow base and delivered to the blade by an eccentric-driven plunger pump having steel ball valves. The machine is provided with a vise that swivels to 45 deg. for cutting at an angle.



HEAVY-DUTY POWER HACKSAW
Weight, 550 lb.; floor space, 14x36 in.; height to top of vise bed, 19¼ in.; height over all, 32 in.; weight on blade, adjustable from zero to 65 lb.

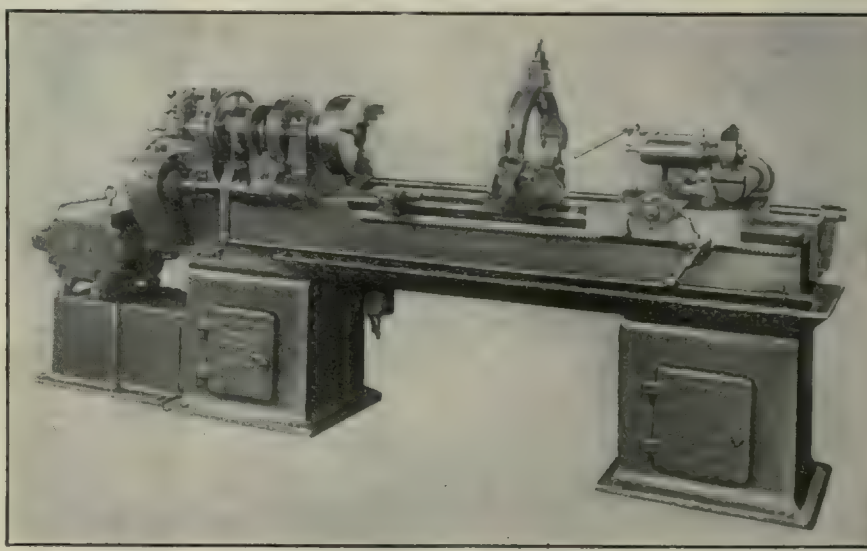
File-Sharpening Machine

The Macleod Co., Cincinnati, Ohio, has recently placed on the market a device known as the Buckeye file-sharpening and cleaning machine. In use, a blast of steam or air carrying an abrasive flint in suspension is directed against the file; the angle of which is fixed by means of guides. The steam or air may be used at pressures varying from 80 to 150 lb. per sq.in. A water jet is used in the nozzle, which prevents dust and undue heating of the files. After being used, the surplus abrasive falls to the bottom of the machine whence it is again sucked up by the blast to be used over again. The machine may also be used as a sand blast for small castings, there being a hand hole near the top at the rear through which the castings may be inserted. A file may be seen projecting from the opening at the left side of the machine. When the particles of abrasive become so worn as to be too small and light for service they are carried away through the overflow pipe by the surplus water from the jet. The surplus air passes off through the pipe rising from the top of the machine.

FILE-SHARPENING AND CLEANING MACHINE

Thread-Milling Machine

The T. C. M. Manufacturing Co., Harrison, N. J., has recently placed on the market two machines known as the Morris Thompson thread-milling machines, type 12-E and type 6-C. The illustration shows the type 12-E machine. Either internal or external threads may be milled by the use of a cutter of a width equal to the length of the thread to be cut, the complete thread being cut in a little over one complete revolution of the work. The work is fed as well as rotated by the main spindle. The cutter is mounted on a hollow spindle running in bronze bearings on a cross-slide and is driven through gearing from a longitudinal shaft. Four speeds are provided by means of gears. The clutch controlling the machine is automatically released on the completion of the thread. The pitch of the thread is determined by means of a threaded sleeve mounted on the work spindle and engaged by means of a split nut. Where face milling is also required, an arrangement is provided whereby the spindle may be rotated without being moved axially. The type 12-E machine is intended especially for threading the nose, base end and base plugs of large shells; while the type 6-E, which is similar except for being smaller and lighter, is intended to machine guns, automobile parts, etc., requiring only a comparatively short thread.



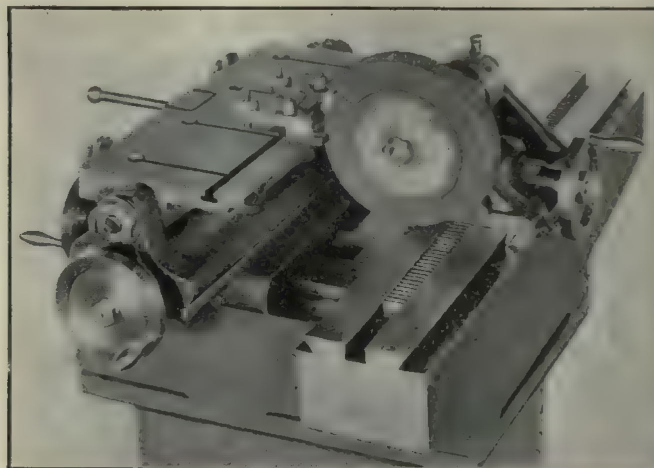
THREAD-MILLING MACHINE

Type 12-E—Capacity, 12 in. in diameter by 42 in. long; horsepower required 10; weight, 4400 lb. Type 6-E—Capacity, 6 in. in diameter by 34 in. long; horsepower required, 5; weight, 2800 lb.; length, 6 ft. 6 in.; width, 3 ft.

Gage Grinder

The grinder shown herewith has been recently placed upon the market by the Steel Products Engineering Co., Springfield, Ohio, and is called its No. 1 Universal gage grinder.

The wheel spindle is of the floating type, running in bronze bearings and lubricated by means of a series of oil grooves through which oil is carried by centrifugal force. The crossfeed is operated by means of a rack and pinion or by a fine pitch screw. The ways are protected by telescoping dust guards. The table may be tilted either up or down for the purpose of keeping the center line of the work on a radial line of the wheel. The table traverse is by means of a fine screw equipped with a handwheel.

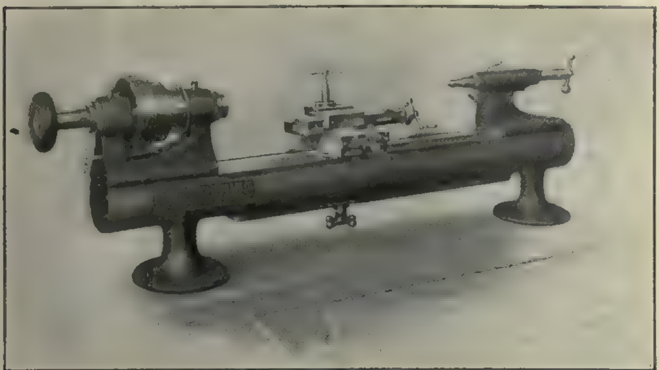


GAGE GRINDER

Table, 6¾x13 in.; table tilt, 10-deg. included angle; crossfeed, 4½ in.; traverse of table, 4¼ in.; traverse of head, 17½ in.; maximum distance spindle to table, 4½ in.; minimum, 1½ in.; floor space, 21½x30 in.

Bench Lathe

The bench lathe shown herewith is one that has recently been placed on the market by H. W. Cotton, Inc., Woolworth Building, New York City. The lathe has a swing of 7 in., collet capacity up to 5/8 in., and a bed 36



BENCH LATHE

in. long. The spindle is of the usual 3-deg. and 45-deg. construction and is lubricated by means of oil wells and felt wipers. Choice may be had of either two- or three-step cone pulleys. Grinder attachments are provided if desired, in which case the countershaft is provided with a 12-in. screw pulley.

Arc-Welded Stellite Tools

To meet the demand for an economical lathe, planer, shaper and boring-mill tool, the Haynes Stellite Co., of Kokomo, Ind., has brought out a tool that embodies a drop-forged, heat-treated shank made from 0.45 to 0.55

CARBON STEEL TOOL WITH STELLITE TIP

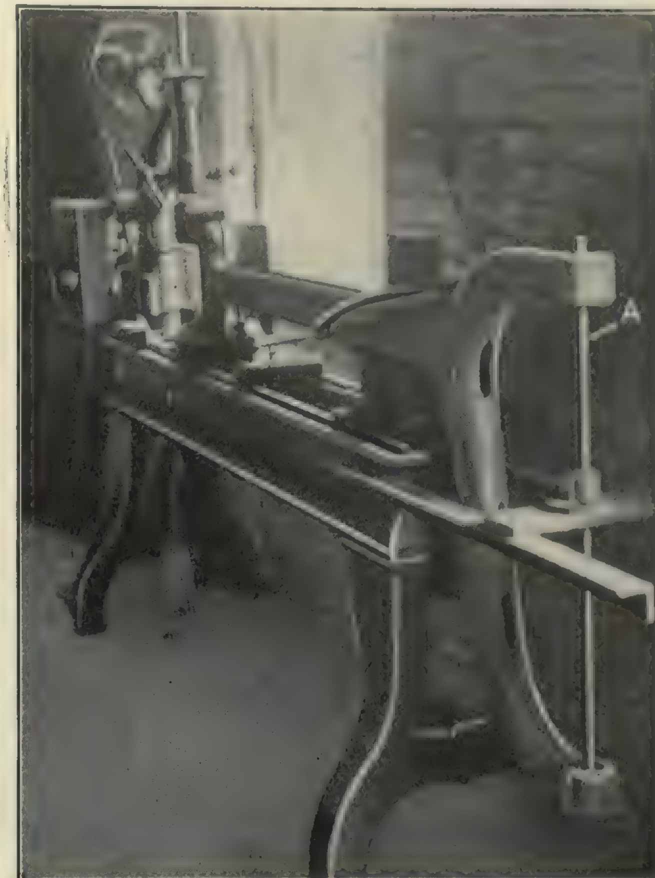
carbon steel, to which a cutting edge of Stellite is electrically arc welded. These tools are made in all standard tool-post sizes in straight, right-hand and left-hand shanks. Each tool is stamped with the grade Stellite used as an inlay and is shipped in an individual carton.

Boring and Babbitting Swing Saw Frames

In making its Reliance swing cutoff saws the Reno-Kaetker Electric Co., Cincinnati, Ohio, uses the device shown for boring out the saw arbor bearing bracket on one end of the frame and for babbitting the swing shaft bearings on the other end.

On one end of an old lathe bed 6 ft. long a part of a drilling machine is mounted, as shown. The spindle is run from a 1-hp. variable-speed motor bolted to the machine. Angle-plate brackets on the bed, to which the frame is held by C-clamps, locate the work. The babbitting mandrel *A* is held exactly in line with the spindle of the drilling machine by means of angle-iron braces. This arrangement insures the two sets of bearings being in line, as the babbitt bearings are poured before the frame is removed from the machine.

Five sizes of saw frames varying from 6 ft. long and 22 in. wide to 3½ ft. long and 10 in. wide are bored and



BORING AND BABBITTING SWING SAW FRAMES

babbitted on this device, the drilling head being adjustable along the bed to accommodate the different lengths.

Civilian Engineers in Navy Yards

At a regular meeting of the New York section of the American Society of Mechanical Engineers, held on Jan. 9, Commander E. P. Jessop, U. S. N., briefly told of the movement to enroll civilian engineers for use at navy yards in case of war or other emergencies. Arrangements are now made to enroll any engineer who can be of service at such yards and to assign him as far as possible to some department to which he can report on call.

He urged all to find out what part they could take, to fix this firmly in their minds, so as to be prepared to begin the work without delay. All applications are examined by a committee to determine where the applicants can be of greatest service. The priority of Government contracts was also urged as a very important and much needed step in the matter of preparedness, the securing of the material now under order being quite necessary to have it of its greatest value.

The commander then showed many interesting views of the "Tennessee" on her relief expedition to Turkey and her trip to South America, closing with her destruction by a tidal wave after being renamed the "Memphis."

Business is Business*

By Berton Braley

"Business is Business," the Little Man said,
"A battle where 'everything goes,'
Where the only gospel is 'get ahead,'
And never spare friends or foes,
'Slay or be slain,' is the slogan cold,
You must struggle and slash and tear,
For Business is Business, a fight for gold,
Where all that you do is fair!"

"Business is Business," the Big Man said,
"A battle to make of earth
A place to yield us more wine and bread
More pleasure and joy and mirth;
There are still some bandits and buccaneers
Who are jungle-bred beasts of trade,
But their number dwindles with passing years
And dead is the code they made!

"Business is Business," the Big Man said,
"But it's something that's more, far more;
For it makes sweet gardens of deserts dead,
And cities it built now roar
Where once the deer and the gray wolf ran
From the pioneer's swift advance;
Business is Magic that toils for man
Business is True Romance.

"And those who make it a ruthless fight
Have only themselves to blame
If they feel no whit of the keen delight
In playing the Bigger Game,
The game that calls on the heart and head,
The best of man's strength and nerve;
Business is Business," the Big Man said,
"And that Business is to serve!"

*Reprinted from the January issue of "The Nation's Business."

New Publications

Examples in Alternating Currents: Vol 1—By Prof. F. E. Austin. Second edition. Published by the author at Hanover, N. H., 1915. Two hundred and twenty-three pages, 5x7½-in.; illustrated. Price, $2.40.

A well-selected list of 57 problems covering electrical pressures, sine curves, inductance, impedance and capacity. Trigonometry and calculus are used freely in the solution of the problems, and for a handy reference the first 45 pages are devoted to a review of these mathematical functions. A number of useful tables and diagrams are also included. The book will find its greatest use among students and engineers who have had some training in mathematics and the fundamentals of electricity.

First Principles of Electricity—By J. E. Homans. Published by Sully & Kleinteich, New York City. Two hundred and forty-eight, 5x7½-in. pages; illustrated; cloth bound. Price, $1.

This book is intended to be used as a primer of electrical science or as a handbook of fundamental principles. The author starts with the assumption that the reader may be unlearned in electricity and attempts to treat the subject from the ground up, passing in review all the matter necessary to constitute a fundamental knowledge of electricity and magnetism. This is one of the weak points in the work. An endeavor has been made to treat too many subjects in the allotted space. The chapter headings are: Electricity and Its Manifestations; The Chemical Generation of Electric Current; Pressure, Resistance and Current; Electrical Proportions and Units; Electrical Quantity, Power and Work; Wire Conductors; Series and Multiple Circuits; Galvanic or Primary Chemical Cells; Storage or Secondary Electric Cells; Current Induction or "Side Action"; Magnetism and Magnets; The Laws of Magnetism; Magnetic Quantities and Units; Alternating Electric Currents; Phase and Circuit Conditions; Polyphase Conditions; Dynamo Electric Machines and Electric Motors; Direct-Current Motors; The Torque or Turning Effort of a Motor; The Field Windings of Dynamos and Motors; Synchronous Motors for Alternating Currents; Induction Motors for Alternating Currents; Rotary Converters for Current Transformation; Magnetic Coils and Transformers.

Personals

H. A. Runge has severed his connection with the Internations Commercial Corporation.

A. R. Griffin is now with the Kellogg Manufacturing Co., Rochester, N. Y., in the capacity of production and factory manager.

Henry Meyers has left the Hamilton Machine Tool Co., Hamilton, Ohio, and taken a position in the sales department of the Cullen Machinery Co., Cleveland, Ohio.

E. E. Witte has been made secretary of the Industrial Commission of Wisconsin, succeeding P. J. Watrous, who has taken a position with Lord & Thomas, Chicago, Ill.

R. G. Miller, formerly district manager of the Westinghouse Machine Co., Philadelphia, has taken the position of district manager at the Philadelphia office of the Kerr Turbine Co.

L. M. Wainwright, president of the Diamond Chain and Manufacturing Co., Indianapolis, is vice-chairman of the new Indianapolis section of the American Society of Mechanical Engineers.

H. W. Sage, formerly Pittsburgh district manager of the Crocker-Wheeler Co., is now district manager of the Boston office of the Kerr Turbine Co. He has been succeeded at Pittsburgh by J. R. Lewis.

James W. Barr, formerly Eastern representative of the Cincinnati Milling Machine Co., has taken a position as general machine-tool salesman with the Vandyck-Churchill Co., Singer Building, New York City.

C. W. Francis, formerly superintendent of the Ahrens-Fox Fire Engine Co., Cincinnati, Ohio, has left the concern and is now superintendent of plant No. 2 of the Robins & Myers Co., Springfield, Ohio.

Charles T. Bird has resigned from the Mott Sand-Blast Co. to take a position with the Pangborn Corporation, Hagerstown, Md., as vice-president and works manager in charge of engineering and production.

Catalogs Wanted

The Franco-American Commerce Co., 21 Park Row, New York, has received inquiries for precision lathes, slotting machines, planers, drilling machines, surface grinders, inside milling machines, hack saws, twist drills, reamers, milling cutters, taps and dies, and would be glad to receive catalogs in duplicate from manufacturers of such equipment.

Trade Catalogs

Trumbull Lightning Tapping Machine. F. S. Trumbull, Bridgeport, Conn. Circular; illustrated.

Slushing Compound. Warren Brothers Co., Boston, Mass. Booklet; pp. 8; 3½x6 in.; illustrated.

Ball-Bearing Tool Grinder. Lamb Knitting Machine Co., Chicopee Falls, Mass. Circular; illustrated.

Collapsible-Reversible Pick-Up Triangle. R. B. Ware, 101 Northampton Ave., Springfield, Mass. Circular; illustrated.

Mesta Improved Pickling Machine. Mesta Machine Co., Pittsburgh, Penn. Bulletin M; pp. 8; 6x9 in; illustrated.

Universal Production Turret Table. Milliken Machine Works, West Newton, Mass. Circular; illustrated.

Duplex Hacksaw Machine. Coats Machine Tool Co., Inc., 30 Church St., New York. Catalog; pp. 20; 6x9 in.; illustrated.

Universal Angle Plate. Boston Scale and Machine Co., 381-89 Congress St., Boston, Mass. Circular; illustrated.

Morris Thomson Semi-Automatic Thread-Milling Machine. The T. C. M. Manufacturing Co., Harrison, N. J. Catalog; pp. 10; 6x9 in.; illustrated.

Vasco-Marvel Semi-High-Speed Steel. Vanadium-Alloys Co., Pittsburgh, Penn. Folder. High-speed steel standard classification of extras adopted July 22, 1915, is included.

Planers. Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Catalog; pp. 32; 9x11 in.; illustrated. Contains very fine halftones and detailed descriptions of the different-sized planers made by this company.

S K F Self-Aligning Ball-Bearing Hangers and Pillow Blocks. S K F Ball Bearing Co., Hartford, Conn. Bulletin; pp 48; 6x9 in.; illustrated. Valuable tables and curves and engineering data upon mounting lubrication, testing lubricants, etc., are given.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Time Studies for Rate Setting as Originated by Dr. F. W. Taylor*

BY CARL G. BARTH†

SYNOPSIS—This is the introduction to a series of articles on time study in machine shops, prepared under the auspices of the Frederick W. Taylor Coöperators. Taken together, the articles in the series will give the first comprehensive statement ever published of the methods used in making time studies on machine tools, and the complete results of such studies on a number of standard lines of machines.

In his paper, "A Piece-Rate System," read before the American Society of Mechanical Engineers at the Detroit meeting, June, 1895, the father of scientific management, the late Dr. Frederick W. Taylor, first attempted to acquaint the members of that society and the world at large with his idea of elementary, or unit, time studies and the use he had up to that time made of such studies in task and rate setting at the Midvale Steel Co., Philadelphia. Much to Dr. Taylor's disappointment, the real significance of what he tried to present was at that time entirely lost on his audience. It was only after the presentation of his second paper before the same society, dealing with matters of management, "Shop Management," read in 1903, that a limited number of engineers and manufacturers began to see what he was aiming at, outside of the exceedingly few who in the meantime had had the good fortune to fall directly under his influence.

While Dr. Taylor never personally had the opportunity to apply his ideas in practice except in connection with a comparatively simple product, his faith in elementary time studies as the only correct basis for just task and rate setting was absolute. He predicted that the time would come when handbooks containing classified and conveniently arranged unit times would be compiled and published, to enable anybody ordinarily familiar with the particular subject treated to predetermine a just total time allowance for any job that might be resolved into elementary, or unit, operations of the kind to which the unit times recorded in such a handbook would be intended to apply. With this in mind he personally organized work in two different fields, engineering construction and machine-shop work. As far back as 1896 in collaboration with Sanford E. Thompson, the study of unit times in construction operations was begun; and one book, "Concrete Cost," has already been published, while others are in preparation. With a view to similar publications to deal with machine-shop work, Dr. Taylor arranged with Dwight V. Merrick to begin a careful review and sifting of the vast number of unit times made and recorded by him during his many years of time study and task and rate setting, partly in connection with and partly subsequent upon my own Taylor system work in preparing a number of shops for Mr. Merrick's particular part of this work, by the development of more scientific general methods of management and by the standardization of the machine and tool equipment of those shops, first under Dr. Taylor's general directions and later independently of him.

In connection with this plan I was called into consultation. It was felt that the work was of such magnitude and nature that a second man combining some shop experience with experience as a writer and editor should be found, to assist Mr. Merrick in the preparation of the text. For this purpose the services of Robert Thurston Kent were subsequently secured.

On Dr. Taylor's death the work thus barely begun was naturally interrupted. However, by an agreement since made by the *American Machinist*, the so-called Taylor Coöperators (consisting of Morris L. Cooke, H. K. Hathaway and myself), and Edward W. Clark, 3d (the executor of Dr. Taylor's estate), the task has been resumed by Messrs. Merrick and Kent. The results will be published in the *American Machinist* from time to time as the work progresses and as it is found convenient by the management of that paper to have the articles appear.

PLANS FOR FUTURE TIME STUDIES ON MACHINE TOOLS

In spite of the facts that Mr. Merrick's time studies through these several years have unquestionably been the most carefully made anywhere in connection with machine-shop operations and that he had them well tabulated and arranged for quick reference by himself and his assistants, when it came to re-analyzing them and preparing them for the proposed publication for general use, he found them to leave much to be desired. As a consequence it was deemed advisable that they be made over again in a far more systematic manner than had been possible at the time they were first made. Thus, while Mr. Merrick's original studies on machine tools were all taken in shops in which the studies were for immediate use, the improved studies for publication will be made in the shops of the manufacturers of such machine tools and simultaneously on a whole line of machines of the same type and general design. Only through such studies can any fully consistent results be obtained. The eventual, full success of this undertaking will thus depend on the amount of coöperation that can be obtained from the machine-tool manufacturers themselves. But very little doubt is entertained about obtaining the fullest degree of coöperation from the manufacturers of such lines as it will be considered worth while to take up, as soon as the present rush of business begins to subside. In fact, this introduction appears now because the studies on a line of vertical boring mills and a line of turret lathes, both manufactured by the Gisholt Machine Co., of Madison, Wis., which Mr. Merrick made in the Gisholt shops some two years ago under the most cordial coöperation of that company, will appear in following issues of this journal.

By elementary, or unit, time is here to be understood the minimum time it takes a first-class but not extraordinary worker to perform an elementary, or unit, operation. It is in deciding where to place a first-class worker between the second class, on the one hand, and the extraordinary one, on the other hand, that good judgment plays

†Consulting engineer, Philadelphia; member of Frederick W. Taylor Coöperators.

such an important part in this whole matter that I have but little confidence in most of the time studies made throughout the country. It requires knowledge and experience that cannot be acquired except through years of contact with work and workers, while numerous so-called time-study men are perfectly green at the work they undertake to study. For this reason I also criticize the labor unions less than many others do for their attack on this part of scientific management, as it is only too often mispracticed, though I greatly deplore their unwillingness to see that it is fundamentally of such a nature that it must eventually find its way through to universal recognition and acceptance, and that it would be to their own interest in the long run, as well as to that of the world at large, to assist instead of to oppose its legitimate development.

Use and Application of Time-Study Results

When a task is set, the total time allowance for it is made up of the sum of all the unit operations—machine and hand—into which the task is analyzed; certain allowances to cover possible variations in the speed of the machine from the normal; the additional time required to perform a series of unit operations over and above the sum of their minimum unit times; minor unforeseeable interferences and delays that cannot be counted out under even the most highly standardized conditions; and necessary rest periods, if any.

One of the articles to follow will discuss the manner of arriving at these allowances and their application, for certain kinds of work. The fundamental basis for just task setting is correct unit times; and before closing I will only add that the difficulties encountered by the really experienced task setter in a machine shop in making allowances over and above the unit times, that are sufficiently liberal, on the one hand, and not excessive, on the other hand, are not as great as often supposed.

In line with Dr. Taylor's wonderful industrial faith, which has sunk deeply into some of us, I will conclude by stating that I believe the time will come when slide rules covering all kinds of machine operations and carefully observed unit times covering all hand operations on their machines will be prepared by the manufacturers of machine tools themselves, and sent out with every machine sold, just as nowadays many valuable—yes, indispensable—directions for the proper use and handling of certain kinds of machines always accompany the shipment.

Forming an Awkward Radius in Sheet Steel

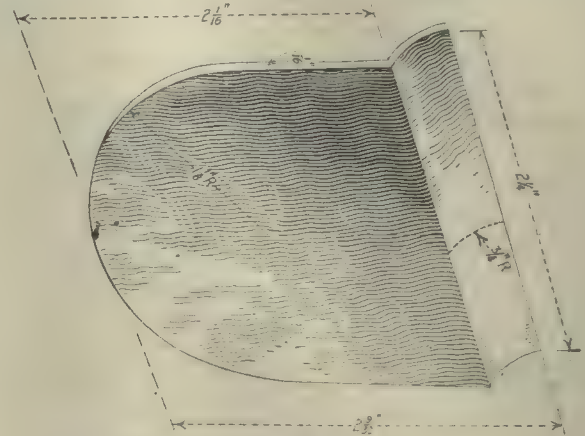
By. W. D. Forbes

A man who had some machine work to be done went into an experimental shop where the system was to hand the customer over to a toolmaker, who would proceed to carry out the job. After discussing the blueprints with the toolmaker, the customer said: "This piece is made of sheet steel, but it must not be annealed. All the sizes are only scale measurements, except the 3/4-in. radius, in which I can only allow a variation of 0.001 in. above or below the nominal size. You will have to make some tools for this, as the inside of the curved portion must not be filed or scraped, but lie flat on a 1 1/2-in. shaft."

The customer had taken out his pocket-knife and used one of the blades for a pointer. Absentmindedly, he stuck the knife in the bench and went away without it; but before leaving, he cautioned the toolmaker to be very careful with that particular piece.

"Get it out first," he said, "and keep the time on the necessary tools separately."

This happened about ten o'clock in the morning. Just before noon the customer returned for the knife that he had left, and greatly to his surprise and satisfaction beside the knife lay the finished piece. He asked the toolmaker where were the tools he had made the piece with.



THE PIECE TO BE MADE

The workman pointed to a vise and then to his head, and answered, "These were the only tools I used." Nor would he tell the customer how he had done the job, except that the radius was about 0.001 in. larger than it was actually supposed to be.

How did the toolmaker do the job and how did he know that the radius was about 0.001 in. large? It must be acknowledged that the piece was an awkward one to measure. If, after a few weeks, your readers have not described the method used, I will give it away; for it seems to me it is a very interesting piece of work to puzzle over, and I think the method will be of value to your readers.

A Repair Job Resulting in an Abrasive Nut

By W. G. Wells

Sometimes we come across things that are extremely funny if we look at them from the right angle. The incident of which I write struck me as being too absurd, viewed from an efficiency standpoint.

The threaded sleeve on the underside of a small surface-grinder table wore out, and a piece of brass was obtained with which to make another. But instead of cutting an internal thread in the brass, it was bored out about 3/16 in. larger than the screw and babbitted, the babbitting being done without first heating the screw. Then an attempt was made to free it by upsetting the end of the screw and forcing it through. When this failed, the boss prescribed emery and oil, which worked: but he evidently does not know that the lapping operation will not cease so long as there is any thread left on the screw.

Modern Punch-Press Department

EDITORIAL CORRESPONDENCE

SYNOPSIS—Herewith are illustrated the punch-press department and equipment in a well-known typewriter-manufacturing establishment, where machinery is operated efficiently under the best conditions as to sanitary features, proper illumination, cleanliness and general convenience of appurtenances in the way of trucks, benches, tool racks and the like. A most interesting tool shortage in this department holds many thousands of dollars' worth of punches and dies. Many of them are of great interest to tool designers and high-grade mechanics.

The accompanying illustrations, recently taken in the plant of the Noiseless Typewriter Co., Middletown, Conn., are views of one of the cleanest and most attractive punch-press departments I have as yet had the opportunity to visit. This department is organized in the wing at one side of the main factory and is splendidly illuminated from the side windows and from liberal skylights in the roof. Fig. 1, which is a general view looking down the length of the shop, shows how light and clean this department really is.

FIG. 1. A GENERAL VIEW OF THE PUNCH-PRESS DEPARTMENT

The presses as at present installed are arranged in long rows down each side of the department, with the central portion of the room left clear for benches and for trucks for handling tools, stock and finished material. The presses range in size from the large-geared machine in the foreground, which is adapted for the heaviest blanking and drawing operations required at this plant, to light foot-power machines shown at the far end of the room. The furniture in the equipment—that is, the benches, foremen's desks, operators' chairs, tool trays and racks—are almost entirely of metal. Such woodwork as is used is merely to cover metal surfaces to provide safe storage spaces for tools that are handled about the shop. The racks, or storage shelves, for the punches and dies are made completely of metal, their arrangement being shown in Fig. 2.

The cabinet for tool storage stands at the head of the punch-press department, near the foreman's desk and near the inspection benches. It consists of 48 compartments and shelves, which are shown completely filled with punches and dies from the smallest subpress tools to heavy blanking equipment for large typewriter parts. Any tool maker will know at a glance that there are thousands upon thousands of dollars' worth of high-grade tools thus stored.

To the casual observer, even to many mechanics who are not familiar with this kind of toolwork, there is nothing about the ordinary punch and die to give a clear indication of its value, as represented by the time and labor involved in its production. Frequently the material entering into the construction of such tools, although expensive in cost per pound, does not total any great sum. However, the labor itself may run into several hundred dollars or even more for tools somewhat intricate in character.

There is much about this work that is not "cut and dried" and that does not permit methods adapted from the factory system of production. It often happens that each operation on a punch or die is distinctive in itself. Frequently, considerable experimental work is necessary in developing the exact dimensions of these tools to produce certain results satisfactorily. It would seem, without asking the question specifically of the management, that there must be in the neighborhood of $50,000 worth of punches and dies on these shelves, or about $1000 per section.

The truck shown at the left in Fig. 2, with tools upon the top shelf, is one of a number of these appliances used about this department. A still handier truck, in some ways, is illustrated in Fig. 3, at the back of the large presses. This truck is for handling very large punches and dies up and down the shop. It is made of such a height that dies and bolsters can be slid directly onto the bed of the press without being lifted at all, which greatly facilitates setting up jobs on these heavy tools. The trucks for handling this class of work are made largely of wood with 3x3- or 4x4-in. corner posts, heavy platform tops, heavy lower shelves and substantial casters which are free to move in any direction. In this way the tools are readily transported about the shop between the press and the storage racks. In some cases where the dies are very heavy, they are practically kept on special trucks all the time, to obviate the trouble of shifting them about.

FIG. 2. THE STORAGE SHELVES FOR PUNCHES AND DIES

Safety Devices for Punch Presses

We all know the dangers of the press department when it comes to the handling of work under the punches and recognize fully the possibility that continuous operation of such machines presents for the loss of a thumb or fingers. It is rare indeed to find an operator of a good many years' service in such a department who is not more or less seriously injured. It sometimes seems impossible, even with the greatest care in applying safeguards, to arrange matters so that the operators cannot possibly get their fingers caught. This is sometimes because of the character of the tools themselves. Sometimes it is due to the tendency of operators, where given any latitude in the matter, either to remove the safeguards entirely or put them out of action by interposing some device to throw the guard out of service.

In the department illustrated herewith a good many of these safety devices have been installed. They have been attached in all cases where second-operation work is being done and where the blanks have to be nested for such operation. The typical kind of safeguard developed at this plant is shown in Fig. 4. In this case it consists simply of a pair of arms pivoted near the rear end and connected at the front end with a through-bolt or rod. This forms a swinging frame whose rear end is so arranged that it furnishes a positive lock for the clutch-releasing mechanism, except when the safeguard is dropped down to a lower position—that is, with the rod in front resting upon the front of the bolster or bed of the press. In other words, this construction is such that the press cannot be started by the foot treadle or otherwise until the safeguard is depressed and swung out of the way so that its rear end allows the treadle-connection mechanism to the clutch to be operated.

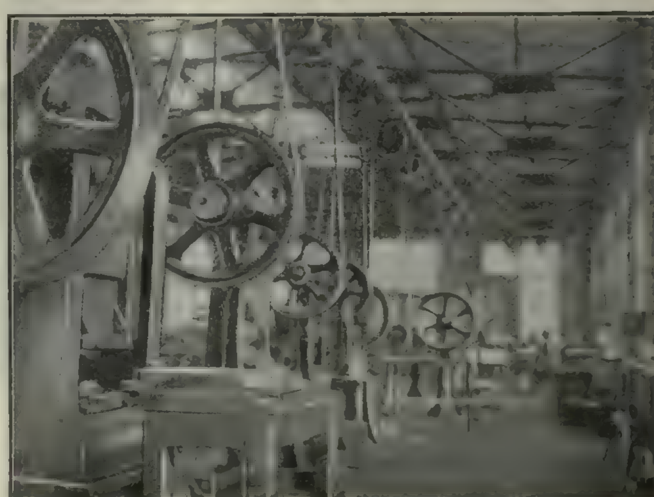


FIG. 3. TRUCK FOR HEAVY DIES

This cannot be depressed as long as the operator has either hand under it. He has to put both hands under it in order to place the work in position, and until he has removed both hands the safeguard cannot drop and allow the press to be started. Consequently, it would seem im-

possible for anybody to catch his fingers under the tools with this device applied. It has been in service for a long time on various presses throughout the department and has eliminated entirely all possibility of accidents due to carelessness, bad luck, or oversight in leaving the hands exposed when the press is started.

FIG. 4. SAFETY DEVICE ON A PRESS

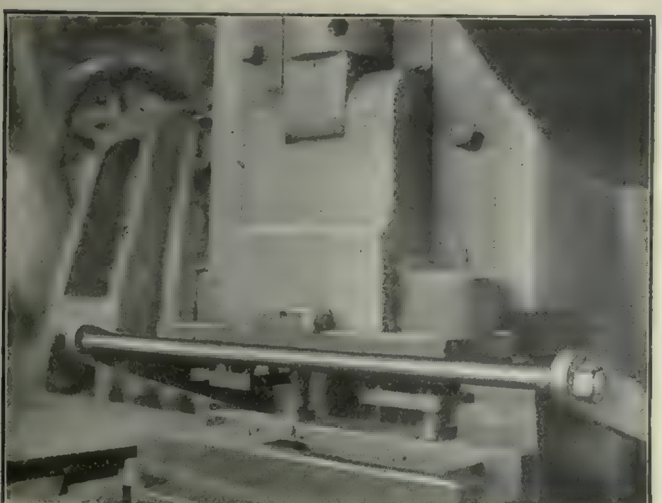


FIG. 5. NEAR VIEW OF SAFETY DEVICE

A similar device is shown in front of the press in Fig. 5. The dies here illustrated are for the second operation on a long strip that has to be formed up at either end, as indicated. In this case a flat strip is nested between two pairs of pins at opposite ends of the main die block, in which are inserted two dies proper. Without a safety device of some kind it would be very easy indeed for the operator, in passing this thin strip, to catch his fingers under the punch when this descends. As a matter of fact, however, with the safety rod at the front, he cannot depress the treadle sufficiently to throw in the clutch, unless both hands are entirely removed from the die. Consequently, the punch in descending cannot possibly catch any portion of the hand.

This form of press guard is easy to install, and its utility and advantages need little explanation. It may be pointed out, however, that the instant the operator raises the guard to place the work in position he locks the treadle mechanism against any possible releasing of the clutch. Only upon getting both hands out of the way and dropping the safeguard can he start the machine. In so far as safety devices on punch presses in any way hamper the speed of output the natural and logical course to pursue would be to get rid of hand feeding of the work entirely. This condition could be effected by applying some automatic device in the way of a magazine feed, either of the rotary or the reciprocating type.

Such feeds have long been in use in many cases where high speed of production is necessary on presses. There are certain cases where entire lines of machinery, involving punch and drawing presses, heading machines, trimming machines, etc., are operated entirely with automatic feeding apparatus.

Some Dredger-Repair Work

EDITORIAL CORRESPONDENCE

Dredging equipment, like most other mechanical apparatus, requires more or less repair work. Owing both to the size of the dredger parts and to the nature of the operations under which the work is conducted, these repairs are oftentimes of a peculiar nature and of considerable interest from an engineering point of view. The illustrations herewith show some of the repair operations on equipment of the Hawaiian Dredging Co., Honolulu.

In Figs. 1 and 2 is illustrated the recovery of a steel dredge ladder preparatory to overhauling and remounting it in place. This 75-ft. ladder carried away, swung outboard, and its lower end rested on the sea bottom with the top end on the boom. The gantry went overboard also and pulled the dredge away from the wharf. The ladder was picked up and hoisted into position again by a 1¼-in. steel-wire power cable. This twisted strand cable was made especially for the requirements of the service in Hawaii. Some idea of the size of the ladder will be gathered upon inspection of the photographs and comparison of the dismantled member with the equipment used in its salvage.

In Figs. 3, 4 and 5 are represented repair operations on a dipper handle and dipper, involving the removal of these parts and their replacement by new ones preparatory to sending the dredging equipment to another island. In Fig. 3 the workmen are seen engaged in the operation of taking out the old dipper handle, and in Fig. 4 preparations are being made to lower the boom. Fig. 5 illustrates the method of putting in a new hoisting cable. This is a 300-ft. length of six-strand plow steel 1⅜ in. in diameter.

Fig. 6 illustrates what might be termed a near wreck. The big dipper is shown with the bail carried away at one side and with only one pivot left to support the heavy structure. Repairs to a broken part of this kind mean either the refitting of the ruptured end with a new yoke, or if this is not feasible, the construction of a new bail.

This latter operation is not always an easy repair job, as it involves the forging of the new part, bending to shape, fitting the yokes to the ends and boring the big hole at the top for the shackle bolt by which it is connected with block and tackle. The lower ends of the yoke have to be bored aproximately in line, and the boring of the larger hole at the top requires the use of a pretty heavy drilling machine—or preferably, where the shop is well equipped, the services of a horizontal boring machine, on the table of which the forging is placed fork ends up, while the hole is bored and finished to size.

Most of the operations in the upkeep of heavy equipment of this character are entirely unknown to the majority of mechanics familiar with general shop practice. Like repair work of all kinds, these problems form a most interesting study; and not the least important feature is the fact that delay in putting such jobs through the shops is most expensive, owing to the great cost of the equipment itself and the consequent loss to its users when it is out of service. For this reason it is generally customary to give repair work preference over the other work passing through the shop at the same time.

FIGS. 1 TO 6. REPAIR OPERATIONS ON A DREDGE AT HONOLULU

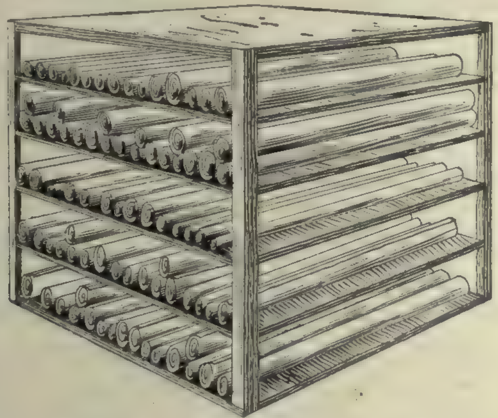
Figs. 1 and 2—The recovery of a steel dredge ladder. Fig. 3—Removing the handle of the old dipper. Fig. 4—Preparations for lowering the boom. Fig. 5—Installing a new hoisting cable. Fig. 6—Dipper with broken bail

System in the Drafting Room

By Charles M. Horton

SYNOPSIS — Of course, every drafting room needs system, but this may be either good or bad. Incidents in the use of both kinds but emphasize this fact. Draftsmen also have bits of system of their own, and these also may be good or bad. Steve Tucker had one that cost him his job.

"Frank!" snapped the chief draftsman, from his office partitioned off from the drafting room, calling to the office boy. "Frank! Boy!" There was a silence. The boy was out in the hall, as we draftsmen well knew, smoking a cigarette. "Where is that confounded boy?" rasped the chief, continuing, as he suddenly strode from his office, eyes blazing and face red with anger. "He's a perfect office boy!" he went on, addressing himself to us, his manner cynical, but mollified. "Never about when wanted! I —"



THE "RACK"—RIGHTLY NAMED

THE DRAWINGS WERE FILED IN CABINETS IN A FIREPROOF VAULT

"Yes, sir?" inquired a soft voice at his elbow. It was the kid—come to life. He was an innocent-faced youngster, about 16, and a jewel for remaining unruffled, even under the boss' most violent tirades. "Did you want me, Mr. Wyatt?"

The chief wheeled. "Oh, here you are!" he rejoined, irritably. "Yes, I want you. I want drawing No. 65. Where is it? It was on my desk this morning, rolled up. What has become of it? Show a little life, now! Where is it?"

"Why," drawled the kid, "it's in the rack."

"Yes; but whereabouts in the rack? The rack is a big place! Go dig it out, now! And the next time I call you I expect you to answer!"

And then to us:

"What this drawing room needs is a system! The idea of being held down in the hunt for drawings by a kid! Nobody else here knows a thing about them after they are put away! It's a confounded outrage!"

Which, verily, it was—an outrage. The pencil drawings were made, tracings made from these, blueprints made from the tracings, the pencil drawings destroyed—all this was the first step. Then the blueprints and tracings would be rolled up promiscuously, with a tab of paper containing the name and number snapped around one end of the roll with a rubber band, and the roll tossed up into the rack by Frank, who when searching for a drawing usually had to handle over the entire collection before he found what he was after. And the chief draftsman, while eternally vowing that he would change the system or, rather, establish one, never did so. As a result, chaos reigned in that particular drafting room. Whenever a drawing was needed, the thing was put up to Frank, because no one else understood his system of filing—and Frank, more than likely, when wanted, would be out in the hall refreshing himself with a Sweet Caporal—"ask Dad."

All drawing rooms are not, fortunately, like the one mentioned above. Usually, there is some sort of system. But as a general rule, the form of system varies with the drafting room, and it has been my observation that there are as many systems in use, almost, as there are drafting rooms. A drafting-room system is but the lengthened shadow of some chief draftsman, for every chief draftsman has his ideas of what a system ought to be and puts these ideas into practice. Therefore, a draftsman needs only to change his job often enough, and he will absorb a knowledge of systems broad enough to warrant his setting himself up eventually as a systematizer—at least of drawing rooms.

The System in a Jersey Jobbing Shop

I believe one of the best systems I ever encountered was the one in use in a small jobbing plant down in New Jersey. The organization had been established almost a hundred years, and because of the nature of the work throughout all these years—tugboat shafts and propellers, smelting-furnace implements, marine engines, cast-iron retorts, grate bars and the like—the drawings naturally were many and of very large variety. A clean-cut system was absolutely necessary to the organization. Repeat orders would come in for material and parts originally made, some of them, 25 years before. Frank's system of filing would not have availed them much in this drafting room. An absolutely and quickly get-at-able system was required—and this company had such a system.

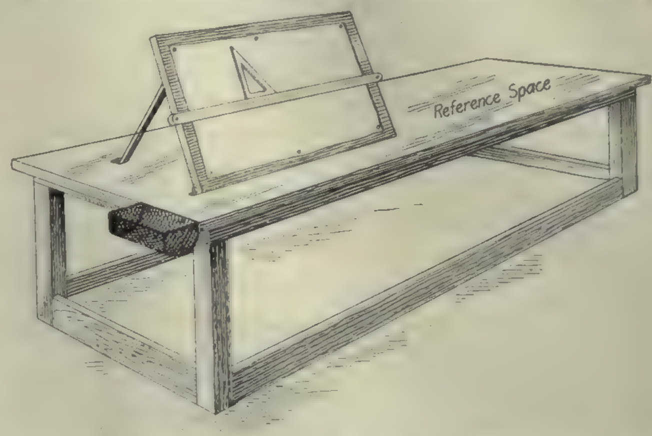
There was, first, a cross-index set of books. There were two of these books, each well bound and of heavy paper.

One of the books contained in the leading column, in alphabetical order, the name of the part, the name of the drawing and the number of the drawing. The other book contained, in the leading column also and also in alphabetical order, the name of the firm for which the piece had initially and thereafter been manufactured, together with all other information relative to the piece —name and number of the drawing and where it was filed. When an order came into the office for a set of grate bars, say, for a certain furnace, or a shaft and propeller for a certain towboat, the chief draftsman, lacking leading information of one sort—the company operating the furnace or the towboat might have changed hands down the years—would consult the other index book and by its information readily place his hands upon the desired drawing.

The drawings were kept well, also. They were filed in cabinets in a fireproof vault just off the drawing room, and they were never removed into daylight except to be blueprinted, which was done by the blueprint "devil" right there in the drafting room, and then were immediately returned to the vault. That was an ironclad rule —and woe betide the draftsman who for any reason whatsoever chanced to violate it. As a matter of fact, the process of removing the drawing from the vaults, slapping it into the printing frame, shooting the frame out of the window into the sunlight, yanking it back again when sufficiently done, hurrying the drawing once more back into the vault, all was done in jig time under the hawk eye and almost unwavering gaze of the soberly attentive chief draftsman. Under these circumstances any blueprint devil would move on the jump, and the particular kid here always did in my time. It was a matter of seconds and of pride with him, and he was always trying to beat his own best record. One jump to the vault, one yank at the correct drawer, three leaps across the drafting room to the blueprint frame, slap, bang, and up with the window and the frame outside. Then a period of restless waiting—with one eye on the chief. After that the process was inverted: Three leaps to the washing tank and, zippo! the drawing safe and secure again in its proper drawer in the fireproof vault. They did not take any chances—those folks! 'Cause why?—Because that drawing was valuable, not only as a drawing, but also as a record of what the thing was; and should this record become lost, the work more than likely would go to the hated rival company on the next street—a young, flourishing and aggressive organization doing jobbing work also.

At that, the system of numbering the drawings was simplicity itself. Each drawing was marked with two letters and one number, thus—*A*-96-*K*. There were four sizes of drawings, and the sizes were listed *A*, *B*, *C* or *D*, according to the size. The cabinet in the vault contained four tiers of drawers, with each tier containing 10 individual drawers. Taking the first tier, containing the largest-size drawings, it was lettered *A* at the top, and each drawer was lettered—*A*, *B*, *C*, *D*, *E*, *F*, *G*, *H*, etc. The next tier, containing the next largest size, was lettered *B* at the top; and its drawers were lettered, as in the case of the first tier, *A*, *B*, *C*, *D*, *E*, *F*, *G*, *H*, etc., all the way down. Likewise the third and the fourth tiers. Therefore, when the book index showed a drawing number to be *C*-57-*H*, one went directly to the third tier of drawers, opened the *H* drawer, turned back the corners of the drawings to No. 57—and that was all there was to what, in some drawing rooms, is a difficult task. As a system, it was originated many years ago; but nobody has ever persuaded the management—and many card-index system men have tried—to accept a change.

This was a small drafting room, carrying at the outside four draftsmen; and when a man needed a drawing for reference in his work, he usually dug out the necessary drawing himself for blueprinting. System in drafting rooms goes beyond mere filing and keeping of drawings.



THE DRAFTSMAN WOULD DROP HIS REQUESTS FOR DRAWINGS INTO A BASKET, AS SHOWN

A System that Thrived in Pittsburgh

In one of the large manufacturing companies where I was at one time employed in the Pittsburgh district, whenever a draftsman needed a drawing for reference, he would make out a slip of paper calling for the particular tracing and drop this slip into a wicker basket at the end of his drawing table. In due time a boy, known officially as a "runner," would come around gathering up these slips, and presently would return with the desired drawing. Men and boys stationed in the drawing vaults would readily locate and hand over the drawing called for. It was an elaborate system, but then the organization, carrying as it did over a hundred draftsmen, was an elaborate organization. Often the waits were long and annoying to the draftsman, who more often than otherwise was "stopped" in his work for lack of the tracing required. But then, also, large bodies must, because of their great bulk, move slowly.

There is a handy little stunt used in some drawing rooms. It consists in a judicious use of the shears in trimming down a finished tracing to its established border line. When doing this trimming, instead of following the penciled line clear around, the draftsman leaves a tiny tab projecting from one corner, outside the line of the border. It is a sort of ear; and when this ear contains, as it does where this system is in use, the number of the drawing in small letters and figures, one searching for the drawing is readily guided to it as it lies in its drawer among others. The tiny lobe sticks out like the tongue of a precocious youngster and so obviates the necessity that otherwise exists of turning back a whole corner of the drawing in the search, and in so doing creating bad wrinkles and creases in the sheet, which in themselves tend to crack off minute particles of india ink and thus decrease the value of the tracing for blueprinting.

The card-index and filing people have made their influence, originality and initiative felt among drafting-

room folk. Uniform systems of filing drawings are steadily becoming installed throughout the country. Many of these systems have merit—notably the upright cabinet containing folders suspended from wooden bars on a rack —and all of them have their uses. The trouble with the upright cabinet, if it be a trouble, is that a man must haul out a full paper folder of drawings, search through this folder in his quest for a drawing and then fuss with the rack system in order to get the folder itself back into place. Nevertheless, as a system of filing and keeping drawings, it has the system made use of by Frank stopped by some considerable number of miles. As a system it is much better for keeping drawings than for bringing one or more to light. Quick accessibility, after all, is what the draftsman and all drawing rooms need most. To be able to get a tracing when wanted, and with the least expenditure of time, is the drafting room's most pressing need.

THE BORDER TAB HELPS TO FIND A TRACING IN THE DRAWER

A Hurry Call and What Came of It

I remember a hurry call for a drawing once coming into a place where I was a checker. Being a checker, I was spared the humiliation of the call brought down upon the heads of the draftsmen because the drawing could not be found—and all hands except myself were compelled to enlist in the search. The order came into the business office by telephone, and the manager of the plant took it upon himself to get the drawing, which was wanted to verify certain information believed to be true by the prospective purchaser of the part. The drawing was hunted for high and low, but could not be found.

The system in vogue in this establishment was something like Frank's, only instead of rolling up the drawings and tossing them into a rack, the drawings were laid away flat in cabinet drawers, though without much regard for order or relationship one to another. And there we were. The buyer was waiting on the telephone for his information; the manager, the superintendent and the entire drafting-room staff, with the single exception of myself, were on the jump in the search, but still the drawing could not be located. I doubt if they ever found that drawing. I know it remained missing that day, even under the vehement outbursts from the executives, until the man on the other end of the phone quit in disgust. Nor was the drawing found in the days that followed, when the search for it, from the chief himself down to the office boy, tapered off and died through sheer weariness of futile effort. The firm lost the job simply because the drawing could not be found quickly.

No doubt, could the matter have been registered successfully against any one man in the drafting room, that individual would have lost his job also—which points its own moral. Have your drawings filed away securely, to be sure. But also see that they are filed away in such a manner that, when wanted, the least expenditure of time is necessary to get them into active service again.

Given sufficient leeway and the proper encouragement, almost any draftsman will work out a satisfactory system for your drafting room. Many draftsmen are systematizers by nature. Knowing this, that is why systematizer organizations, even when concerning themselves only with office systems, enlist the services whenever possible of draftsmen of experience. Systematizing is engineering. It is the utilization of known forces, the adapting of achievements of science to a required end with the least waste. And your draftsman, whose daily exercise of thought is the utilization of known forces to certain ends, cannot but be especially interested and the one man for the job in this work. Your draftsman systematizes in his own daily tasks—no two draftsmen work alike—and he is ever pondering the ways of drafting rooms in general in the quest for improvements. That he rarely mentions these improvements unless called upon to do so need not lend the belief that he does not possess ideas on the subject. He does. What deters him from butting into a discussion off and away from his board—the thing he is at work upon—is that he feels a natural timidity against opposing his ideas to those of his superiors. On the face of it and because of the difference in their positions, his superiors are supposed to have the better ideas. Why place a man of inferior ideas over one of superior ideas? Why, indeed! That it is frequently so—that the draftsman often harbors thoughts of greater value to the organization than those of his superior—need not be set down here. It is often the case. Yet no draftsman desires especially to jeopardize his job; so he maintains a discreet silence—and the organization loses. Encourage the opinions of your draftsmen, Mr. Chief Engineer. In the long run it will pay, and this applies especially to large organizations. In the smaller shops chief and draftsmen, down to office boy, often are as one family with a common pride and a common aim.

So draftsmen are systematizers. Ever on the alert for short-cuts, as a race, they themselves, as much if not more than any other known factor, have brought the science of drafting to the point of efficiency that it now possesses. They have invented adjustable T-squares, erasing shields, angles out of the fixed 30-45-60 deg. kind, instruments in strange and great variety. They have invented other things, too.

A Draftsman's Chart—and a Miss

Once upon a time there was a draftsman named Tucker who, more than usual among his kind, possessed that type of mind. He was always studying out short-cuts in his work. He prided himself, in fact, on his successes. He would boast about his achievements and in consequence take a lot of kidding from his associates. His work, among other things, had to do with estimating weights for the foundry. The concern was one with a big foundry practice—one of the largest loam foundries along the Atlantic Coast—and Tucker used to estimate the probable weight of castings going through on orders from outside. Many of these castings were mammoth cylinders for marine engines for service in government cruisers and battleships being built in shipyards along and down the coast.

Tucker, as I have said, figured the weights. It was his especial job. After estimating successfully a very great number of cylinders—ascertaining their correct weight when cast and checking it off with his estimated figures —it occurred to him one day to scheme out a chart, a

sort of curve, by which to shorten his task in future estimating; that is, having ascertained the weight of a 20-in. bore cylinder, the weight of a 50-in. and the weight of a 72-in. cylinder, with the weights of a number of sizes in between, he determined to strike a curve through these figures and then, later, by the simple process of consulting his curve, be enabled to make a stab at the weight of any and all future castings. It looked all right. But wait!

The Extra Big Job

There came into the office one day an order, accompanied by the necessary blueprint, for a large low-pressure cylinder. The cylinder was one of three belonging to a triple-expansion engine, and it was a government job. In diameter the cylinder ran something like 108 in.—the largest of its kind ever to come to this shop. There was much talk as to whether the foundry could handle it and great enthusiasm among the executives when it was decided to take the job. One end of the foundry was cleared for action, two skilled loam foundrymen, at \$7 a day each, were put to work, and the thing was started. In order to have the proper amount of iron melted against the time for the big pouring, Tucker, as always, was given a copy of the blueprint to estimate the weight. I remember that Tucker came into the drafting room from the front office that morning, blueprint in hand, with a peculiar light o' love in his eye. He was thinking deeply over something.

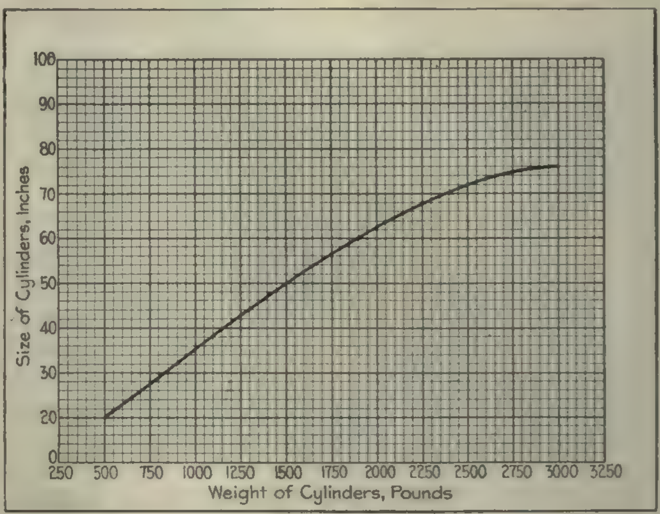
The days passed into weeks and the weeks into months. The huge mold in the foundry steadily became huger, and the interest in and around the plant rose with the top of the loam men's work. We were all on edge. Even the office boy got to loafing in the foundry—a place which he naturally abhorred, owing to its damp and smelly atmosphere, together with the grime produced by lampblack and baked sand. Tucker long since had filed his slip containing the probable weight of the casting, and the foundry boss long since had instructed his cupola men on the size and importance of their duties relative to the big pouring. Tucker himself, as the mold grew, appeared apprehensive, but he said nothing. Nevertheless he would spend long minutes gazing out of the drafting-room window, the one that overlooked the foundry, with that same light o' love in his eye and, now, a certain grim set to his jaw. He certainly was thinking deeply.

The Fatal Pouring

At last came the big day. The president of the company, owing to the size and importance of the cylinder, had ordered built at one end of the foundry a slight wooden structure, a stand, and he also had issued invitations to the local newspapermen and the city officials, these last from the mayor down. It was one John-Smith of a day. The stand was draped with the American flag; a distant corner of the foundry held three kegs of beer for the workmen after the pouring; the office force quit to a unit and took up positions of advantage in the foundry; the invited guests appeared; the newspapermen produced their notebooks; the foundrymen took their stations; the mayor and his staff mounted with solemn dignity to their places. Then the foundry boss—a lean, scrawny-neck man with a nervous manner—took a last, inquiring look about him and gave the word. The gate behind the spout slowly lifted, and the molten metal began to stream forth with its customary flare of sparks and intense waves of heat.

It was a big day, as I have said. Huge ladle after huge ladle was filled and poured into the mold until suddenly, and I need hardly say unexpectedly, there came the word that the iron was giving out. There was much hurrying to and fro, and there were a lot of orders given, with that result that, following the last drop of iron from the cupolas and with the big casting as yet not flowing over, some small ladles were brought hurriedly upon the scene from the other end of the shop. But too late. The first large pouring had chilled, and the second, and smaller, addition would not unite with it. The mold was spoiled. There was the loss in wages of two foundrymen at \$7 a day each, to say nothing of a few tons of iron to be broken up and sent through the cupola again. It was a costly experiment for Tucker.

It was costly for Tucker in another way. In silence the following day, as the carpenters out in the foundry were gloomily taking down the stand, Tucker quietly



TUCKER'S CHART, SHOWING APPROXIMATE CURVE (SKETCH NOT ACCURATE), FROM WHICH HE DEDUCED THE WEIGHT OF THE BIG CYLINDER—AND MISSED!

packed up his instruments after a brief interview with someone on the front carpet—and, like the Arab, stole away. He stole away with tears in his eyes, and there was not a man among us but pitied him and would have had it otherwise if such a thing were possible. You see, we draftsmen understand each other.

There can be too much system in drafting rooms.

Old Material Presented as New

The article, "Standardizing Inserted Blade Milling Cutters," by Charles F. Scribner, of Springfield, Mass., which was published on page 890, Vol. 45, and which was represented by the author as being original and uptodate practice, is an exact copy of the Pratt & Whitney standards for these cutters which were established in 1905 and discarded in 1911.

Mr. Scribner has been offered two opportunities to make an explanation of this matter, but has not seen fit to do so. We regret the necessity of making an announcement of this kind, but feel that it is necessary for the protection of our readers and our many conscientious contributors.

Scrapping $150,000 Worth of Special Machinery

By Frank A. Stanley

SYNOPSIS—An unusual illustration and some data on the cost of changing typewriter models for an output of 50 machines a day. The scrapping of jigs and fixtures is but a part of the cost of such changes and is one of the problems of modern manufacturing and merchandizing.

Readers familiar with the manufacture of certain high-grade mechanical apparatus, including such equipment as typewriters, guns, cash registers, adding machines and so on, know something of the great expense involved in the design and construction of the large number of special tools required in the way of jigs and fixtures, punches and dies, gages, etc. It is very often true that the special tool outfit for even a limited amount of product of the kind indicated may run into an expenditure of at least $200,000.

When a manufacturer contemplates redesigning his machines or bringing out an improved model of, say, rifle or typewriter, one of the most serious factors for consideration is this tremendous item of expense in making practically an entire equipment of drill jigs, milling fixtures, press tools and similar devices required in such numbers for intensive manufacture. Sometimes it is feasible to save a considerable portion of the old equipment, where various parts of the machine manufactured have met little modification in the design of the new model. As a rule,

A PORTION OF $150,000 WORTH OF DISCARDED TOOLS

however, it is not practicable to make over any great number of special tools for the new parts. The result is that the management has to sacrifice a lot of expensive special equipment.

In addition to the financial loss involved there is another very serious consideration—namely, the time required for redesigning and for putting through the toolroom the new outfit of tools. This sometimes means the continuous work of a large corps of toolmakers and high-grade machinists over a period of six or eight months, possibly a year.

It is not often that a visitor to a factory arrives at the right moment to see assembled what is practically a complete equipment of special tools displaced and really "scrapped" because of the bringing out of a new-model machine, with the consequent redesign and construction of a full line of manufacturing apparatus. Some time ago, however, while at the plant of the Noiseless Typewriter Co., Middletown, Conn., I was fortunate enough to see such an exhibit of discarded tools. I was so impressed by the object lesson that I secured permission from the factory manager, J. A. Ruffin, to photograph these groups of tools, which are here shown.

Difficulty of Remodeling Old Jigs

When this company brought out its new-model Noiseless typewriter a short time ago, the redesign of the machine involved doing away with the cam mechanism formerly used for operating the type bars. There was substituted the pendulum toggle movement already described in these columns. It was found upon careful study of all the elements of the new model that there were very few of the jigs, fixtures, press tools and the like that could be utilized in the manufacture of the new machine. Many of the old tools were naturally of such character as to make it impossible to modify them for the new typewriter parts. Many others, because of their design or because of the methods under which they were originally intended to be employed, would not fit in with the new line of manufacture. Therefore, practically the whole equipment of special tools and devices was discarded and a new series of tools put into service.

It is always possible in such cases to reclaim a certain amount of material in the way of punch holders, die blocks and bolsters, straps, cams, binder handles and certain types of jig and fixture bases, together with quantities of small parts such as bolts, nuts and screws. After all, however, the value of these parts is small as compared with the sum total of the entire outfit. Very often, in fact usually, it is the case that the great item of expense in making a special tool is not the material itself, but the labor involved in its design and construction. There is of course no way in which any appreciable portion of that labor item can be saved.

The parts referred to above as serviceable for the new set of tools are in most instances the very parts which are most easily made and in the production of which the ratio of labor expense to the total cost is fairly low. In reference to the time and skill involved in working out, say, an intricate punch and die or in finishing a very accurate gage of peculiar construction, there is no process by which this expensive factor may be saved; it all disappears with the scrapped tools.

Referring now to the discarded tools shown in the illustrations, these represent an original outlay of approximately $150,000. Possibly $5000 worth of material in small parts was retained for further use, but this is a liberal estimate, and it is more than likely that it is far higher than it should be.

Estimating Within 1 Per Cent.

It is sometimes possible, as tool designers well know, to lay out and build a new series of tools at considerably less expense than was incurred in making the original outfit. Perpetual study of manufacturing methods leads to cutting corners in many directions—simplifying numerous processes and oftentimes doing away with certain intermediate operations. If tools seemingly more intricate in their nature are devised, they are justified because they eliminate the use of many other tools and in general lead to a much greater output and to correspondingly decreased labor costs in manufacture.

When it was decided in this factory to make the new tool outfit, it was estimated by Mr. Ruffin that it would require a year's time to get these tools through the shop, ready for use. A detailed estimate was made of each item required; and upon the completion of the work, which by the way took only eight months instead of the twelve originally expected, it was found that the actual costs in total varied from the estimate by less than 1 per cent.

The Cost of Jigs

It is interesting to be able to state in this article that these new tools as constructed for the manufacture of 50 typewriters per day cost less than $50,000, including all overhead expense, labor, material, etc. In this work there were constantly employed over 30 toolmakers for the period stated. In addition to labor costs were added 100 to 125 per cent. overhead charges, so that actual labor costs were really less than one-half the amount mentioned. At that time toolroom labor ranged from 25 to 48c. per hr. and was computed to average 40c. per hr., covering all grades of skill. Considerably over 1000 special tools were made, including all drill jigs, milling and grinding fixtures, press tools, gages, etc. These tools replaced several thousand tools in the old equipment.

Freight-Car Situation Improving

The freight-car shortage, which in November of last year was becoming increasingly serious, has decreased almost 50 per cent. since that time according to the figures for Jan. 1, 1917, which have been made public by the American Railway Association. This is indeed a great improvement, and it is to be hoped that this condition is not simply temporary.

On Nov. 1, 1916, there was a shortage of 114,908 freight cars; on Dec. 1, it was 107,778 and on Dec. 31 it had fallen to 59,892 cars.

This improvement in the situation is attributed more than anything else to the coöperative efforts of the Interstate Commerce Commission, the shippers and the railroads. The latter for the past two months have had a special committee of the American Railway Association to deal with the subject. Emergency measures have been adopted and progress has been made in getting cars out of congested districts into territory where they are most needed.

Metric System in Engineering

By F. A. Halsey*

SYNOPSIS—The adoption of the metric system even during a transitional stage would seriously interfere with the mental conceptions of engineers and would create the need for a rewriting of technical literature, especially engineering tables.

The scientific or laboratory use of the metric system involves little more than reading metric scales and instruments and is the easiest of all applications of the system. Anyone who knows the names of the units can do it. The engineer, however, especially in his capacity as a designer, must be able to form mental conceptions of the values of quantities expressed in metric units—to "think in the system," as the expression is. Here again it is no longer necessary to speculate regarding the effort necessary to acquire this faculty, as we have on record the result of the most extended adoption of the system ever undertaken in English-speaking countries.

A Result of Experience

When the Willans & Robinson works, of Rugby, England, was organized to manufacture the Willans engine, the metric system was adopted for the engine. No more favorable opportunity for the experiment ever existed, as both works and engine were new and without awkward precedent or practice to interfere.[1]

After 10 or 12 years' use of the system the chief draftsman of these works, E. R. Briggs, read before the Rugby Engineering Society a paper on the experience of the works with the metric system, in which paper this phase of the subject was covered. Mr. Briggs had of course been obliged to acquire this faculty and he had seen many, both draftsmen under his immediate charge and others, similarly situated. He wrote as an avowed metric advocate, thus giving an added value to his statement, from which I quote:

> There are men who, by application to the values of the units, have been able in the short space of 12 months, or even less, to think not only in millimeters and kilograms, but also in compound units, such as kg.-sq.cm., m.-sec., etc.; while there are men who, although in daily contact with the system, have hardly taken the trouble to think even in millimeters in as much as five years.

Clearly, the effective learning of the system involves more than memorizing the names of the units and the meanings of the prefixes.

Mr. Briggs also gives his testimony on the main point of all this discussion—the persistence of old units after the adoption of the new—in these words:

> The frailty of human nature has been the subject of many homilies, and it may be taken for granted that the end of 10 years, nay, 100 years, would still see the existence of the Imperial system.

This persistence of old units has now been demonstrated beyond possibility of doubt; and it is plain that we must consider, not the hypothetical condition of the metric system standing alone, but the actual condition of conjoint use of both systems. I have given a few illustrations as found in metric countries and could give more, to the point of tedium, but let us now consider the conditions to be met when applying the system to engineering calculations during the transition period.

Technical Literature Must Be Rewritten

Take the simplest possible case—finding the size of a bar of steel to carry a given load in tension. We place the load on one side of an equation of which the other side includes as factors the required area of the bar, the tensile strength of the material and the factor of safety. We write the load in kilograms and the tensile strength in kilograms per square centimeter and find the required area of the bar in square centimeters, to be at once confronted with the fact that all American merchant bar is rolled to diameters in inches. We, like metric countries, have plenty of tables of areas, but in all cases they connect diameters and areas in the same system of units. With either system used alone we would, after finding the area, take the diameter directly from a table; but we must now find the diameter in inches from the area in square centimeters by calculation, until such time as someone has prepared and printed a transition table giving diameters in inches and areas in square centimeters, or by first finding the diameter in millimeters and then converting the result to inches.

An alternative procedure is possible. The formula might be altered into a transition formula giving the tensile strength in kilograms per square inch and the area in square inches. We could then use existing tables of areas, but in addition to the transition formula we should need transition tables giving strength in kilograms per square inch. Such tables must be prepared and printed before this procedure is feasible. Whatever the procedure, we shall at the end have the same result—that is, the same load and the same bar, to get which we have discarded existing tables and made the calculations which the tables have been prepared to avoid.

I have gone into this in, perhaps, tedious detail, because it illustrates in the simplest possible way a universal principle: Whenever basic quantities—loads, powers, velocities, pressures, capacities, etc.—are expressed in one system of units while commercial materials are made to, and their properties are recorded in, another, we have a conflict in every application of one to the other. Existing formulas, English or metric, do not fit, and existing tables do not apply. To suit this condition, our technical literature must be rewritten from the beginning in transition form for use so long as existing commercial sizes of materials continue in use and to be discarded when, and if, the transition period comes to an end.

Illustrations of this may be multiplied to the point of weariness. Suppose we are laying out a belt transmission. The formula for the capacity of belts includes the velocity and width of the belt, with other factors. Our reference books contain charts that give the effects of speed, centrifugal force, thickness, type of joint and arc of contact almost at a glance, but these we must discard and make the calculations which the charts have been prepared to avoid.

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*Editor emeritus, "American Machinist."

[1]When, some years later, these works took up the production of other specialties, the use of the system was not extended to them, as experience in the engine work had failed to demonstrate the anticipated advantages.

With the load in metric units this calculation gives us the velocity in meters per second and the width in millimeters; but when we take up the matter of pulleys, we find that all pulleys made in this country are made to inches of diameter which, multiplied out, give the circumferential velocity in feet per minute, and this result we must equate with belt velocities in meters per second. Ultimately, we must use the pulleys we can buy—that is, of English diameters and widths.

Going farther, we determine the shaft sizes, to be confronted with an applied torque in meter-kilograms equated with the resisting torque of a shaft in inches of diameter, on which the only available information as regards torsional strength is in pound-inches. As before, we need a transition formula and tables giving, in this case, resisting torques of shafts in kilogram-inches, and as before, we get the same result in the end.

Since closeness of fit is not involved, we may still place a belt of metric width on English pulleys, shafts and bearings; and then, if we are true-blue metric advocates, we will shout from the house tops: "We have adopted the metric system!"[2]

Do we calculate the diameter of a pipe or a boiler for a given pressure, it is the same. From the pressure in kilograms per square centimeter we get the stress in kilograms per square centimeter, to be equated with the strength of the material, of which the thickness is in inches, and all available data for strength are in pounds per square inch.

Do we calculate the weight of structures, it is again the same. We have extended tables of the weight of materials in pounds per foot of length and area; but if we are to use the metric system with these materials, we must have transition tables for I-beams, channels, angles, bars, pipe, sheets, etc., giving weights in kilograms per meter of materials rolled to inches of cross-section.

All Technical Tables Must Be Recalculated

The matter of the tables is perhaps of even greater actual, though less fundamental, importance than the formulas. Our tables are now so complete and comprehensive that the large majority—in some applications perhaps 80 per cent.—of such problems are solved by direct reference to them, resort to the formulas being had only for occasional cases beyond the range of the tables. All our tables are based on one system of units. We have no tables for a mixture of units; and until someone has been good enough to prepare and print them, we must resort to calculation which the tables were prepared to avoid and, so long as existing materials are used, get the same result in the end. What is gained? What is it all for?

As another illustration consider the most ordinary problem in hydraulics—finding the diameter of a pipe to carry a given quantity of water. Hydraulic tables are remarkably complete, and most such problems are solved by simple reference to them. Using the metric system, we have the head, the velocity and the length of the pipe in meters and the discharge in liters, but the diameter of the pipe is in inches. We have neither formulas nor tables fitting this condition, and again we must calculate and convert, our calculations in this case involving the square root of the fifth power in millimeters of the pipe diameters in inches. The results of these calculations we now take directly from the tables, and again the final result is the same.

In the foregoing cases we have to deal with repeated conversion of units, which while bad enough, is not all. Let us therefore consider one more everyday case in which even this will not answer—finding the size of an I-beam to carry a given load. Our span is in meters and our load in kilograms, but the cross-sections of our beams are in inches. What shall we do with the moment of inertia? In the moment of inertia of an I-beam four dimensions enter, two by their first powers and two by their cubes. There is no possible conversion factor between English and metric moments of inertia. Moments of inertia of all common cross-sections in English units have been worked out and tabulated in great profusion, but we cannot use them even by conversion. Until new transition tables of metric moments of inertia of sections rolled to inches have been prepared and printed, every calculation of an English section I-beam for metric loading involves the calculation of the moment of inertia for the cross-section or, as an alternative, the use of English units for the load and span. Which will be done?

A Few Examples

Following is a list of a few such tables that will be needed: Square roots of fifth powers in millimeters of pipe diameters in inches; weight of materials in kilograms per cubic inch; board measure; section moduli, radii of gyration and squares thereof and areas of rolled sections; friction head and discharge of pipe; weight of all rolled sections and of rivets, bolts, bars, balls, plates, pipe—cast, welded, cold drawn, etc.; strength of columns and pillars; strength and weight of chain and rope—wire and hemp; weight and other properties of brass, copper and lead pipe and other products of these materials; strength and other properties of timber beams, columns, etc.; properties of boiler and condenser tubes; bursting and collapsing strength of pipe; pipe flanges; flow of air in pipes; all screw-thread and gearing tables; chain-driving tables; the strength of riveted joints; angles when considered as tapers per foot; chord-spacing tables of circles; weights and other properties of all materials made to wire and sheet-metal gages; loads on bearings; strength of shafting; strength and deflection of springs; all machine-shop standards—tapers, dovetails, machine parts and details, press- and running-fit practice, etc.; performance and power requirements of machines in endless variety; strength of materials of all kinds and grades; steam-engine and boiler practice from the ground up. But the list is endless. Open any engineers' reference book and look for a formula or a table (other than mathematical tables, which are universal) that will be useful during the transition period, and you will look long before finding one.

Of these two requirements in preparation for the transition period the transition formulas will come first. We shall then be in shape to use the metric system, provided we are willing to discard all the tables that have been

[2]This is not sarcastic, but descriptive of every "adoption" of the system of which I have any knowledge, all such adoptions being partial. The metric enthusiast makes the easy changes. He does not make the difficult ones, but he invariably talks as though he had made them all. He regards the difficult changes that he has not made as not worth counting. If we are to study difficulties, we must study difficulties, the changes which he does not make because he cannot, and does not count because it suits his purpose not to, being the very ones that must be counted.

prepared through many decades to shorten and in many cases eliminate calculations, the physical result being the same in all cases and the psychological result the proud and superior consciousness that we are using the metric system.

We are to discard these devices for saving time in calculations and make the calculations which they make for us, in the cheerful belief that the loss will be compensated with a balance to the good through the magic of the "beautiful inter-relation and correlation of the units." This is the hook which engineers are asked to swallow, and by all that is logical, the proffered bait is economy of time in calculations!

The reader who is familiar with these problems will recognize that many of them must be solved by successive approximation or trial and error. With the tables we soon find the appropriate size; but when calculation is resorted to, we must calculate and recalculate until a satisfactory result is found.

All this leads to but one conclusion: So long as existing commercial sizes of materials of construction endure, no sensible man will resort to metric calculations with them more than once; and approaching the subject from this point of view, we see what we have already seen from another—the effective adoption of the metric system involves the abandonment of all existing standardized things.

Who Will Lead the Procession?

Will the rolling mills lead in this change? For them to do so involves the duplication of their list of sections and assortment of rolls, the doubling of the number of changes of rolls, with the resulting loss of time and the warehouse stocks to be carried. Incidentally, they will recalculate and reprint their tables of the properties of their sections, first in transition form for existing sections and then in metric form for the new sections, supplying also, meanwhile, the existing tables for those recalcitrant engineers who prefer the old and simple way. When it is all done, the new sections will do their work no better than the old, and we cannot look for enthusiasm in that quarter.

The doubling of stocks to be carried is the minimum involved. During the transition period we shall have occasion to put English pulleys on metric shafts and metric pulleys on English shafts, and we shall therefore require the following pulleys: English bore and rim; metric bore and rim; English bore and metric rim; metric bore and English rim. A pulley manufacturer's warehouse stock now comprises about 10,000 pulleys. The multiplication of this list by four will curb enthusiasm in that quarter.

In pipe fittings the case is equally serious. The new sizes of pipe must be connected with the old, and the most simple fittings—nipples and couplings—would be multiplied by three and the tees and crosses by not less than six. As before, the new pipe and fittings will carry water, steam and gas no better than the old. These illustrations can be extended indefinitely, but I must stop somewhere.

Shall we then conclude that the change is impossible and therefore not to be feared? That would be as shallow, as stupid and as fatal as the worst of the metric conclusions. Let no one forget that, while a complete change is impossible, a partial change is easy—as easy as going down a toboggan slide—and this partial change is exactly the thing that leads to the welter of confusion which I have endeavored to picture. Let no one imagine that in the absence of compulsory law he can use it or not as he sees fit. Once here, we must all deal with it and use it, whether we wish to or not. In this matter no man lives unto himself. Every metric stone thrown into our industrial lake is the center of an expanding area of disturbance. If this article and the two that have preceded it (pages 93 and 139) mean anything, it is that a partial change spells total confusion and that every introduction of the system is to be fought as the intrusion of an enemy of our industrial life.

Making a Pressed-Steel Thimble

By Ernest A. Walters

The thimble shown at E in Fig. 1 is made of 15-gage cold-rolled steel. It must be held close to the required dimensions, and is made in five operations without annealing. The walls must also be held to original thickness. By making the thimble in five operations the reduction is gradual and the stock is less strained, thus preventing the stretch that would otherwise take place.

Subpress dies are used to facilitate the die setting, and fewer presses are necessary to start the job going. In this way the presses can be set up and the finished article turned out in a very short time compared with the usual method of running a single operation in a press. The drawing dies are operated in two small presses set close together. The blanking and cupping operation is performed in an inclined press.

The punch C (Fig. 2) serves a double purpose. As it descends it cuts the blank, which is held between its face and the pressure plate J. As it descends further the blank is forced by the punch H through the central hole in C, thus forming the cup. The pressure on the plate J is obtained from the pins K and the rubber bumper X. The required regulation of pressure on the plate J is obtained in the usual way by the stud L and the nut N. The blanking die F is held by the screws G. The cup is carried up into the cavity in the punch C, and as this die is used in an inclined press, the cups roll out of the opening at the back and into a receptacle, being forced out by the succeeding cups as they are formed. At no time are there more than two cups in the cavity.

The lower punch is vented at O so that the cups will strip readily. The production on this operation is 3000 pieces per hour.

The second, third, fourth and fifth operations are now put through the die shown in Fig. 3, whereby the operator transfers the operations in proper rotation from one die to another, keeping all the dies supplied. The capacity of this die is 1000 finished pieces per hour.

In Fig. 3 is shown the front view of the gang dies for the four final operations. The punch holder A and the die holder B are kept in proper alignment with each other by guide pins.

The shell B (Fig. 1) is drawn in the second-operation die F by the punch G. This punch has an air hole O to allow easy stripping. The shell C (Fig. 1), is drawn in the third-operation die H by the punch I. This punch also has an air hole at O. The shell D (Fig. 1) is drawn in the fourth-operation die J by the punch K, a 45-deg.

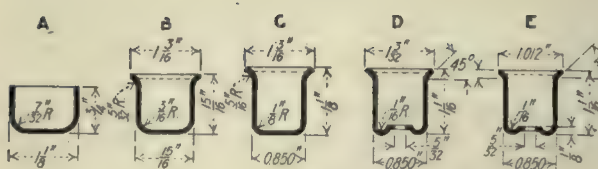


FIG. 1

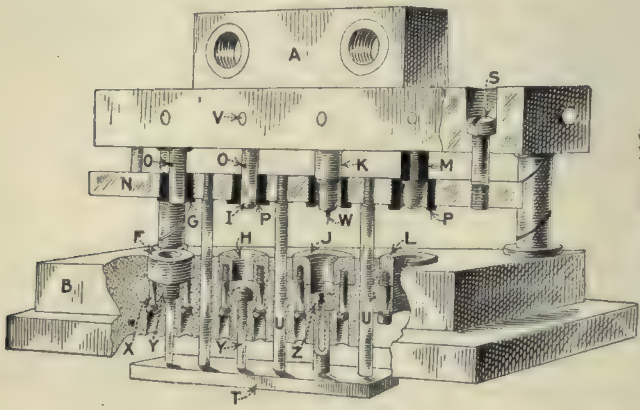


FIG. 3

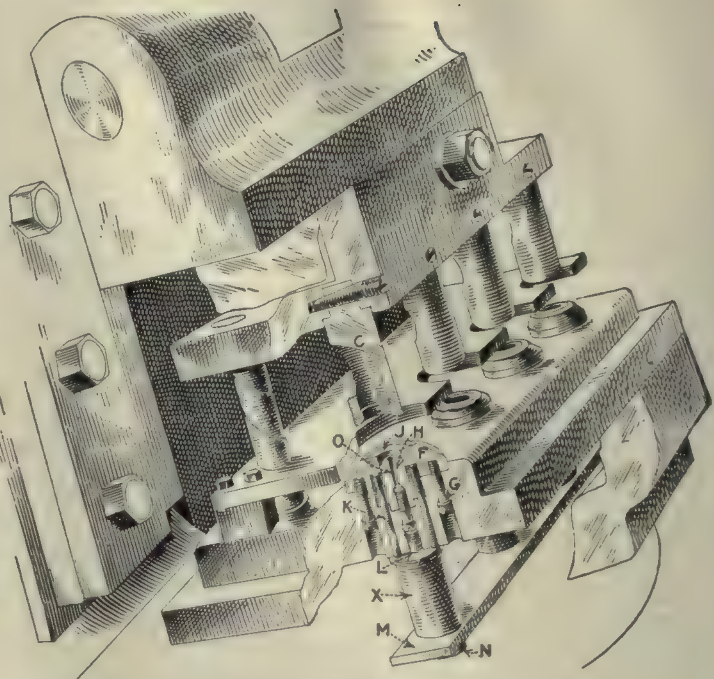


FIG. 2

FIGS. 1 TO 3. THE WORK AND THE DIES

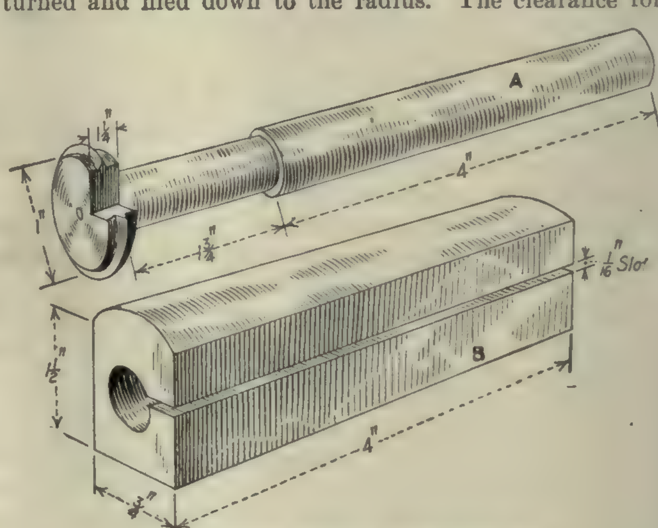
angle flange being bulged in the bottom and a $\frac{5}{32}$-in. hole punched. The shell E (Fig. 1) is trimmed on the flange in the fifth-operation die L by the punch M. The stripper plate N has carbon-steel bushings P screwed into place. The stripper N is held in place by the screws SS, which are long enough to give the stripper the proper movement to release the shells from the punches with the aid of the lower knockout plate T. The plate also releases any shells from the dies by giving the knockout pins Y and Z the proper movement. The stripper bolts U are adjusted with relation to the stroke of the press. The punches G, I, K and M are held in position by tapered pins V. The punch K has a perforating punch W inserted to perforate the bottom of the shell and must be adjusted to suit the thickness of the metal in order that it may not go through too far before the forming of the bottom takes place, as this will distort the hole. This punch is screwed in place. The dies F, H, J and L are held in position by the screws X. The knockout pin Z in addition to acting as such also acts as a perforating die for the fourth operation.

Whitworth Thread Tool and Holder

By Otto Weber

I had a large quantity of 14-thread Whitworth V-bottom ring gages to make with a pitch diameter of 1.990 in. I found that the thread tool described below gave good results in regard to correct angle, smooth finish and right radius, and all are accomplished by a single setting.

A piece of 1-in. round steel about 6 in. long was centered and turned to the dimensions shown in A. The shank was turned to fit the holder B, which was also used for grinding. The lathe was then geared for 14 threads and the thread cut deep enough to have the top come up to a sharp V. A Pratt & Whitney 14-thread Whitworth tool from which the sides were ground off to just leave the front radius was employed. After the threads were cut, the middle thread was left on and the rest were turned and filed down to the radius. The clearance for



THREADING TOOL AND HOLDER

the cutting edge on the remaining thread was milled down to ½ in. in diameter. The tool was then hardened and tempered.

Embargoes Curtail Supply of Hides from Foreign Countries

An American firm that has used hides of French, Swiss and Italian origin in the manufacture of belting, packings and various kinds of mechanical leathers has found its sources of supply curtailed by embargoes. Investigations on the subject have been conducted by Consuls General A. M. Thackara at Paris and F. B. Keene at Zurich. In their opinion it is probable that whenever the embargoes are removed the hides will be procurable in adequate quantities.

Critical Speeds of Rotors Resting on Three Bearings

By Walter Rautenstrauch*

SYNOPSIS—In this article are shown the formulas used when determining the critical speeds of rotors resting on three bearings. Examples are given of the graphical methods used to obtain the bending and deflection moments. A example shows how the formulas and graphical methods are used.

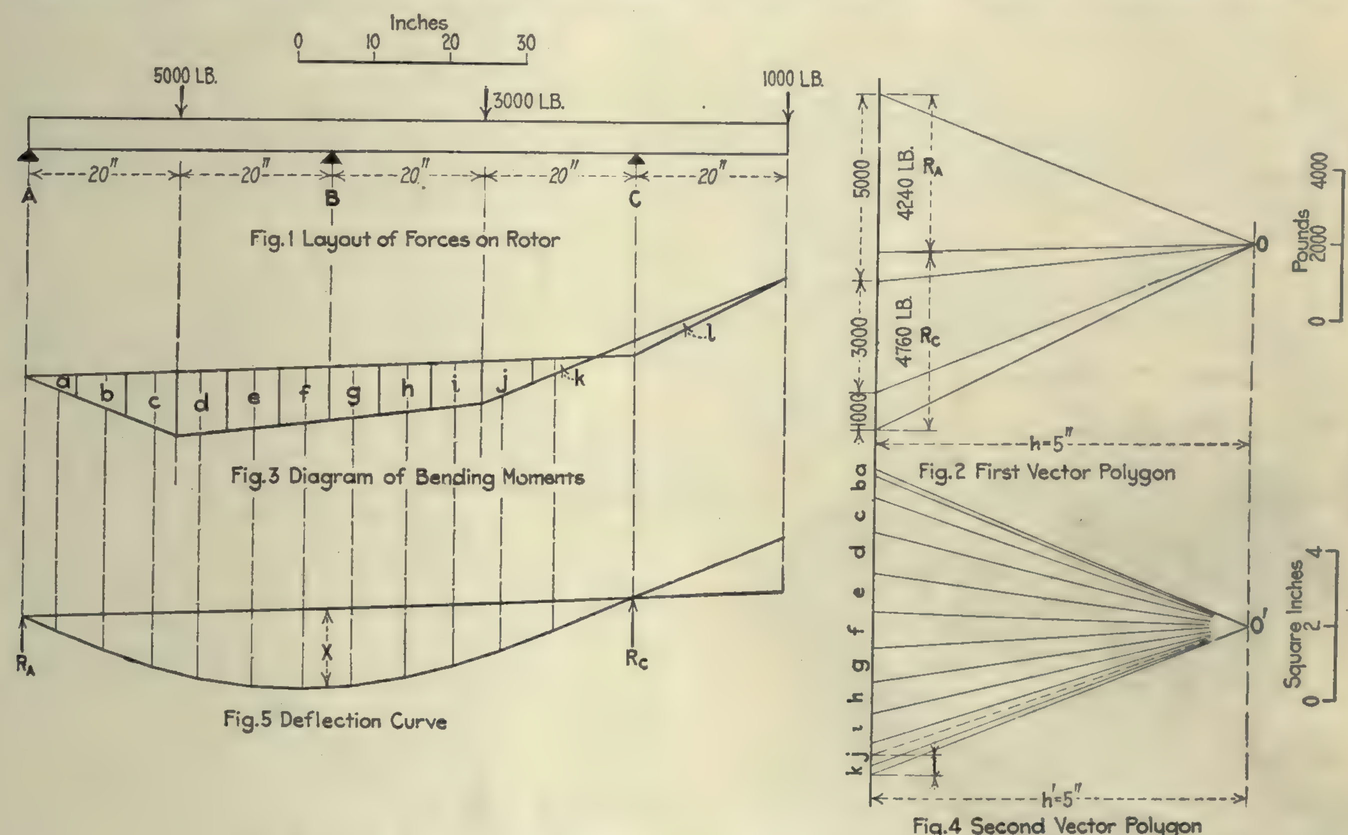
When the turbine rotor shaft is rigidly coupled to a generator shaft or the shaft of any other driven machine such as a centrifugal pump or blower, the situation is a different one, since the case becomes one of a beam over three supports.

The situation may perhaps be clearly shown through the solution of a problem. Since this solution involves the graphical determination of bending moments and deflections of a beam over three supports, it will be necessary to lay down the principles of construction in the general case before proceeding to the particular problem at hand.

In treating the problem of the deflection of a beam over more than two supports we will use the principle announced by Dr. G. Wilson in the "Proceedings" of the Royal Society of London, 1897. On page 269 of these "Proceedings," Dr. Wilson states:

> The displacement of any point by reason of the deformation of the beam is the resultant of the displacements which would be produced if one supposed all the external known forces to act separately and one after the other. This being so, the continuous beam may be considered as a simple beam supported at each end and under the action of the supporting forces at the intermediate pieces acting vertically upward. If the neutral fiber of the beam in the unloaded condition is assumed to be a straight line, then the result of the action of these two distinct systems of loading is to make the final deflection of the neutral fiber at each of the intermediate points of support equal to zero.

In other words the deflection of a beam over three supports is found by first considering the beam supported by the end bearings and determining the resulting deflection and then supported by the center bearing only and finding the resultant deflection. From these deflections the reactions at the supports may be found and then the true deflection curve of the continuous beam determined. This problem is best handled by graphical methods.



FIGS. 1 TO 5. FORCES, BENDING MOMENTS AND DEFLECTIONS FOR A ROTOR

Let Fig. 1 represent the shaft of a motor generator set with bearings at A, B and C. In order to simplify the solution it is assumed that the shaft is of uniform diameter throughout its length. With the shaft assumed to rest on the bearings A and C only, the first vector diagram and the bending-moment diagram are as found

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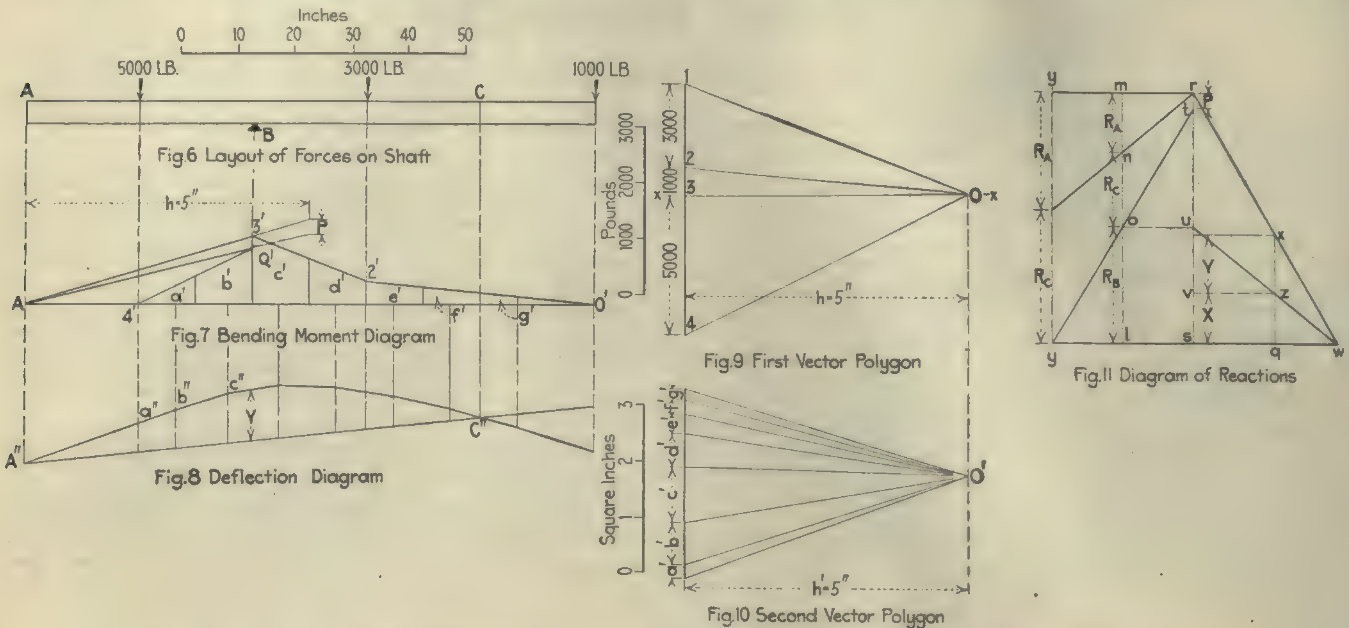
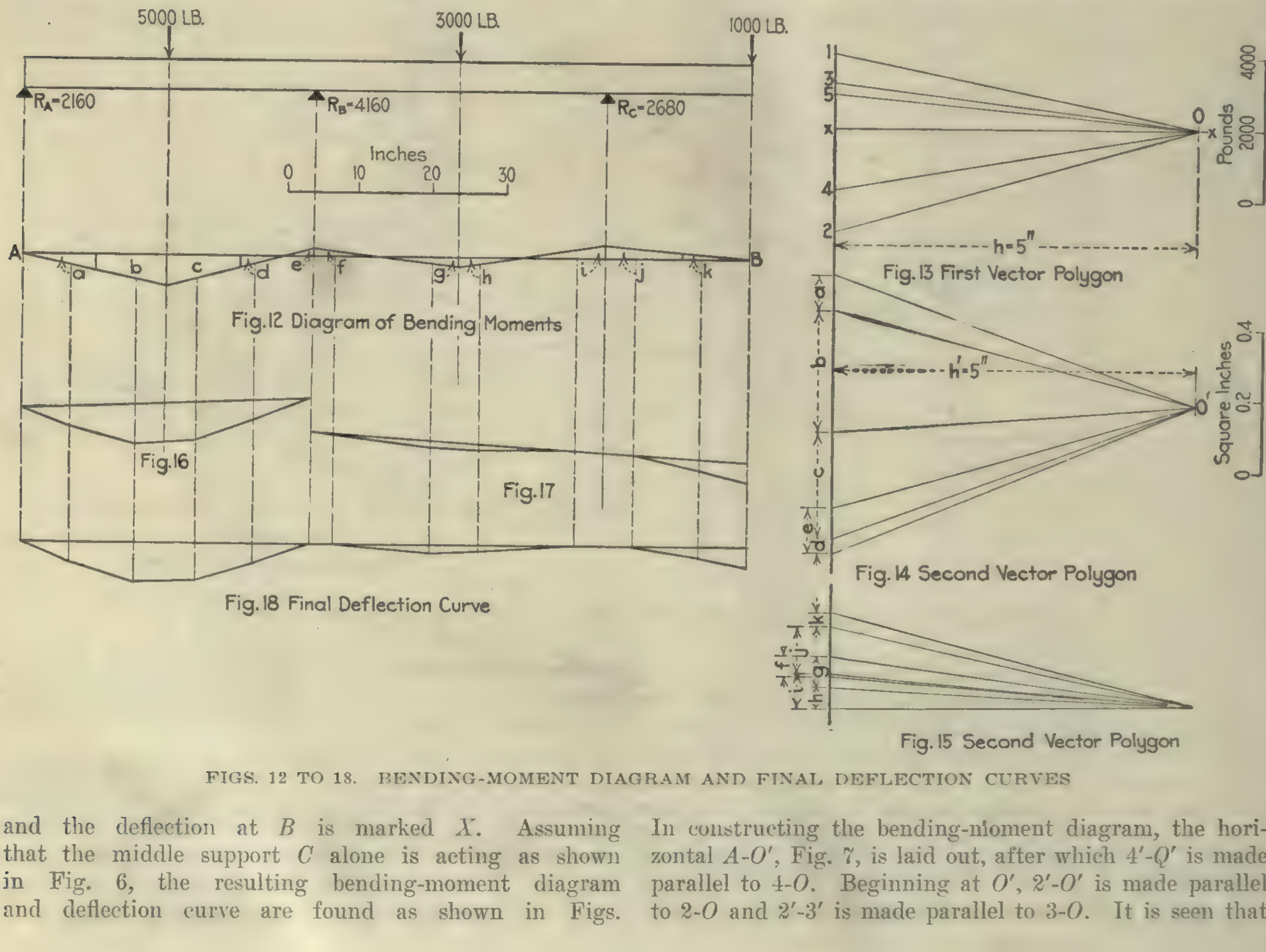
in Figs. 2 and 3. Dividing the bending-moment diagram, Fig. 3, into convenient sections a to l, it is found that the area of each division is as shown in Table 1.



FIGS. 6 TO 11. VARIOUS BENDING-MOMENT, FORCE, DEFLECTION AND REACTION DIAGRAMS

Letting 1 sq.in. of area in the bending-moment diagram equal 1 in. on the load line of the second vector diagram, Fig. 4 is accordingly constructed. The deflection curve is then formed as shown in Fig. 5, and the deflection at B is marked X. Assuming that the middle support C alone is acting as shown in Fig. 6, the resulting bending-moment diagram and deflection curve are found as shown in Figs. 7 and 8. In the construction of the first vector diagram, as in Fig. 9, the horizontal x-x is first laid down, after which the loads in the load line are taken 3-4 downward = 5,000 lb. to the left of the support; 3-2 upward = 1,000 lb. and 2-1 upward = 3,000 lb., both to the right of the support. The pole O is taken 5 in. to the right of the load line and the diagram completed.



FIGS. 12 TO 18. BENDING-MOMENT DIAGRAM AND FINAL DEFLECTION CURVES

In constructing the bending-moment diagram, the horizontal A-O', Fig. 7, is laid out, after which $4'$-Q' is made parallel to 4-O. Beginning at O', $2'$-O' is made parallel to 2-O and $2'$-$3'$ is made parallel to 3-O. It is seen that

the diagram does not close, indicating a greater moment to the right than to the left of the support. The load required at A and acting downward to balance the moments is readily found to be P, according to the construction shown in Fig. 7. It is found that the areas of the sections into which the bending-moment diagram has been arbitrarily divided are as shown in Table 2.

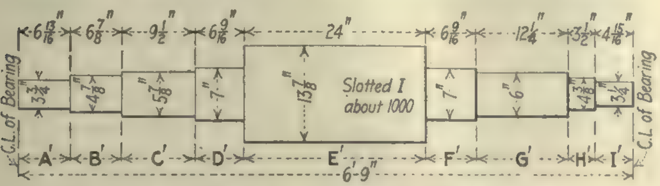


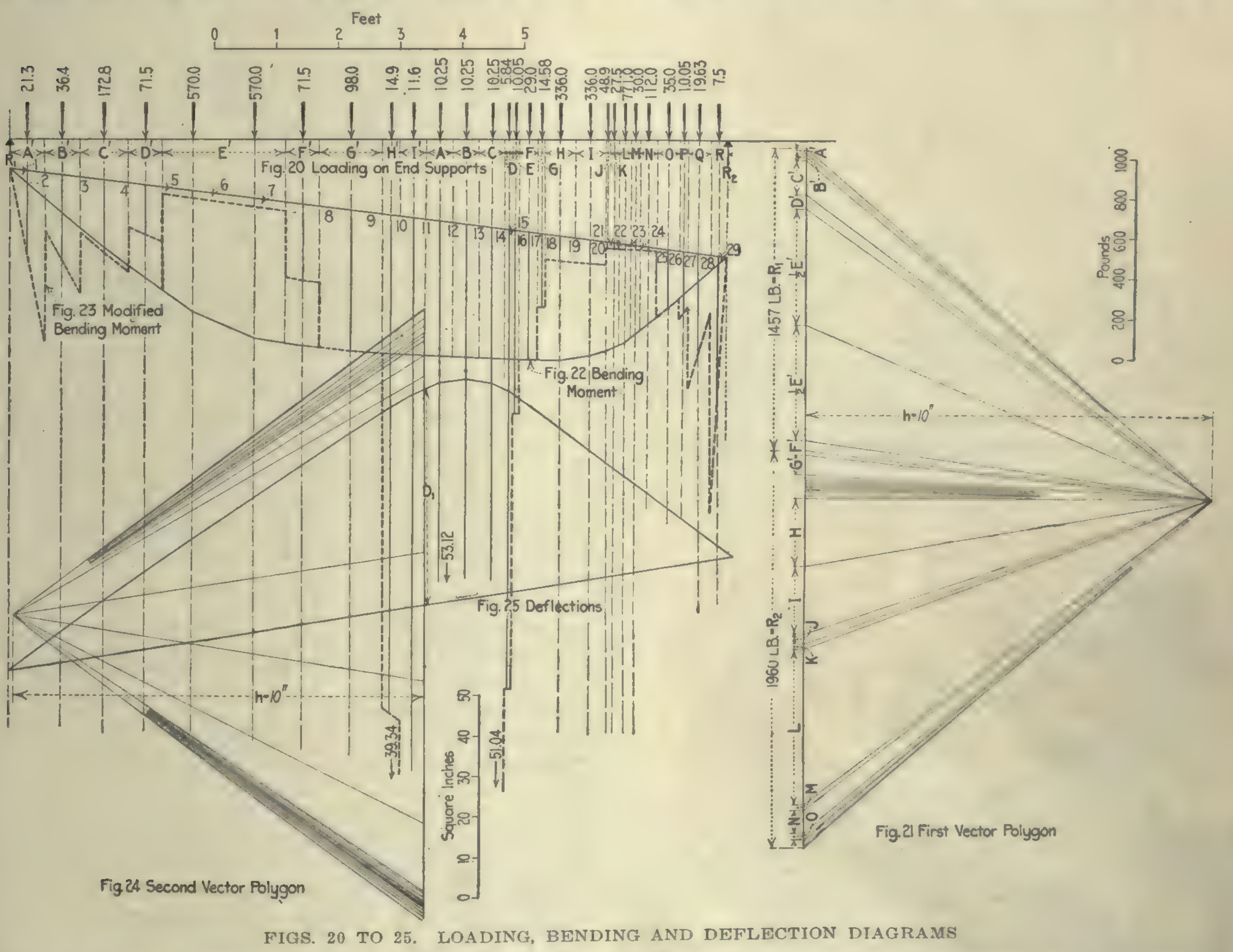
FIG. 19. DETAIL OF ELECTRIC ROTOR

The load line of the second vector diagram, Fig. 10, is constructed from the areas as shown. Making a''-b'' in the reactions at the supports, as is shown in Fig. 11. Construct the vertical y-y in which lay off the reactions R_C and R_A to the scale 1 in. = 2,000 lb., as given in Fig. 9, the greater reaction always being laid off first from the bottom. Take any convenient distance on

TABLE 2. AREAS IN SQUARE INCHES

Section	Area, Sq.In.	Section	Area, Sq.In.
a′	0.25	e′	0.35
b′	0.75	f′	0.25
c′	1.00	g′	0.20
d′	0.60		

the horizontal such as ys and draw the rectangle $yyrs$. Lay off $rt = P$. Select any point w on the horizontal and draw rw. On sr lay off X and Y from Figs. 5 and 8 and project across to wr such that $xq = X + Y$. The remainder of the construction is very clear and needs no further explanation. Thus the true reactions at the three supports are found to be R_A = 2,160 lb.; R_B = 4,160 lb.; R_C = 2,680 lb., as illustrated in Fig. 8.



FIGS. 20 TO 25. LOADING, BENDING AND DEFLECTION DIAGRAMS

Fig. 8 parallel to the bottom line of the second vector diagram the deflection curve is begun. Let the deflection curve from a'' to the left be a straight line, that is, continue b''-a'' to A'' and join A'' and C'', thus finding the base line from which deflections are read. Mark Y under the support B. It will now be possible to find

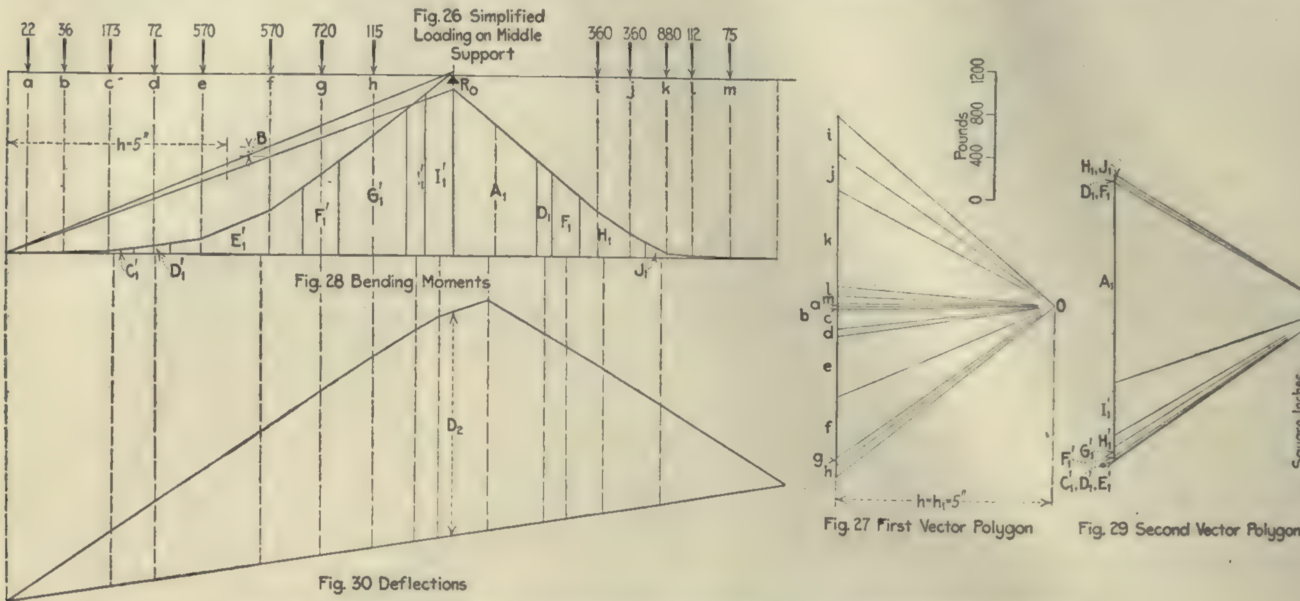
TABLE 1. AREAS IN SQUARE INCHES OF ROTOR

Section	Area, Sq.In.	Section	Area, Sq.In.
a	0.094	g	0.462
b	0.286	h	0.422
c	0.470	i	0.396
d	0.554	j	0.292
e	0.526	k	0.120
f	0.488	l	0.260

Having determined the reactions at the supports it will now be possible to determine the bending-moment diagram of the shaft resting on its three supports. This is accomplished in the usual way, as shown in Figs. 12, 13 and 14. In constructing the first vector polygon, Fig. 13, it is to be noted that downward forces are headed downward and upward forces are headed upward in laying out the load line and also that the forces or loads are taken in order from left to right, beginning from the horizontal x-x. Thus x-1 = 2,160; 1-2 = 5,000; 2-3 = 4,160; 3-4 = 3,000; 4-5. = 2,680 and

5-x = 1,000. A check on the accuracy of the work is had in the closing of the load line at x. After constructing the bending-moment diagram, the accuracy of which is tested by having A-B close horizontal, as in Fig. 12, the areas of the sections are found to be as in Table 3.

on the same level. The case is first treated as a beam resting on the end supports only, whereupon the loads and their positions are as shown in Fig. 20. The first vector polygon, Fig. 21, is constructed and the bending-moment diagram, Fig. 22, is obtained by its use. Re-



FIGS. 26 TO 30. LOADING, BENDING-MOMENT AND DEFLECTION DIAGRAMS

With these areas as the elements of the load lines to the scale 1 in. equal 0.2 sq.in., the vector diagrams, Figs. 14 and 15, are constructed. From these, the deflection curves for each span, Figs. 16 and 17, are found in the usual manner. Fig. 18 gives the final deflection curve having a horizontal base line.

The scale to which the ordinates of the deflection curve are to be read is

$$1\ in. = \frac{q^3 pmhh'}{EI}$$

in which

$q = 10$;
$p = 2{,}000$;
$m = 0.2$;
$h = h' = 5$;
$E = 30{,}000{,}000$ (steel shaft);
$I = 12.544$ (4-in. circular shaft).

Accordingly,

$$1\ in. = 0.01062\ in.$$

The determination of the critical speed from the deflection curve proceeds exactly as disclosed in the previous examples. The deflection curve just found obtains for the condition that the three bearings are in perfect alignment. It might at first appear that any settling of one or more bearings might upset the calculations for critical speed or indeed result in a change in critical speed. That this is not the case can readily be proved, but the calculations are too long and complicated to justify their being given at this time. We will next apply the analysis to a practical problem.

The turbine rotor treated in the first article, *American Machinist,* Vol. 46, p. 97, when coupled with the electric rotor shown in Fig. 19, forms the complete rotor of a turbo-generator set for which it is proposed to determine the critical speed. This rotor rests on three bearings, and the supposition is that the bearings are all

ducing the bending-moment diagram to apply to a 6-in. diameter shaft by multiplying each ordinate of the original bending-moment diagram by the ratio $\frac{I_F}{I_x}$, where I_F is the I for the 6-in. shaft and I_x is the I for the section of the shaft spanning the moment ordinates being treated, the modified bending-moment diagram, Fig. 23, is obtained. This is divided into 29 sections, each area of which is measured and used as the load increments of the second vector polygon, Fig. 24. From this is found the deflection curve, Fig. 25. The deflection at the place of the middle support is measured D_1. The case is then treated as a beam resting on the middle support only, as shown in Fig. 26. The loading, however, is simplified to reduce the great amount of labor involved. From this loading the 'first vector polygon, Fig. 27, is constructed and used in finding the bending-moment diagram, Fig. 28. This diagram is divided into sections C'_1 to J_1, corresponding to the lengths of shaft section.

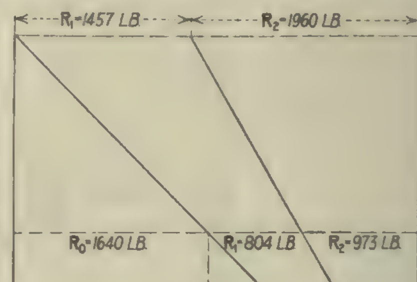


FIG. 31. DIAGRAM TO OBTAIN THE REACTIONS

For example, section F'_1 is immediately under section F' of Fig. 20. This division is made for the purpose of determining the modified bending moments without the necessity of constructing the modified bending-moment diagram and determining the areas therefrom. Table 4 is then prepared.

TABLE 3. AREAS IN SQUARE INCHES

Section	Area, Sq.In.	Section	Area, Sq.In.
a	0.100	g	0.077
b	0.340	h	0.062
c	0.300	i	0.100
d	0.040	j	0.130
e	0.028	k	0.040
f	0.054		

These reduced areas become the load increments of the load line of the second vector polygon, Fig. 29, from which the deflection curve, Fig. 30, is constructed. The deflection at the middle support is then measured D_2.

By the construction shown in Fig. 31, the reactions at the three bearings are obtained, assuming that these are all on the same level. Having determined these reactions it is now possible to lay out Fig. 32, from which the first vector polygon, Fig. 33, is readily constructed.

TABLE 4. AREAS IN SQUARE INCHES OF MODIFIED BENDING-MOMENT DIAGRAM

Section Symbol	Area, Sq.In.	$\frac{I_F}{I_X}$	Reduced Area, Sq.In.
C_1'	0.10	6.61	0.66
D_1'	0.16	0.54	0.08
E_1'	2.24	0.063	0.014
F_1'	1.56	0.54	0.84
G_1'	4.38	1.00	4.38
H_1'	1.56	3.55	5.55
I_1'	2.12	11.63	24.70
A_1	5.86	16.00	93.80
D_1	0.72	3.55	2.55
F_1	1.10	1.00	1.10
H_1	1.20	0.198	0.24
J_1	0.15	0.057	0

By the use of this polygon the bending-moment diagram, Fig. 34, is constructed. This is conveniently divided off into the sections A'_2 to R_2, each of which is immediately under that portion of the shaft length marked with the corresponding number in Fig. 20 for the purpose of convenient determination of the increment areas of the modified bending-moment diagram without having to construct it. Accordingly, Table 5 is prepared.

TABLE 5. TABLE OF INCREMENT AREAS

Area Symbol Fig. 36	Area, Sq.In.	$\frac{I_F}{I_X}$	Reduced Area, Sq.In.
A_2'	0.28	6.61	1.85
B_2'	0.85	2.30	1.96
C_2'	2.04	1.09	2.22
D_2'	1.92	0.54	1.04
E_2'	7.80	0.063	0.49
F_2'	1.56	0.54	0.85
G_2'	1.50	1.00	1.50
H_2'	+0.08	3.55	+0.28
I_2'	—0.19	11.63	—2.21
A_2	+0.30	16.00	+4.8
D_2	0.36	3.55	1.28
F_2	0.90	1.00	0.90
H_2	3.10	0.198	0.62
J_2	2.74	0.057	0.01
O_2	1.02	1.00	1.02
Q_2	0.40	2.5 ap.	1.00
R_2	0.08	16.00	1.30

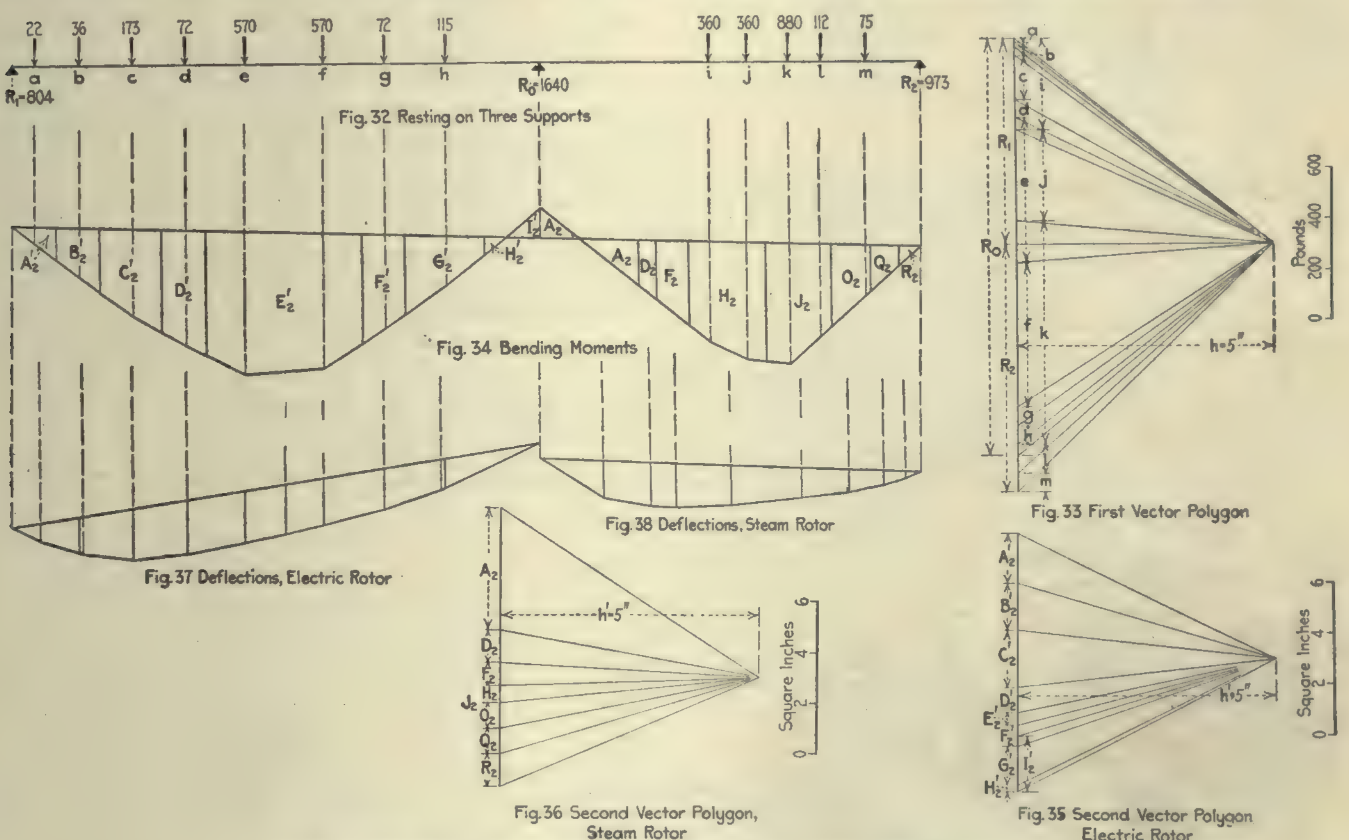


Fig. 36 Second Vector Polygon, Steam Rotor

Fig. 35 Second Vector Polygon Electric Rotor

FIGS. 32 TO 38. BENDING-MOMENT AND DEFLECTION DIAGRAMS

The reduced areas in the table are then laid out as the increment of the load line of the second vector polygons, Figs. 35 and 36. From these vector polygons the deflection curves for the steam and electric rotors, Figs. 37 and 38, are constructed.

TABLE 6. TABLE OF DEFLECTIONS OF SHAFT

w Load	y Deflection, In.	y^2	wy	wy²
22	0.000810	0.00000065	0.001780	0.00001430
36	0.001890	0.00000357	0.068040	0.00013500
173	0.002727	0.00000744	0.471771	0.00128712
72	0.002916	0.00000850	0.209952	0.00061200
570	0.002754	0.00000757	1.569780	0.00431490
570	0.002424	0.00000617	1.415880	0.00351690
72	0.002187	0.00000478	0.157464	0.00034416
115	0.001593	0.00000254	0.183195	0.00029210
360	0.002214	0.00000490	0.797040	0.00176400
360	0.001993	0.00000219	0.717480	0.00078840
880	0.001857	0.00000345	1.634160	0.00303600
112	0.001458	0.00000212	0.163296	0.00023744
75	0.000919	0.00000084	0.068925	0.00006200
			7.458763	0.01640432

The scale to which these deflections will be read is

$$1\ in. = \frac{200 \times (8)^3 \times 5 \times 5 \times \pi}{30{,}000{,}000 \times 63.6} = 0.0027\ in.$$

Accordingly, Table 6 is prepared.

It is found that

$$w = \sqrt{\frac{32.2 \times 12 \times 7.4587}{0.016404}} = 419.2\ \textit{radians per sec.}$$

and

$$N = \frac{30}{\pi} \times 419.2 = 4{,}000\ r.p.m.$$

The running speed of this set is 3,600 r.p.m.

Cut and Carry Press

A subscriber has suggested that many of our readers might be interested in the so-called cut and carry press, and has requested that we publish some articles relating to the press, product, dies and methods followed in producing large quantities of work.

Any contributions on this subject will be welcome.

Making Washers with Countersunk Holes in a Punch Press

By Ernest A. Walters

The countersunk washer at *B*, Fig. 1, is produced in the die shown in Fig. 3. The washer is made from ⅛-in. hot-rolled steel in three operations, employing a progressive pillar die with three sets of dies and punches. The operator after starting the sheet of steel runs the large countersunk washers and 7000 ½-in. washers per hour, making a total production of 11,000 per hour.

The ½-in. washer shown at *C*, Fig. 1, is blanked out in the space left between the large washer blanks. By referring to the illustration of scrap shown in Fig. 2, it will be observed that little steel is wasted.

The washer *A*, Fig. 1, has been put through the first operation in the die *N* and punch *L*, Fig. 3. The surplus stock is drawn to the bottom by the punch *L*, which now continues on its downward course, perforating a ⅞-in. hole. While the punch is on its upward course the steel strip is moved ahead to allow the blanking punch *H* to remove the ½-in. washer. Simultaneously, the first operation is repeated.

As the stock again advances it comes between the punch *G* and die *P*. The dished stock shown at *A*, Fig. 1, is now flattened, forming the desired countersink, and at the same time is embossed by the punch *G* and the die *P*. As the stock is advanced to the third operation the countersunk washer is blanked out by the die *S* and the punch *F*, which is provided with a pilot *Q*.

The punch holder *B* is made of cast steel and the die plate *C* is of cast iron. Both are properly aligned by the guide pins *D* and the bushings *E*, which are pressed into position and lapped to fit the guide pins *D*. Under operating conditions the guide pins should be well lubricated. The punches *F, G, H, R* and *J* are held in position by tapered pins. The dies are pressed into position in the die plate *C*.

The stripper *Z* is held in place by cap screws *K*. The perforating punch *L* is secured by the headless screw *M*. The die *N* is adjustable by means of the threaded sleeve *T*. Small pinholes in the bottom and a pin spanner are provided for adjusting.

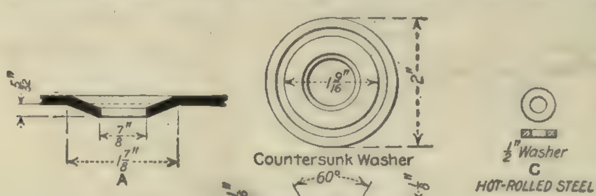


FIG. 1

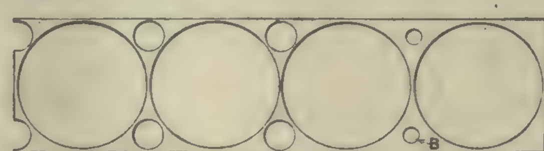
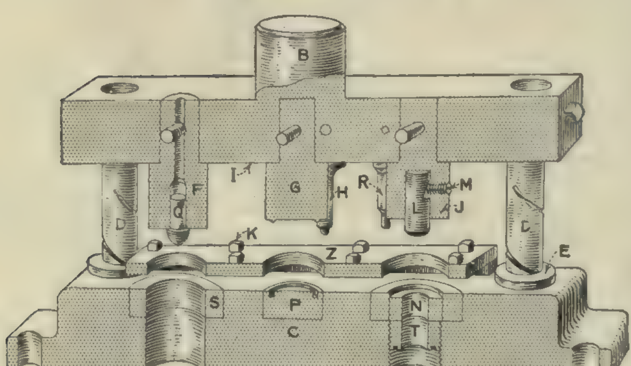


FIG. 2



Blanking Die and Punch for Countersunk Washers
FIG. 3

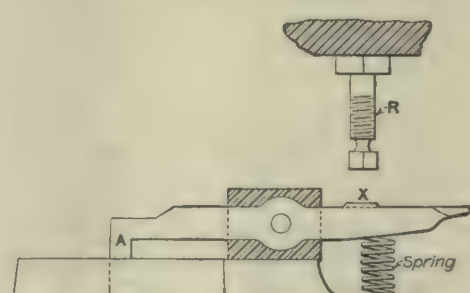


FIG. 4

FIGS. 1 TO 4. THE WORK AND THE DIES

press continuously. The automatic trigger gage shown at *A*, Fig. 4, locates the stock properly.

Under usual conditions countersinking is performed on a drill press. It is an exceedingly slow operation, and this die was designed to speed up the process. It gives satisfaction and under ordinary conditions produces 3500

The trigger gage works automatically under operating conditions by the proper adjustment of the setscrew and lock nut *R*, Fig. 4, which shows the side elevation of the automatic trigger spacing gage. As the punch, Fig. 3, descends, the screw strikes at *X* and raises the gage point *A* out of the hole *B*, Fig. 2, in the edge of the stock

When the punches draw out of the stock on the upward movement of the ram of the press the trigger is still held up. In the meantime the stock is fed forward. By this time the trigger has been released and the point A, Fig. 4, drops into the next hole B, Fig. 2, on the edge of the stock. The trigger gage is sensitive and when properly adjusted gives complete satisfaction.

Unusual Dust-Collecting Installation

By John L. Alden

Aside from the production machinery of the new plants of the Remington Arms Co. of Delaware, Eddystone, Penn., much of the auxiliary equipment is unusual and interesting. This is particularly true of the dust-collecting systems. Not only are these larger than the ordinary commercial installations, but their very size has necessitated some radical departures from what has hitherto been standard practice. One of these installations embodying some of the latest engineering developments has been designed and installed by the Oneida Steel Pulley Co., Oneida, N. Y.

The polishing room of this plant is 216x80 ft., lighted from above by skylights in the monitor, about 70 ft. above the floor. The general arrangement of the 628 polishing wheels is shown in Fig. 1. Across a wide trucking aisle is the browning department, which has two groups of 25 wheels and brushes each. The total number of wheels connected to exhaust systems is 678. Wheels 18x5 in. are mounted on the jacks in the middle of the room. Along the line of columns on each side of the room are two rows of small bench polishers fitted with 6x2-in. wheels or smaller. The wheels in the browning room are 12x4 in. and 12x5 in.

The two styles of dust hoods for the large wheels are illustrated in Fig. 2. Of these, 96 wheels operate as "overshot," while the remainder, 192, run in the opposite direction. Corresponding wheels on opposite pairs of jacks standing back to back are connected to the same branch pipe. The connection to each hood is rectangular and is equivalent in capacity to a 3½-in. round pipe. The bench wheels and those in the browning room are connected in pairs through rectangular breechings. The two wheels on the same spindle use the same branch. In the browning room each opening is equivalent to a 3½-in. pipe, while those of the small bench wheels are equal to 3-in. round branches.

The design of the hoods deserves comment. In Fig. 2, the hoods are hinged at the back so that the entire wheel covering may be swung completely out of the way when changing wheels or truing. In many respects this is a decided improvement over the ordinary hood with the side door. The "undershot" wheels in Fig. 2 had to be provided with the other style of hood, because there was not room enough between the wheel and the branch pipe to permit the top of the hood to swing back. Each of these hoods is so designed that the dust is thrown from the wheel directly into the mouth of the pipe. This gives a much better removal of dust than where the material is allowed to strike some part of the hood, losing the velocity acquired from the wheel. Each particle leaves the wheel at a mile-a-minute speed. If it can fly directly into the current of high-velocity air in the suction pipe, it will be removed with a minimum of external effort. If these bits of emery and metal are allowed to lose their initial speed by striking the side or back of a poorly designed hood, it will require a high vacuum and a strong blast of air to start them up the pipe from a state of rest. This is a recognized principle of hood design.

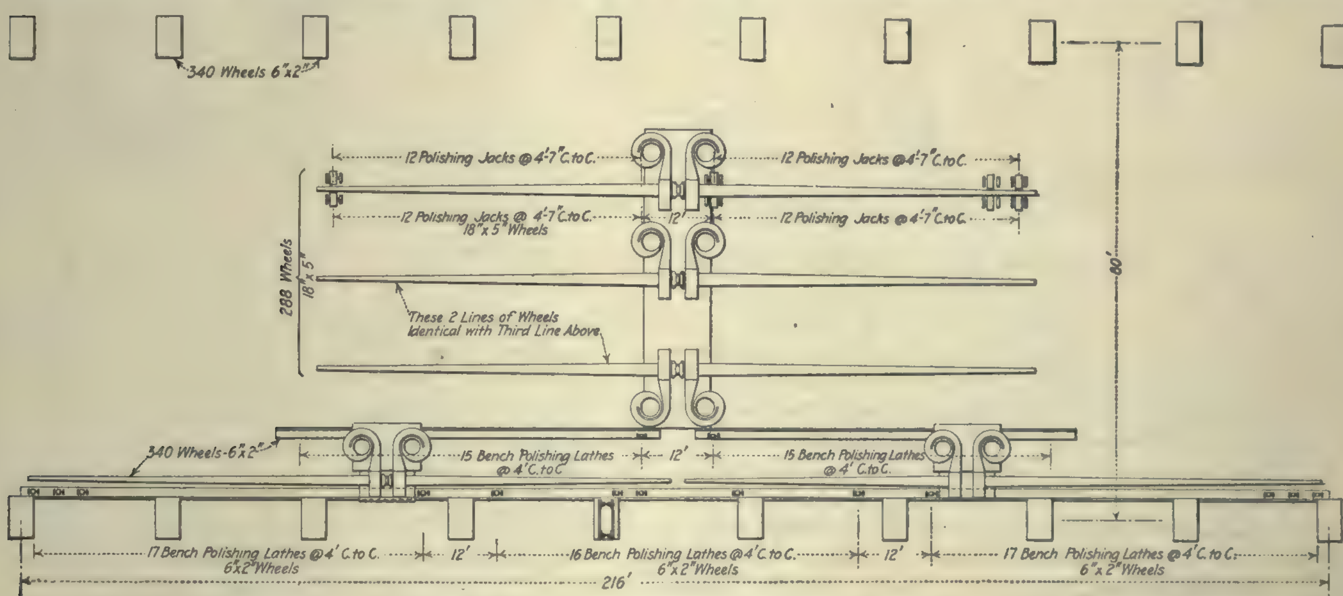


FIG. 1. ARRANGEMENT OF POLISHING ROOM

Ball-Bearing Fans

The large wheels are served by three large systems, each of which handles the dust from 96 wheels. The bench jacks are connected to four smaller systems along the side. In every case Oneida double exhausters, equipped with SKF ball bearings, are used. The construction of the blast wheel differs materially from standard practice. This is seen plainly in Fig. 3, which shows a small wheel with one side plate removed to expose the blading. When built in this manner, the wheel is not only efficient, but extremely rigid. The use of high-grade ball bearings eliminates most of the ordinary fan troubles. The bearings are mounted in dust-tight housings, and when once packed with lubricant, need little attention.

The dusty air from each system is discharged into a pair of Gale centrifugal air washers, which thoroughly remove the dust, wash the air and return it to the room in a purified condition, entirely fit to breathe. Each double fan and pair of washers is erected as a self-contained unit, with water tank, strainer and pump. The small size of this unit as compared with the usual bulky dust collector

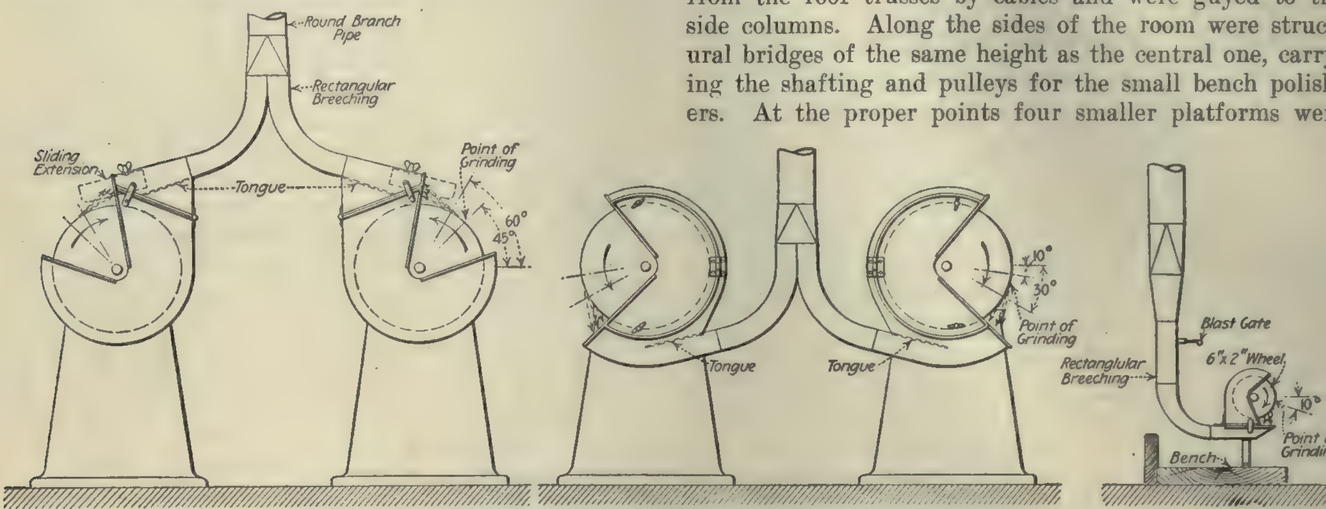


FIG. 2. DIFFERENT TYPES OF EXHAUST BREECHINGS

is remarkable. But very little more floor space is taken up by the fan and washers than by the fan alone. The wash water is recirculated by a 1½-in. Goulds centrifugal pump belted to each fan. Each pump handles from 30 to 35 gal. per min. This is at the rate of about 1½ gal. per 1000 cu.ft. of air, or about half that usually required by air washers. This is remarkably good economy when it is considered that the air washers at this plant are handling extremely dirty air. Several pailfuls of mud and lint are removed from the strainers every day.

Fig. 4 shows a plan view of one washer. The dirty fan blast enters at *A*, and in passing through the curved passage *B* the dust and lint are thrown against the curved outer surface of the washer, which is kept thoroughly wet by the three batteries of nozzles *C*. This effectively disposes of the heavier material, which is washed along the bottom to the drain connection to the strainer. In its passage through the outer washing chamber the finer dust becomes sufficiently moist and heavy to be thrown out of the air against the comparatively dry eliminating surface *E*. The sticky collection of mud on this surface is washed down by intermittent flooding from the nozzles *F*. The function of all sprays in this type of washer is to moisten the dust enough for it to be acted upon by centrifugal force and to keep the accumulated material washed from the curved surfaces. Very little dependence is placed upon the direct wetting of dust by the sprays. As the name implies, these washers depend upon centrifugal action for their best result. This is the reason why extremely dirty air is thoroughly cleansed with about half the volume of water ordinarily used for washing street air. After the washing operation the purified air is returned to the room through the outlet *D*, Fig. 4.

Owing to the close spacing of the double rows of jacks in the middle of the room, it was impossible to run the main-line exhaust pipes along the floor. A transverse power bridge of structural iron, from which the main motors were suspended, had already been erected. A timber deck on this steel framework provided a substantial footing for the three large double fans, washers and fan motors. This brought the center of the main-line pipes about 18 ft. above the floor, requiring vertical branch pipes 15 ft. long. Since it was not desirable to obstruct the floor space with pipe supports, the mains were slung from the roof trusses by cables and were guyed to the side columns. Along the sides of the room were structural bridges of the same height as the central one, carrying the shafting and pulleys for the small bench polishers. At the proper points four smaller platforms were

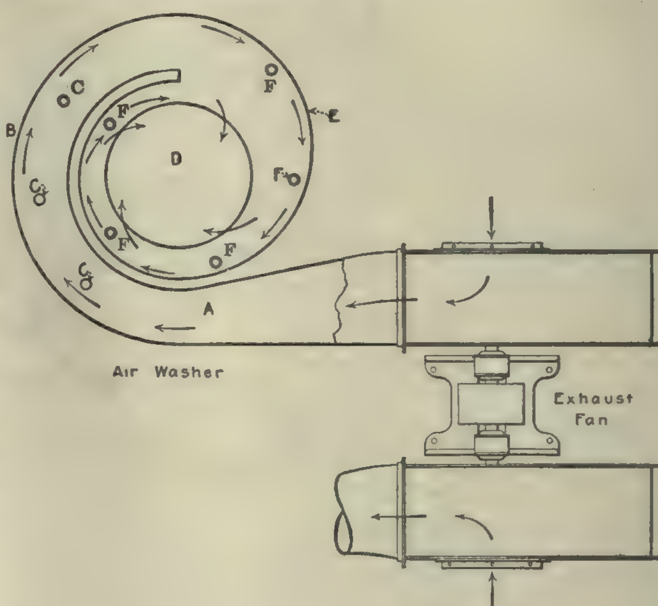


FIG. 4. PLAN OF AIR WASHERS

built on this bridge to accommodate the fans and washers. The motors for these fans were hung from the girders between columns, driving down to the fans at a 15-deg. angle. The main-line pipes for the small jacks were run along the top of the shafting support.

The preparation of the details shows considerable care. One of these points, in particular, is the design of the small breechings by which each pair of wheels is connected to the branch pipes. Fig. 5 shows the construction of this piece. By making it of rectangular cross-section it is possible so to shape it that the two currents of air are flowing parallel at the junction point. This eliminates all losses due to eddies and interference of air currents, especially when one current is stronger than the other.

All elbows and angles have a throat radius of two diameters of pipe and are made of metal two gages heavier than the corresponding suction pipe. A shorter radius than this causes too great a friction loss, whereas nothing is gained by using a longer radius, as experiments show that the reduction in friction is almost negligible beyond this point.

Vacuum, or "shoe," tees, Fig. 6, are used throughout, as these have been found to give the most uniform result.

In this installation it was absolutely essential to provide some means of purifying the air and returning it to the room. The exhaust requirements were 180,000 cu.ft. of air per minute, and under the old method this would have been discharged into an outdoor separator. To heat this air costs about $3400 a year. Had this heat been wasted, it would have been necessary to provide 44,000 lin.ft. of 1-in. heater pipe in addition to that now in stalled. Aside from the extra heating cost and the addi

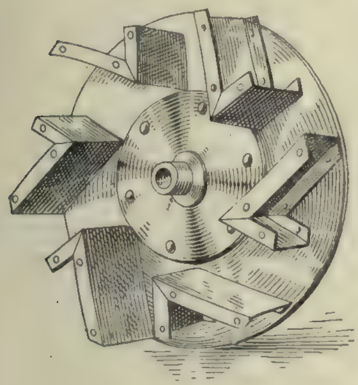


FIG. 3. HOW THE BLAST WHEEL IS MADE

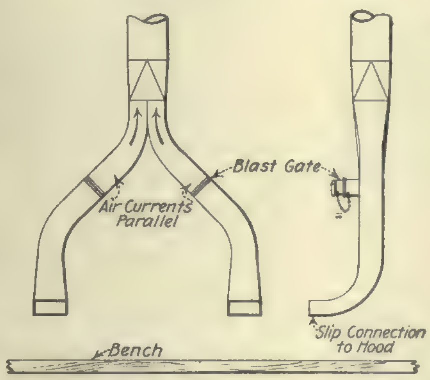


FIG. 5. BREECHING FOR BENCH POLISHERS

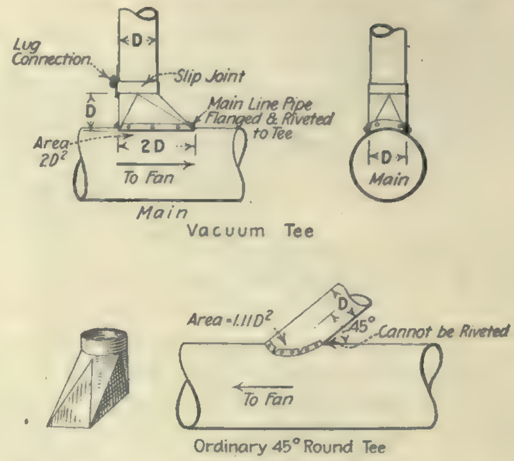


FIG. 6. VACUUM AND ORDINARY 45-DEG. ROUND TEES

They also have the advantage of providing a secure fastening, as they can be riveted to the main-line pipe on all sides. The ordinary 45-deg. round tee shows erratic pressure losses and cannot be riveted at the "heel," which makes an insecure connection. Each branch pipe is connected to the main-line tee with a detachable lug and bolt. This arrangement permits the branch pipe to be taken down without breaking a soldered joint, and at the same time a firm and solid connection is assured.

Hand Holes for Cleaning

To facilitate cleaning, the main-line exhaust pipe is provided with hand holes at 10-ft. intervals. Each hand hole has a tight-fitting sliding cover, so that there is almost no leakage. The connection between the fan and the main line is through a bolted joint fastened with angle-iron lugs and bolts. The removal of these bolts gives easy access to the interior of the fan through the inlet and also to one end of the main. The far end of the main is closed with a removable cap.

The galvanized steel used in the construction of the piping is of the following gages: For all pipes 12 in. and under, No. 24; 13 to 20-in., No. 22; 21-in. and larger, No. 20. All pipe is riveted and soldered, with the laps made in the direction of the air flow. Unusually heavy pipe supports of angle and band iron are used for holding the piping in place.

Particular attention was paid to the engineering features of the job. The pipe lines were designed for a uniform velocity throughout. A uniform vacuum of 2 in. of water is produced at each hood, the back pressure imposed by the dust separating and washing apparatus being reduced to a minimum. Competition was not allowed to influence the choice of the fan size or any of the important details. In a word, the entire installation was designed to produce the most economical operating conditions.

tional pipe involved, a very important item was the physical comfort of the men. Had this great volume of air been removed from the room, it would have been almost impossible to provide comfortable working conditions in winter without objectionable drafts and considerable discomfort on cold days, a condition that would hardly have been permissible.

The argument may be advanced that the recirculation of this air in summer will create a close, humid condition. The plans are, however, to use Delaware River water as wash water during the summer, which will cool and dehumidify the air. It is possible to cool the air several degrees on a hot, moist day and to lower the relative humidity to a comfortable point when using cool water.

Power Consumption

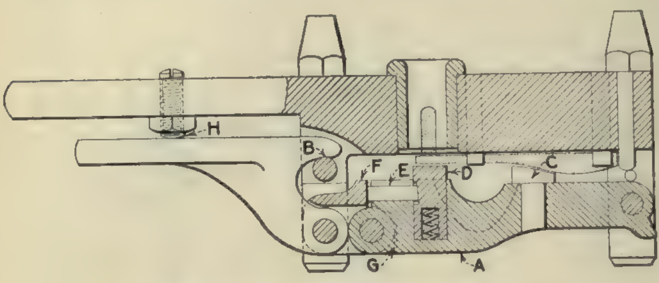
The power consumption of these systems is very low; 25-hp. motors drive the large double fans together with the recirculating pumps. These fans are equivalent in economical capacity to the ordinary No. 70 slow-speed double fan. The remaining exhausters, equivalent to No. 60 fans, are driven from 15-hp. motors. The vacuum produced is 3½ in. of water at the inlet of the large fans and 3 in. on the smaller ones.

The refinement necessary to produce the required results with a minimum expenditure of power and to save the heat that would otherwise be wasted is fully justified, as it is paying well over 100 per cent. on the investment. The specifications were unusually rigid and were more severe than those of the state labor departments. A complete guarantee of horsepower, vacuum and back pressure was specified in the contract, and the whole was secured by a heavy forfeit. B. T. Converse, plant engineer of the Remington Arms Co., was responsible for the installation, and the fan department of the Oneida Steel Pulley Co. did the engineering and contracting.

One-Motion Drill-Jig Clamp

By J. H. B.

The operation illustrated is hollow milling, the post projecting up into the drill bushing. The piece is seated on the body of the jig, located sidewise by four pins and endwise against the pin shown at the end opposite the post. It is held in this position with the thumb, clearance for which is cut in the cover A. The cover is swung into position and clamped over the pin B. In this action the pin C, conforming to the shape of the work, clamps it to the seat and assures its being held to the end pin stop. At the same time the spring pin D comes into position under the work as a support and is itself securely held by the pin E, bearing on the angular surface with the pressure transmitted through the knuckle F connecting the cover and the locking cam.



ONE-MOTION DRILL-JIG CLAMP

Following the outline of the knuckle around the joint with the cover, the dotted line at G shows tangential to the radius, but at an angle to the vertical, and the clearance cut in the cover is shown vertical. This allows the knuckle to release the spring pin, but prevents it from opening too far to displace the smaller pin E. A nut and screw at H prevent undue pressure on the device. One motion either clamps or releases the work.

Chart for Obtaining the Velocity of Air

By Francis J. G. Reuter

The accompanying chart is useful for obtaining the air velocity from the formula

$$V = 1096.5 \sqrt{\frac{P}{W}}$$

V = Velocity in feet per minute;
P = Pressure due to velocity in inches of water;
W = Weight of air in pounds per cubic feet.

To read the chart and obtain the value V, take on the axis of abscissa a value for P which has been measured with a pitot tube or a similar instrument. From P's value run vertically to an oblique line representing the value for W; from the intersection of those two lines run horizontally to the curve. From the intersection on the curve run vertically to an oblique line 1096.5 in., and from that intersection run horizontally to the ordinate V. If the intersection is found on the first "1096.5 line," the value of V is read from 0 to 2400. If the intersection is found on the second "1096.5 line," V the scale number from 0 to 2400 plus 2000. Similarly 4000 is added for the third line and 6000 for the fourth line.

An example is shown by the dotted lines, having P = 0.4 and W = 0.1. The intersection comes on both the first and second "1096.5 line." From the first intersection line V read 2193; from the second, 193 + 2000 = 2193, which is the velocity in feet per minute.

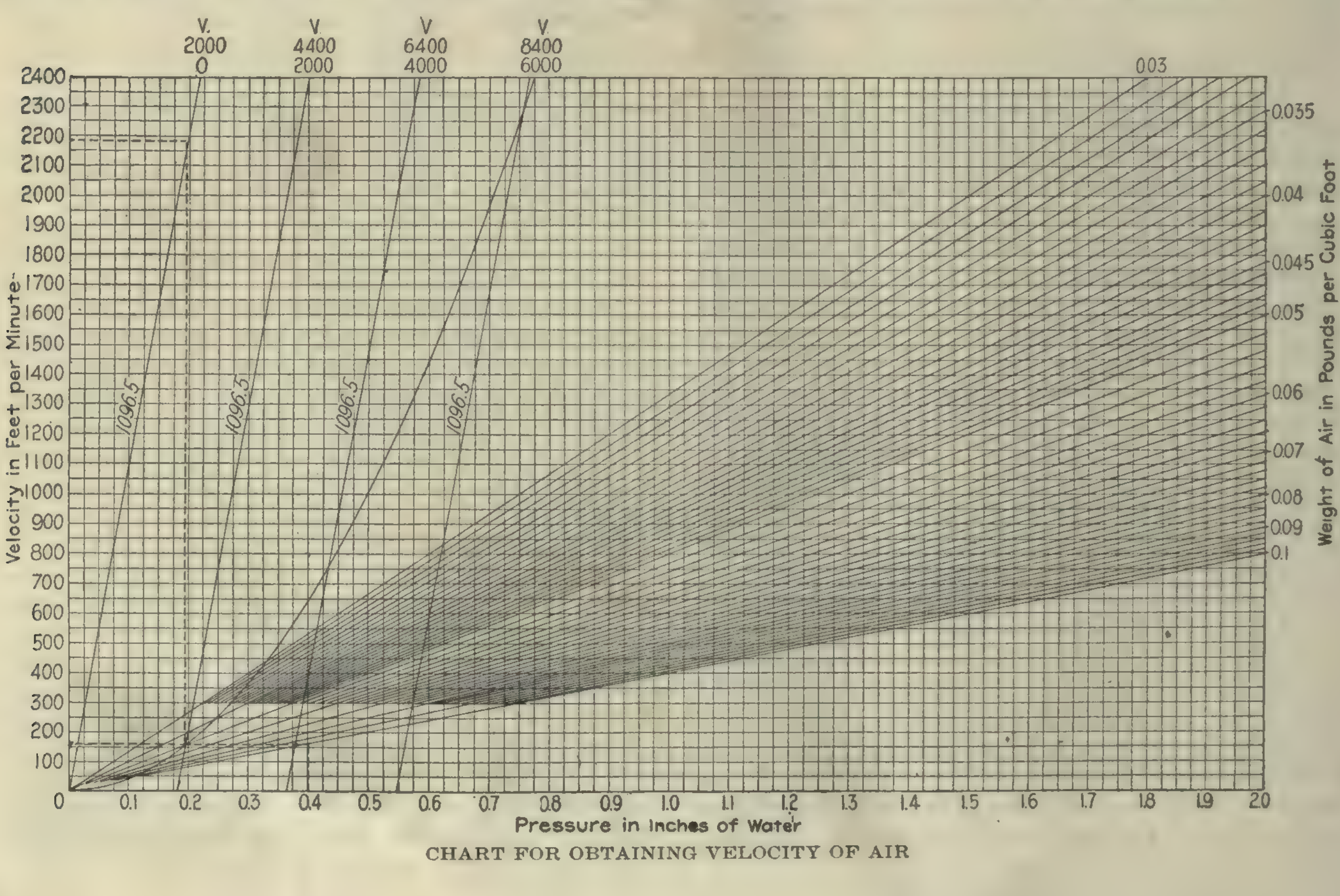


CHART FOR OBTAINING VELOCITY OF AIR

Specifications for Electric Motor Applications—I

By A. G. Popcke*

SYNOPSIS—The principal points to be considered in selecting and specifying electric motors in industrial plants. Horsepower ratings, classes of service and the electrical considerations are outlined. The efficiency, starting torque and speed regulation of direct-current motors, and the voltage, efficiency and power factor for alternating-current motors are all discussed.

Before purchasing electrical equipment, a knowledge of the general details required to specify apparatus to meet specific requirements is necessary. It is the object of the following discussion to point out the principal points requiring consideration before purchasing electrical equipment for the shop.

Before it is possible to purchase any equipment, it is necessary to determine the horsepower and speed requirements of the machine or group of machines to be driven. These requirements are best determined by a motor application engineer; the larger central stations or electrical manufacturers provide experts for making such recommendations.[1] For greatest economy, motors and controllers of standard characteristics should be used wherever possible. The standard horsepower and speed ratings furnished by motor manufacturers have been selected at intervals that will make it possible to choose a standard economical motor for the majority of applications met with in industrial service.

All motors are characterized by a rating given them by the manufacturers. This rating is the basis on which the maker guarantees his product to the user. The distinction between motor rating and motor capacity to do work requires a little explanation. The capacity is usually determined by the maximum temperature at which the material in the machine, insulation particularly, may be operated for long periods without deterioration. When the safe limits are exceeded, deterioration is rapid and results in shortening the life of the machine. There does not appear to be any advantage in operating at lower temperatures than safe limits, so far as the life of the insulation is concerned.

Up to the present time, it has been customary for manufacturers to guarantee their motors as follows: Continuous service—full rated load continuously, 40 deg. C. rise; 125 per cent. rated load, 2 hr., 55 deg. C. rise.

This means that if, for example, a 10-hp. motor is operated at 10-hp. output continuously, the temperature of any part will not exceed 40 deg. C. above that of the initial temperature (room temperature = 25 deg. C.); operating the motor at 12.5 hp. for 2 hr. will produce a rise in temperature not exceeding 55 deg. C.

Motors for intermittent service are rated on the basis of 5, 10, 15, 30, 60 and 120-min. periods with 55 deg. C. rise. This means that if a motor is run at the rated load during the time period given, its temperature will not exceed 55 deg. C. Thus, a 10-hp. motor rated on a ½-hr. 55-deg. basis will not have a temperature rise exceeding 55 deg. if operated ½ hr. at 10 hp.

The application of intermittently rated motors is largely based on experience. Past experience with a given application has shown that the motor first selected was either too large or too small. In making the application over again, a motor of capacity more nearly

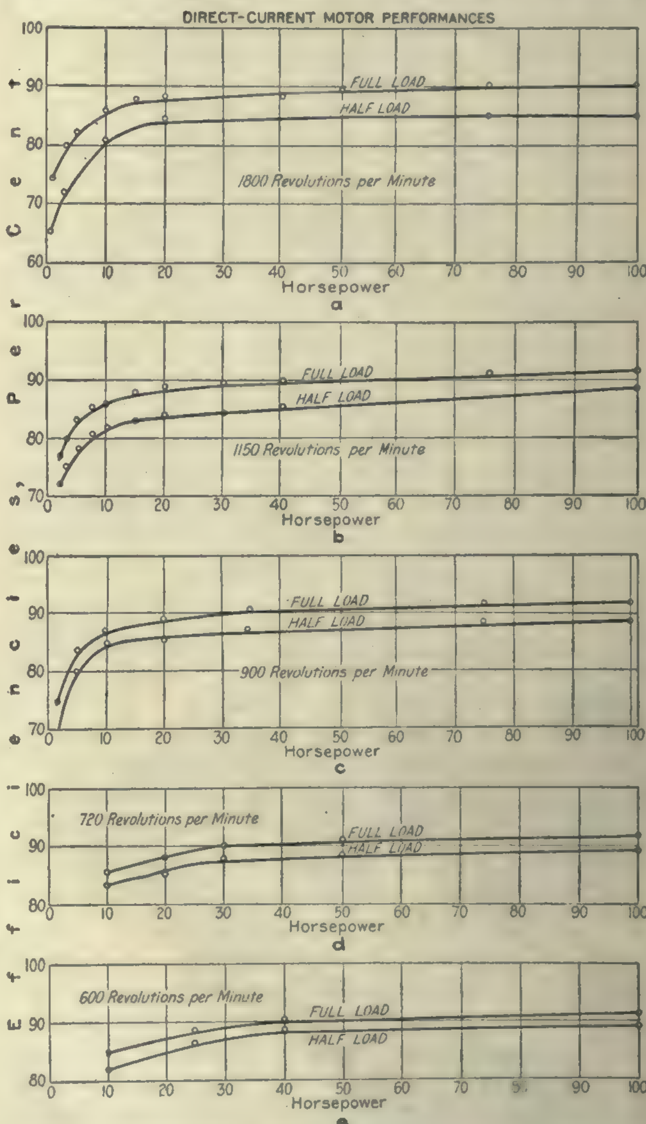


FIG. 1. EFFICIENCY OF DIRECT-CURRENT MOTORS

Efficiencies for different speed motors (1,800, 1,200, 900, 720 and 600 r.p.m.) are given separately. A comparison of the various curves shows how the efficiency varies with the different speeds.

equivalent to the requirements was chosen. Thus, at the present time, manufacturers of machines using electric motors of intermittent ratings to drive them, are in a position to specify the motor of proper horsepower and time rating (5, 10, 15, 30, 60 or 120 min.).

A motor required to operate for very short periods at a time, with long intervals between the periods of opera-

*Industrial Electrical Engineer, Westinghouse Electric and Manufacturing Co.

[1]Each large industrial plant should have an expert for this purpose in its organization.

tion, would be most economically selected on a 5- or 10-min. rated basis. Motors for operating valves, or motors for operating the crossrails, tailstocks or headstocks of machine tools, can usually be rated on a 5- or 10-min. basis.

In crane service experience has shown that a motor rated on the ½-hr. basis has sufficient capacity to do the work in this class. A crane motor usually operates continuously all day; that is, it goes through its cycle of operation—starting, accelerating, stopping and reversing—all day long. Thus, a 10-hp. crane motor does not operate continuously at 10 hp. If it did, it would burn up, for it would attain a 55 deg. C. rise in ½ hr., as per its guarantee. In actual service the average capacity is equivalent to perhaps only 3 to 5 hp., whereas its peaks exceed 10 hp.

Motors for operating the main driving mechanism of machine tools are either rated on the 1- or 2-hr. basis, and in some cases even continuously rated motors are required.

Consideration must be given to the time of loading the machine, the time of operating under cutting service, and the magnitude of the load while cutting. In some instances it will be found that quite similar machines may be equipped with motors having a rating of 1 hr., in other instances 2 hr., and under extreme conditions the service may require that a motor having a continuous rating be installed.

Experience shows that the maximum permissible temperature to which the insulation of commercial motors can be subjected is 105 deg. C. Investigation shows that the difference between the actual temperature measurable by a thermometer and the actual temperature of the hottest spot is 15 deg. C. Thus, commercial insulating materials will withstand a maximum measurable temperature of 90 deg. C.

Taking into consideration engine-room temperatures, the A. I. E. E. has adopted 40 deg. C. as the basic room temperature. On this basis, therefore, a 50 deg. C. rise in temperature is permissible.

The correct application of motors consists in selecting a motor of proper rating for the different classes of service, and this is a subject entirely separate and apart from the responsibility of the maker to produce apparatus that will meet the guarantees given in his sales specification.

Classes of Service Requirements

Service requirements can be divided into two general classes: (1) General service; (2) special, specific service, continuous or intermittent.

In the first class are included motors on which the load requirements do not follow a definite known cycle, or where the conditions of load may vary from time to time. A motor operating line shafting usually requires a margin of overload capacity for adding additional machines in the future and, therefore, belongs in this class. Any motor driving a machine in which the class of service varies from time to time, requiring provision for carrying overloads during short periods, belongs in this class.

In the special class are included applications where the load follows a definite known cycle, or where the load is continuous and not subject to overloads, except perhaps peaks of only short duration.

As experience with electric drive increases, the power requirements of various machines will be more definitely known, the number of applications in class 2 will increase, and the 50-deg. motor without overload will be used more and more. For this reason the manufacturers of electric motors are taking steps to supply standard 50-deg. motors without overload guarantee, except that motors will carry an overload of 50 per cent. momentarily. This method of rating has been employed by European manufacturers for several years past.

Electrical Considerations

The type of electrical equipment is determined first of all by the characteristics of the electric circuit supplying power—that is, direct or alternating current. Commercial direct-current circuits are 115, 230 or 550 volts. For power purposes 230 volts is almost universally used; 115 volts is used principally for lighting, and 550 volts is met with only where power is obtained from street railway circuits. There are only a few central stations that supply 550-volt direct current. The characteristics which determine an alternating-current circuit are its frequency, phase and voltage. Alternating current is mostly supplied at a frequency of 60 cycles, less frequently at 25 cycles and in a few districts at 50 or 40 cycles. Power circuits are two or three phase, the latter covering approximately 90 per cent. of the application of alternating-current motors.[2] Voltages used in plants are 110, 220, 440 and 550; 220 and 440 are used in the majority of cases. The relative demand for different voltages is approximately as follows: 110 volts, 5 per cent.; 220 volts, 68 per cent.; 440 volts, 21 per cent.; 550 volts, 6 per cent. The higher the voltage used, the smaller the amount of copper required for conducting the current economically. Therefore, in distributing power long distances, 2,200, 6,600, 11,000 volts and higher are used, but these voltages are always transformed by the power company to the above lower voltages for the use

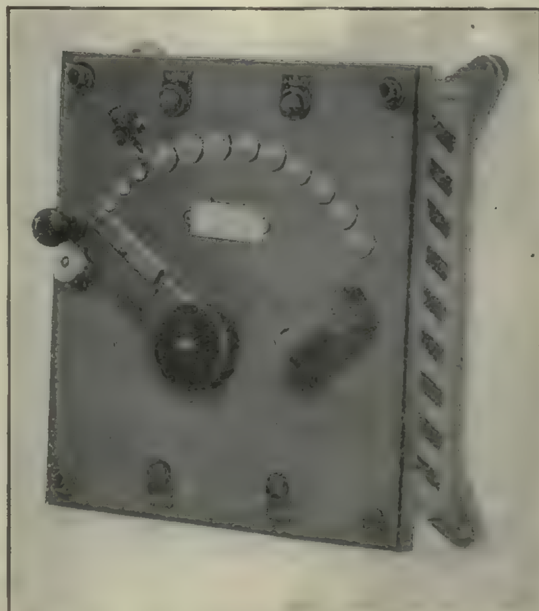


FIG. 2. STARTING RHEOSTAT FOR DIRECT-CURRENT MOTORS

[2]Single phase is also used, mostly for operating fractional horsepower motors; where polyphase is not available, as in isolated districts, central stations sometimes supply single-phase lines.

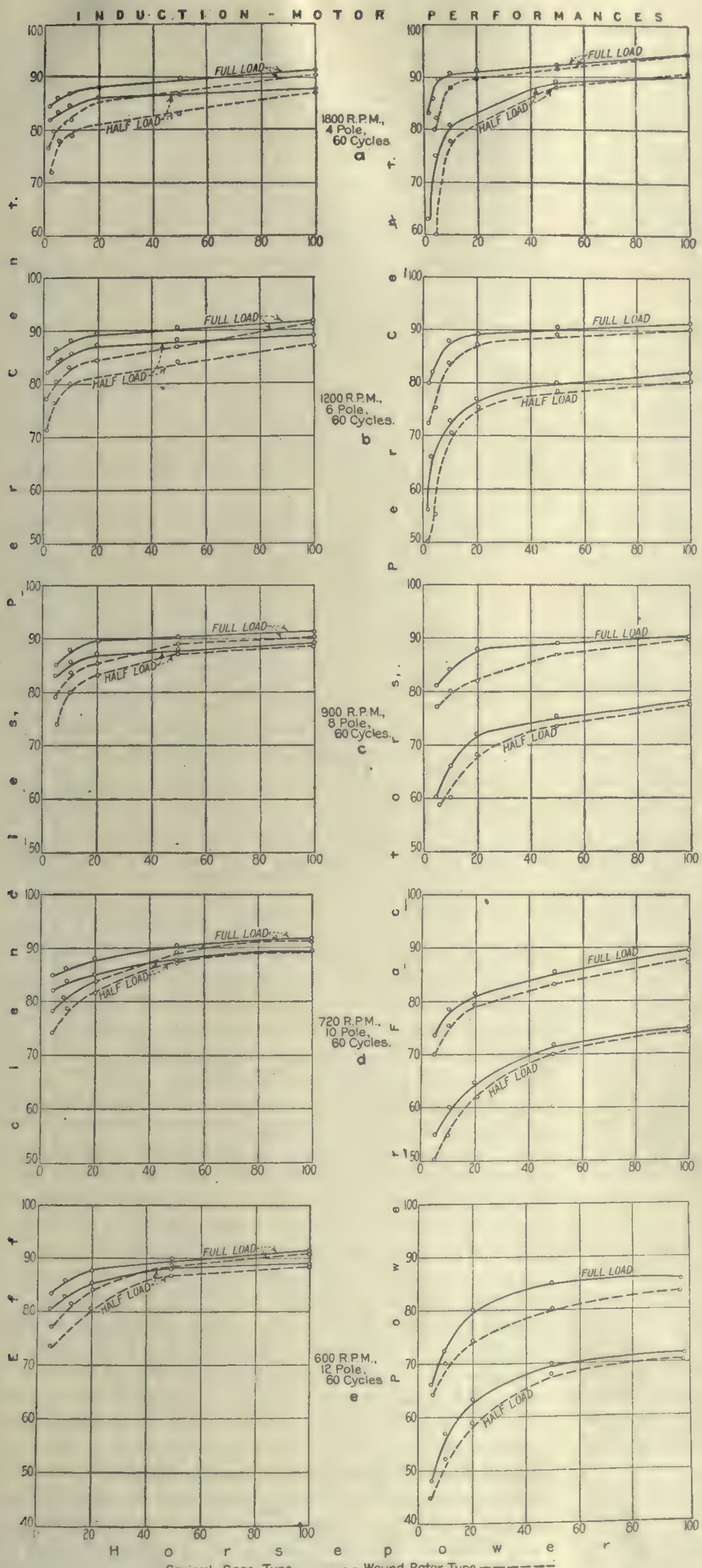


FIG. 3. EFFICIENCIES AND POWER FACTOR OF SQUIRREL-CAGE AND WOUND ROTOR INDUCTION MOTORS

of industrial plants. The maximum for safety to operators, where the motor application is such that operators come in contact with the driving motor, is 550 volts. The characteristics of the supply circuit being outlined, the characteristics of the different types of motors will be discussed. A direct-current motor is characterized by its horsepower, speed in revolutions per minute and type of field winding-shunt, compound or series. The first is most generally used. Compound motors are used where the torque exerted to start and accelerate a load is large. Series-wound motors are used only where the starting torque is heavy and where the motor is not subjected to light loads. (Series motors attain a dangerous high speed under light load conditions.) Shunt-wound motors are of two general classes as regards speed—constant speed and adjustable speed. By weakening the shunt field of a direct-current motor, its speed increases. Motors of 2 : 1, 3 : 1, 4 : 1 and sometimes higher speed range are supplied commercially. Table 1 gives a list of combination of horsepower and speeds listed as standard by the majority of manufacturers. This table also gives the value of full-load torque and square root of torque for each combination. The use of these values will be explained later. To conform with the voltage of circuits available, direct-current motors are supplied for 115, 230 and 550 volts. Motors are guaranteed to operate successfully on voltages 10 per cent. higher or lower than these; that is, 115-volt motor, 103 to 126 volts; 230-volt motor, 206 to 252 volts; 550-volt motor, 495 to 605 volts. In all cases the speed of the motor will vary in approximately the same proportion as the change in voltage; that is, if the voltage is 5 per cent., high speed will be 5 per cent. high and vice versa. If the voltage is more than 10 per cent. high, the field windings will get hot, owing to increased current in these windings. When the voltage is reduced below normal, the current in the armature for a given output increases. This not only produces increased heating, but commutation troubles arise because of the heavy armature current and weak field. To operate a motor at reduced voltage, the rated output should be reduced in the same proportion as the reduced voltage. Thus, at 15 per cent. reduced voltage, the rated output should be reduced 15 per cent. The necessity of operating motors continually at voltages varying more than 10 per cent. from normal occurs only infrequently in the circuits used in the majority of industrial plants. If greater variation is encountered on central station lines, the users have just cause to ask for better service. An isolated plant properly designed should

be able to maintain voltage within 10 per cent. of normal; if not, an investigation should be made to determine the cause of the defect.

The efficiency or relation of output to input requires consideration, particularly if the motor is operating continuously during the working day. In cases like this, especially in the larger motor, 1 per cent. difference in efficiency produces considerable difference in the yearly power consumption. Where a motor is operated intermittently, this feature is not of so great importance. The curves in Fig. 1 show the relative efficiencies of commercial constant-speed, shunt-wound, direct-current motors.

TABLE 1. HORSEPOWER AND SPEEDS OF DIRECT-CURRENT MOTORS MOST COMMONLY USED

Values of Torque and Square Root of Torque Are Given for Each Rating

Horsepower Rating	Full-Load Speed 1750 T	1750 √T	1150 T	1150 √T	850 T	850 √T	600 T	600 √T
½	1.5	1.2	2.3	1.5				
¾	2.3	1.5	3.4	1.9				
1	3	1.7	4.6	2.1				
1½	4.5	2.1	6.8	2.6				
2	6	2.5	9.2	3				
3	9	3	13.7	3.7				
5	15	3.9	22.8	4.8	35	5.9		
7½	22.5	4.8	34.2	5.9	52.5	7.2		
10	30	5.5	46	6.8	70	8.4		
15	45	6.7	69	8.3	105	10.2	138	11.8
20	60	7.8	91	9.6	140	11.8	184	13.6
30	90	9.5	137	11.7	210	14.5	276	16.7
40	120	11	183	13.5	280	16.8	370	19.2
50	150	12.2	228	15.1	350	18.7	460	21.4
75	225	15	342	18.5	525	23	690	26.3
100	300	17.3	456	21.4	700	26.5	920	30.4

For direct-current, shunt-wound motors with full field strength, the starting torque varies almost directly with the starting current, which is in turn dependent on the resistance in the armature circuit. The standard starting rheostat, when thrown into the first position, limits the armature current to from 125 to 200 per cent. of normal full-load current, giving a starting torque of 125 to 225 per cent. normal for shunt-wound and 130 to 260 per cent. for compound-wound motors. The higher percentages of current and consequent torque are obtained with the smaller motors.

If greater starting torque is required, it is obtained by advancing the rheostat handle (Fig. 2) to the second or third point, allowing a greater current to flow in the armature. The allowable starting torque to be obtained in this way depends upon commutation, the current being limited to approximately 200 per cent. of normal for a shunt-wound motor and to about 250 per cent. for a compound-wound motor. This current will correspond to about 225 per cent. full-load torque for shunt and 300 per cent. for compound motors. Motors in sizes smaller than ½ hp. are usually started without a rheostat, being started at normal voltage by a knife switch.

TABLE 2. RATINGS OF ADJUSTABLE-SPEED DIRECT-CURRENT MOTORS

Horsepower	R.P.M.	Horsepower	R.P.M.
2	700 to 2,100	2	500 to 2,000
3	700 to 2,100	3	500 to 2,000
5	700 to 2,100	5	500 to 2,000
7½	600 to 1,800	7½	450 to 1,800
10	600 to 1,800	10	450 to 1,800
15	500 to 1,500	15	350 to 1,400
20	500 to 1,500	20	350 to 1,400
25	500 to 1,500	25	350 to 1,400
35	500 to 1,500	35	300 to 1,200
50	400 to 1,200		

The maximum momentary torque allowable is limited by commutation only, and is about 225 per cent. for shunt- and 300 per cent. for compound-wound motors. Corresponding armature currents are 200 per cent. full-load current for shunt and 250 per cent. for compound motors.

To summarize:

	Per Cent. Full Load Torque	Per Cent. Full Load Current
Normal starting torque, shunt	125 to 225	125 to 200
Normal starting torque, compound	130 to 260	....
Maximum allowable, shunt	225	200
Maximum allowable, compound	300	250
Maximum adjustable speed (weak field)	160	150

Speed Regulation for Direct-Current Motors

Speed regulation—that is, decrease in speed from no load to full load—averages about 6 per cent. for standard shunt-wound motors or about 20 to 25 per cent. for compound-wound motors for moderate-speed motors. Very slow-speed motors have greater speed regulation.[3]

TABLE 3. RATINGS OF SQUIRREL-CAGE AND WOUND ROTOR INDUCTION MOTORS

The Values of Torque and Square Root of Torque Are Given for the Ratings Most Commonly Used

Poles	4		6		8		10		12		14	
Full Load Speed	1750		1150		850		690		580		495	
Horsepower Rating	T	√T	T	√T	T	√T	T	√T	T	√T	T	√T
¼	0.7	0.8	1.1	1.1								
½	1.4	1.2	2.2	1.5								
¾	2.2	1.5	3.3	1.8								
1	2.9	1.7	4.4	2.1								
2	5.8	2.4	8.8	3	11.7	3.4						
3	8.8	3	13.1	3.6	17.5	4.2						
5	14.6	3.8	22	4.7	29.2	5.4	36.5	6	43.7	6.6	51	7.1
7½	22	4.7	33	5.8	43.8	6.6	54.7	7.4	65.5	8.1	77	8.8
10	29	5.4	44	6.6	58.4	7.8	73	8.6	87.5	9.4	102	10.1
15	44	6.6	66	8.1	87.5	9.4	110	10.5	131	11.5	153	12.4
20	58	7.6	88	9.4	117	10.8	146	12.1	175	13.2	204	14.3
25	73	8.5	110	10.5	146	12.1	182	13.5	218	14.8	255	16
30	88	9.4	131	11.5	175	13.2	219	14.8	262	16.2	307	17.5
40	117	10.8	175	13.2	234	15.3	292	17.1	350	18.7	410	20.2
50	146	12.1	219	14.8	292	17.1	365	19.1	437	20.9	510	22.5
60	175	13.2	263	16.2	350	18.7	438	20.9	525	23	613	24.8
75	219	14.8	329	18.1	437	20.9	547	23.4	655	25.6	766	27.7
100	292	17.1	438	20.9	583	24.2	730	27	875	29.6	1,020	32
125	365	19.1	546	23.4	730	27	915	30.3	1,090	33	1,280	35.8
150	438	20.9	657	25.6	875	29.6	1,100	33.2	1,310	36.2	1,530	39.2
200	584	24.2	875	29.6	1,170	34.2	1,460	38.2	1,750	42	2,040	45.2

Constant-speed motors can be increased 15 per cent. in speed by inserting resistance in the field. If greater increase is desired, adjustable speed motors should be specified. The ratings given in Table 2 cover the field of application of this type of motor.

Alternating-Current Motors

At the present, approximately three times as many alternating as direct-current motors are used in industrial work. The induction type is used almost universally for industrial service. These are of the squirrel-cage and wound rotor types. In approximately 90 per cent. of the applications, squirrel-cage motors are used. This type is applicable where constant speeds are required and where the torque required at the start is not excessive. Wound rotor motors are required where the starting torque is heavy. This type of motor is also necessary where speeds below normal speed of motor are required. The use of this motor is not equivalent to the adjustable-speed direct-current motors mentioned above. On the wound rotor alternating-current motor speeds are reduced below normal by inserting resistance in the rotor by means of a controller. The horsepower output decreases in direct proportion to the speed. Reduced speeds are only obtainable when the motor is loaded. On the direct-current adjustable-speed motor for a given adjustment the speed does not vary over 6 per cent. from light load to normal rated load.

An alternating-current motor is characterized by its horsepower, speed, phase, voltage and frequency. Only

[3]The allowable variation in speed due to manufacturing variation is guaranteed not to exceed 7½ per cent. on motors up to and including 7½ hp., 1,150 r.p.m.; on larger motors this variation shall not exceed 5 per cent. As a direct-current motor heats up its speed increases; the variation in speed from full load cold to full load hot will not exceed 10 per cent. based on full-load speed.

certain definite speeds are obtainable; this is dependent on the number of poles for which it is wound—that is, 2, 4, 6, 8, 10, 12, etc. Sixty-cycle motors operate at the following speeds:

No. of Poles	Motor Speeds Rated Load	Synchronous or No Load
2	3,400	3,600
4	1,750	1,800
6	1,150	1,200
8	850	900
10	690	720
12	580	600

Twenty-five-cycle motors operate at the following speeds:

No. of Poles	Motor Speeds Rated Load	Synchronous or No Load
2	1,400	1,500
4	720	750
6	480	500

Table 3 gives the combination of horsepower and speeds furnished by the majority of manufacturers for continuous-duty squirrel-cage and wound rotor motors. The value of torque and square root of torque is given for each rating.

The difference between the no-load and full-load speed is called the slip, and is usually 5 to 7 per cent.

Voltage

To conform with the voltage of the circuits available, alternating-current motors are supplied for 110, 220, 440 and 550 volts. Two- and three-phase motors are guaranteed to operate successfully on voltages 10 per cent. lower or higher than these; that is,

Motor Voltage	Allowable Line Voltage	Motor Voltage	Allowable Line Voltage
110	99 to 121	440	396 to 484
220	198 to 242	550	495 to 545

An increase in voltage will produce a slight increase in full-load speed; the no-load speed depends only on the frequency. A 10 per cent. increase in voltage will produce a 10 per cent. reduction in slip, or if a motor has 5 per cent. slip at normal voltage and on the other hand at 10 per cent. reduced voltage, the slip will be increased from 5 to 5.5 per cent.

The starting and maximum torques increase in direct proportion as the square of the voltage. Thus a 10 per cent. increase in voltage will produce a 21 per cent. increase in these torques and vice versa. A 10 per cent. reduction in voltage will enable a motor to produce only 81 per cent. of the torques at normal voltage.

An increase in voltage in general tends to better the performance (efficiency and power factor) and a decrease to decrease the performance. This, however, depends on the details of design, as the relation of iron and copper losses.

As explained in the discussion of direct-current motors, voltages ranging more than 10 per cent. from normal are not often encountered, and if they are met with the cause of the greater variation should be explained, whether the source of power be from a central or from an isolated plant.

As in a direct-current motor, the efficiency is the relation of power output to power input. In addition to this, the power factor requires consideration on alternating-current motors. This is the relation of the $\frac{\text{watts input}}{\text{volts} \times \text{amperes input}}$. The effect of poor power factor on a system is to reduce the current-carrying capacity of both the distributing system and the generating equipment. It is therefore important that the power factor be as high as possible.

The curves in Fig. 3 show the relative efficiencies of commercial squirrel-cage motors; it also shows the power factors.

The higher the efficiency, the lower the yearly power bills for operating a motor. The cost of power per year (based on 3,000 hr. operation at a rate of 1c. per kw.-hr.), motor operating at full load, is

$$\frac{hp. \times 746 \times 0.01 \times 3{,}000}{\textit{full-load efficiency}} = \frac{22.38\ hp.}{\textit{full-load efficiency}}$$

The figure of 1c. per kw.-hr. is used because on this basis the corresponding values at other rates of power can be easily computed.

For example, the difference in power cost of a 100-hp. motor having a full-load efficiency of 91 per cent. and one having a full-load efficiency of 90 per cent., power costing 2½c. per kw.-hr. is as follows:

Motor at 89 per cent. efficiency $\frac{22.38 \times 100}{0.90} \times 2.5 =$ \$6,210

Motor at 90 per cent. efficiency $\frac{22.38 \times 100}{0.91} \times 2.5 =$ 6,140

Difference per year \$70

The selling price of a motor at 580 r.p.m. is \$900 approximately. This saving per year is 7.7 per cent. of the cost of the motor, or the saving in power will pay for the cost of the motor in 13 years.

The following will show the importance of high efficiency even on a small motor that is operated continuously.

For example, comparing 5-hp. motors, 1,750 r.p.m., with efficiencies of 86 and 87 per cent., cost of power 3c. per kw.-hr.:

Motor at 86 per cent. efficiency $\frac{22.38 \times 5}{0.86} \times 3 =$ \$390 per year

Motor at 87 per cent. efficiency $\frac{22.38 \times 5}{0.87} \times 3 =$ 385 per year

Saving per year \$5

The selling price of the motor is \$80. Saving is 6.3 per cent. of motor cost, or saving will pay for the motor in 16 years.

Essential Features of High-Speed Motors*

In his paper before the Society of Automobile Engineers, A. F. Milbrath, secretary and engineer of the Wisconsin Motor Manufacturing Co., brought out a number of interesting points in regard to high-speed automobile engines. As this company has built many motors that have proved successful in the great speed contests, the suggestions given are well worth noting.

The first compromise is between the reduction of the weight of reciprocating parts by use of a long stroke and the increase of weight of the complete motor when the stroke is excessively long. A stroke of 1.70 to 1.75 times the bore has proved very successful in motors having 300-cu.in. cylinder capacity.

The speed depends principally on the valve area, valve timing, size and bore of inlet manifold, location of spark plugs, and on the resistance offered by the carburetor to the incoming charge. Two intake and two exhaust valves of $1\frac{9}{16}$ or 1¾ in. in diameter per cylinder will develop maximum speed at 3000 r.p.m. This on a 300-

*From a paper before the Society of Automobile Engineers.

cu.in. motor gives an actual gas velocity of about 200 ft. per sec. through the valves when using a lift of $\frac{5}{16}$ in. The inlet manifold should be of a size to give a gas velocity of about 175 ft. per sec. and should be as smooth and free from sharp bends as possible.

Volume of Compression Space

The volume of compression space for high-speed motors should be 18 to 20 per cent. of the total volume. This will give compression pressures of about 90 to 110 lb. per sq.in. The combustion chamber should be free from pockets, and the more nearly spherical the shape the better it is for rapid flame propagation and gas flow as well as for the reduction of heat lost in the jacket water.

Ignition can be either single or double spark. In the first instance the plug should be located as near the center of the combustion chamber as possible. Mr. Milbrath prefers two-point ignition with spark plugs on opposite sides, giving more rapid combustion, more power and reduced fuel consumption.

The best material should be used for both valves and springs, and the springs must be carefully designed for high-speed work. It is often found advisable to use double springs, the inner spring being for safety and the tension kept much lower than on the outer, or main, spring, which does most of the work of closing. With this construction the valve will not fall into the cylinder, should the outer, or main, spring break. In actual practice at engine speeds of 3000 r.p.m., spring tensions of 80 lb. with the valves seated have been satisfactory on 1¾-in. valves weighing, with accompanying retaining parts, 0.9 lb. For higher speeds greater spring tension is necessary, which brings increasing difficulty in securing springs that will stand up.

Valve Timing for High Speeds

While the very best valve timing for a high-speed engine depends on so many things that it is possible to secure best results only by actual test, the following gives a good basis for beginning this work: The inlet valve opens at or slightly before upper center and closes about 50 deg. after lower center. The exhaust valve opens about 50 deg. before lower center and closes about 10 deg. after upper center. These figures are for engines with large valve areas at speed of 3000 r.p.m. Various valve-operating mechanisms were discussed, these depending on the individual design. One of the most important considerations is the weight of piston, the aluminum alloy seeming to have a large number of advantages in high-speed work. Wristpin or piston-pin bearings can be in the aluminum casting or can be bushed, if desired. Thicker piston rings should be used than with a cast-iron piston, as the thin rings are apt to wear into the aluminum and gradually widen the groove. Two rings are sufficient for high-speed work, and even one has been used successfully.

Connecting-rods of both tubular and I-beam section are satisfactory. Chrome nickel, or chrome-vanadium steel, heat-treated to secure an elastic limit of at least 115,000 lb. per sq.in., should be used. Rods are machined all over to obtain light and uniform weight. Connecting-rods, pistons and all reciprocating parts must be balanced perfectly to insure freedom from vibration.

Crankshafts must be made of equally good material; to insure stiffness the shaft should not be under 2 in. in diameter for a 300-cu.in. motor, and 2¼ in. in diameter is considered better in every way. A large shaft gives sufficient mass to absorb vibration set up by light pistons and rods, and in the opinion of Mr. Milbrath no additional balance weights are necessary if the ratio of connecting-rod lengths to the piston stroke is at least 2 to 1.

Aluminum-alloy pistons $3\frac{15}{16}$ in. in diameter and weighing 12 oz. have been constructed of ample strength. With wristpin and ring the weight was 21½ oz. The connecting-rod for the same motor weighed 43 oz. Considering one-half the weight of the rod as a reciprocating mass, this would give a total reciprocating weight for piston pin and rings of 43 oz., or 2.69 lb. With a 6½-in. stroke the inertia forces at 3000 r.p.m. varied from minus 2760 lb. at a zero crank angle to plus 1710 lb. at 180 deg. crank angle. Taking the explosion pressure as 325 per sq.in., the total pressure on the piston is 3710 lb. The total compression pressure at 90 lb. per sq.in. is 1027 lb. The centrifugal force always acts outward from the center of the shaft and therefore exerts a constant pressure of 2110 lb. on the crankpin bearing.

The crankpin of this motor was 2¼ in. in diameter and 2½ in. long, giving a projected area of 5.625 sq.in. The greatest pressure per square inch is 4870, divided by the area, or 865 lb. With good lubrication it would be safe to allow a maximum pressure of 900 to 1000 lb. per sq.in. if the oil used is heavy enough to stand up under these high pressures, high speeds and heat. The weight of these shafts can be lessened by boring the pins and main bearings. The diameter of this bore can easily be one-half the diameter of the shaft without weakening it appreciably.

Difficulties in Manufacture of Airplane-Propeller Hubs

The propeller is one of the serious factors in airplane development, as it contains problems that are new and difficult to solve. Aside from the question of efficiency the mechanical problems are many and are not of such nature that they may be easily, quickly and accurately solved.

The pulsations of the motor, which transmit a series of hammer blows to the hub through the bolts, and the bending and torsional stresses all exert a tremendous influence on the material of the propeller at the hub. It was early discovered that the flanges must be set up very tight and that small flanges were sometimes crushed into the wood as much as ⅜ in. Bolt areas are now increased, in one instance the hub being enlarged to take eight ¾-in. bolts with 18 threads, the original hub having but six ½-in. bolts.

Some idea of the working of the wooden hub in the flange and the tremendous friction developed may be understood when we learn that there are cases where the wood chars under the heat at this point.

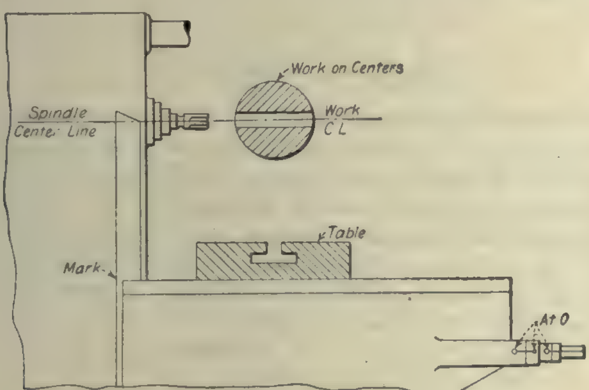
There is little doubt that metal propellers will be developed for airplanes; but as it requires large and expensive dies for manufacturing them economically, no one has yet attempted this branch of the work on a sufficient scale to warrant the initial expense which would be necessary in order to make sure of the success of the venture.

Letters from Practical Men

To Set Work Central with the Miller Spindle

The following method may be old to some, but it is seldom taken advantage of in the toolroom. It provides a means of bringing the work exactly central with the spindle of the miller, in milling the elongated slots in pieces such as collapsing taps. The same result can be accomplished with the indicator, but that way is slow and tiresome.

As the work is always held in the index centers, a piece is put in position and located as usual with the



THE MACHINE, WORK AND GRADUATIONS

indicator. Then the zero on the graduated dial of the vertical screw shaft is set to correspond with the zero on the knee. The zero line on the graduation is run to the outer ėnd, and a corresponding line and zero are put on the collar that holds them in place. Next, a light line is scratched on the column at the top of the knee, all as shown in the illustration.

The next time a piece of work has to be brought central, all that is necessary is to run up to the mark on the column, see that the three zero marks are in line—and the work is central. JOHN H. MOORE.

Detroit, Mich.

Removing Tight Pulleys

Considerable trouble is often experienced in removing tight pulleys from shafts, especially countershafts, as the pulleys are almost always held by setscrews. Of course, countershafts should be spotted for the setscrews that hold the tight pulleys, but often they will be found to be tightened off the spot. This results in a burr, and in forcing the pulleys off, the shaft is very apt to be badly scored.

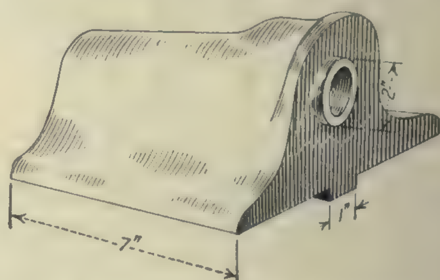
To avoid scoring get the job in the drill press and then remove the setscrews one at a time, and with a drill the same size as was used for the tap drill spot the shaft. This will remove the burr, and the pulley is ready to come off without trouble. J. A. RAUGHT.

Janesville, Wis.

Machining Cast-Iron Bearings on a Lathe

I recently machined a quantity of the cast-iron bearings shown in the illustration, with only the ordinary facilities of a jobbing shop at my command.

The problem was to bore this casting exactly in line with the step on the bottom face, so an improvised



THE BEARING TO BE MACHINED

fixture was made by bolting an angle plate to the faceplate of a lathe and fastening a parallel on the angle plate in line with the lathe centers, after which it was a comparatively simple matter to clamp the bearing on the angle plate with the step set against the parallel, bore, ream and face the job.

After the first casting was finished there was practically no setting up required, and the resulting average time was 25 min. per bearing. GEORGE WOOD.

Brooklyn, N. Y.

Tap-Drill Sizes

Thousands of holes are tapped every working day with machinists' hand taps of V or U. S. Standard form of thread. Every one of these holes had been previously drilled to a size known as the tap-drill size, representing the prevailing idea of the shop or individual as to how much stock should be left to form a perfect thread.

Every screw made to fit such tapped holes has a certain definite dimension, known as the root diameter of thread, and this dimension is evidently the correct theoretical tap-drill size. Practically, however, few if any taps will cut a thread that is anywhere near perfect at the point; and unless the tap drill is somewhat larger than above indicated, frequent breakage of taps results, especially when tapping by power. By using a larger drill than the theoretical tap-drill size, it is evident that the thread will be flattened at the point and the actual depth of thread will be less than the theoretical depth. Far from being a bad thing, this is really a very good and necessary expedient, for it merely removes the weak and imperfect point of the thread and adds much to the life of the tap. The things that the average shopman wants to know are how much the point of the thread can be cut away, and how large the tap drill should be.

Tables of so-called tap-drill sizes are common and can be found in many catalogs, but the figures given are for the most oart such as are just over the theoretical size and are nearly or quite useless for practical purposes. The accompanying table is calculated for U. S. Standard threads, but it is all right for V-threads and can be used just as it is. It contains three double columns. In the center is the tap, with its number of threads per inch and theoretical double depth of thread. At the left is the old list of tap-drill sizes with the percentage of full thread that should (theoretically) result. At the right is

TAP-DRILL SIZES

Old List		Per Cent.	Tap		Double Depth	New List		Per Cent.
3/16		96	1/4	20	0.065	13/64		72
C	(0.242)	98	5/16	18	0.072	G	(0.261)	72
N	(0.302)	90	3/8	16	0.081	8 mm.	(0.315)	75
S	(0.348)	96	7/16	14	0.093	U	(0.368)	75
27/64		97	1/2	13	0.100	27/64		78
		..	1/2	12	0.108	10½ mm.	(0.413)	80
29/64		02	9/16	12	0.108	12 mm.	(0.472)	84
33/64		93	5/8	11	0.118	17/32		80
37/64		93	11/16	11	0.118	19/32		80
5/8		96	3/4	10	0.130	41/64		84
11/16		96	13/16	10	0.130	45/64		84
47/64		98	7/8	9	0.144	3/4		87
51/64		97	15/16	9	0.144	13/16		87
27/32		96	1	8	0.162	55/64		87

a new list with percentage of full thread, ranging from 72 per cent. for a ¼-20 tap to 87 per cent. for a 1-in. tap. This list has stood the test of experience. It gives a good clean thread of ample strength, and the taps will stand up well in power tapping. The progression is fairly uniform from 72 to 87 per cent., and the millimeter drills called for can be bought in the open market.

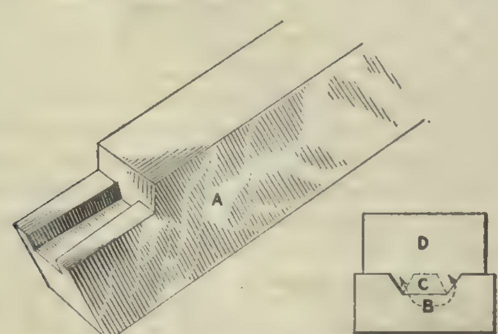
It is dead certain that for threads under ½ in. nothing is gained by trying to get more than 75 per cent. of full thread; above that size the taps are stronger and will stand up to cut a little nearer to a full thread.

Portland, Maine. FRANK E. WILDER.

Lathe Tool with High-Speed Steel Brazed Tip

The following method of brazing a high-speed steel tip on a low-carbon shank has proved satisfactory, as the tool can be retempered and worked to a certain extent without loosening the tip.

The low-carbon shank is forged as shown in the illustration at *A*, and notches *B* are cut with a chisel. The



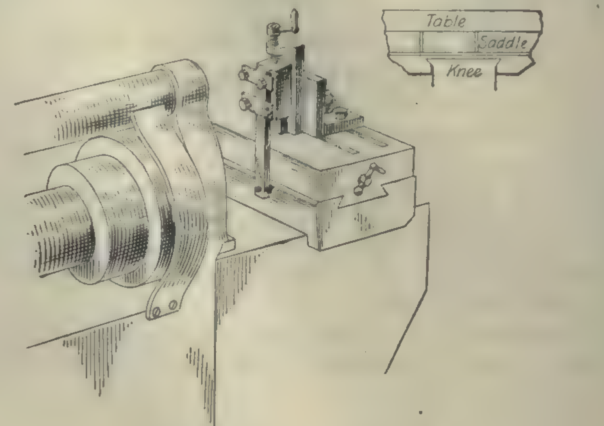
ASSEMBLED TOOL

center section *C* is then removed by a shaper or miller. A high-speed steel tip is forged to the shape *D*, the dovetail section being tapered to assist in holding. The shank is then heated, the ears are forged into the dovetail and brazed in place, after which the tool can be tempered. No trouble has yet been experienced due to loosening.

Huntington, W. Va. W. BURDETT.

A Hand Slotting Job

The illustration shows how a section of the inner surface on the saddle of a miller was slotted true, to receive a bracket that was to be secured at this point. When ready for attaching it was found on examination that the



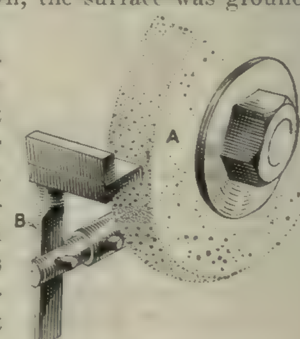
THE HAND SLOTTING RIG

surface had never been machined. On first consideration it seemed as if the machine would have to be dismantled, but after a little study it was decided that with the aid of the broken vise shown in the drawing the desired result could be obtained. Though somewhat laborious, the job was satisfactorily accomplished, and the method used saved considerable time due to the fact that it was not necessary to tear down the job.

Claremont, N. H. WILLIAM H. HARRIS, JR.

Special Rest for Use on a Grinding-Wheel Stand

The accompanying illustration shows a special rest for an emery wheel stand that the writer found to be useful and the means of saving much time in grinding the correct bevel on the edges of a number of trigger guards for shotguns. The "tail," or that part of the guard that fits into the wood of the gun stock, has the edge beveled to facilitate fitting. This had been done by hand with a file, but by using the rest shown, the surface was ground much truer and more quickly. The piece is laid in the rest and fed across the wheel by hand. Such an arrangement can be modified to do similar work on any small, flat stock. The regular rest on the grinder is removed and the special one *B* put in its place. This is easily made by pinning together any convenient flat stock to make the "trough," and screwing it to a post cut off at the angle desired. The angle grinding can be varied slightly by moving the rest above or below the center of the wheel *A* or by changing the length of the horizontal part of the support, which is provided with setscrews for this purpose. HARRY M. INGRAHAM.



THE SPECIAL REST

Batavia, N. Y.

Discussion of Previous Question

Applying the "Plattsburg Plan" in the Shop

I was glad to see your editorial on applying the "Plattsburg plan" to the shop. I spent a month at Plattsburg last summer and had the time of my life. I gained weight in camp and lost it all and more on the hike. I learned something of how much there was to know about the military business and how little of it could be gained in four weeks. There was the further interest of learning what is really meant by *esprit de corps,* both in the small groups of squad and company and in the big group of 7000 men. Some of the nights in camp on the hike with these 7000 men will never be forgotten, and they counterbalance in my memory the unmitigated and concentrated misery of some brief hours spent on the hike itself, which at the time seemed to pass so slowly.

Above all, I learned to respect and admire my captain and to feel something very close to affection for him; and from talking with other men it was plain that our captain, good as he was, was by no means exceptional. If the time ever comes when our country decides to have a really democratic army drawn from all classes and walks in life, a large percentage of the body of officers will measure up to the new conditions and new opportunities, if those on duty at Plattsburg are a fair sample of the whole.

Fine as all this was, it was not what I went to Plattsburg for. I had hoped to have an opportunity to get acquainted with the modern field gun under something approaching service conditions—to know just what it does and just how the ammunition behaves—in a word, to become informed as to the field conditions that determine the manufacturing conditions under which our guns and ammunition are made. It may be that this hope could not have been realized under the best conditions; but as it was, there was absolutely no chance to learn anything of this sort. The artillery was all down on the Mexican border, so none of us could specialize in that branch of the service, as we had hoped, except for a few of the second-year men.

On my return home the importance to the engineer of getting in touch with munition manufacture was still more firmly impressed on my mind, and I wrote to the headquarters of the Department of the East, suggesting the possibility of something very like what Dr. Hollis has been urging. The letter was referred to Howard E. Coffin, chairman of the Production Committee of the Naval Consulting Board. A reply from his office reads in part as follows:

> The ideas and suggestions contained therein are very interesting and much to the point. At present there is no machinery by which your ideas can be practically acted on. I hope, however, that as soon as some pending legislation at Washington is passed there will be an opportunity provided for carrying out your suggestions.
>
> I shall be glad to see that your letter is kept in file and turned over to the proper parties as soon as the legislation I referred to is passed.

Your editorial is an excellent one. With the backing of Dr. Hollis and with a widespread interest among the membership of the American Society of Mechanical Engineers, it would seem reasonable to hope for some legislation that would give the Government and individual engineers the benefit of this arrangement.

This is another phase of the relation of the mechanical engineer to the preparedness program, to which the writer's attention has been drawn by George Merryweather, of Cleveland.

The circular sent out advertising the Engineer Reserve Corps is very defective in making absolutely no provision for mechanical engineers, and it is to be feared that the plans of those in charge of the scheme are similarly defective. Someone must have the wrong point of view in this matter; and unless this point of view is changed, conditions in this country in case of serious trouble would be identical with, if not worse than, those which obtained in England at the commencement of the war. The mining, electrical, civil and railroad engineers are all provided for. Now, in all these branches of work, with the possible exception of the railroad engineer, the amount of real engineering involved is ridiculously small. Military science requires a highly specialized knowledge of a not very abstruse kind within certain narrow lines, and in the case of civil engineering in particular the mathematical knowledge required is almost zero. The electrical engineer fares somewhat better, but his work in the military line would seem to be more nearly that of a highly skilled electrician than of a broadly developed and trained electrical engineer.

Everything the army uses is the product of the mechanical engineer or of the machines made by him, and it is not too much to say that in our own country the success or failure of a severe campaign would depend on the strictly military organization on one side, and the mechanical engineering and production on the other, with the other branches of engineering playing important but subordinate parts.

Mechanical engineers and mechanics must see that this situation is formally realized and acted upon, if any attempt is to be made to carry out a rational preparedness program. RALPH E. FLANDERS.

Springfield, Vt.

A Business Necessity—Freedom to Co-operate for Foreign Trade

I most heartily approve of the opinions contained in your editorial, "A Business Necessity," on page 84. I have devoted many years of business experience to export trade and am fully convinced that a strict enforcement of the Clayton Act, as it relates to export trade, will prove to be a bar against the class of competition which we will have in post-bellum times.

The best organized manufacturing nation on earth is Germany, with which I have had extensive dealings

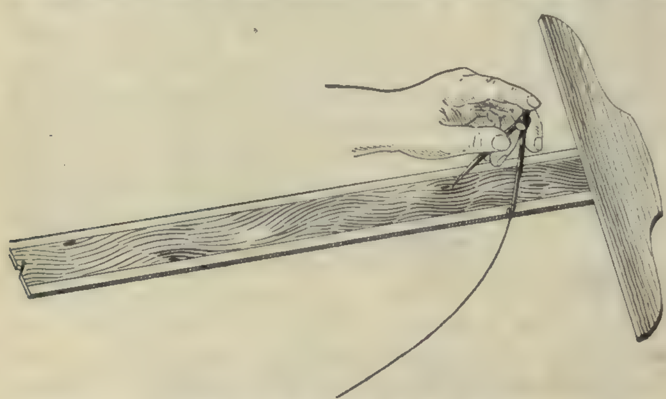
covering a period of over 20 years. We know that they are already looking ahead and making plans which will prove successful if our expansion is hampered by Governmental restrictions.

There are many lines of industry which could not afford to be singly represented abroad, but in combination it would be possible. The foreign representative must not only be a man well versed in his line of business but a gentleman, and this class of representatives demands high prices for services in America. In Germany the low scale of wage applies to competent representatives in the same way that it does to workmen, and it is thus possible for them to compete with us by personal representation to a degree that the average man has not realized.

New York City. CHARLES RENSHAW.

A Drafting-Room Kink

On page 957, Vol. 45, is shown a method by John E. Titus which I think can be improved upon. His illustration shows a T-square standing edgewise as a beam and carried at the other end round a suitable pivot, the latter being tied to the shaft. This arrangement gives a



METHOD OF USING THE IDEA

shaky beam at its best and does not guarantee neat ink lines. The way in which I combine these two instruments to obtain a beam compass is shown in the illustration herewith. A small V-groove is cut in the end of the T-square and forms a rigid center to revolve the T-square round a pin in the board; and somewhere on the square, near the circle to be drawn, stick the sharp point of the compass firmly in the wood, rest the pencil or the ruling pen on the paper and against the edge of the square. Then take hold of the scriber and hold it firmly against the square and revolve, cutting the desired circle.

Brooklyn, N. Y. JAN SPAANDER.

Actual Sizes of Drills

J. A. Raught, on page 1094, Vol. 45, volunteers to give Mr. Shirley some information regarding twist drills. If this information is correct, there is a difference in methods pursued by different manufacturers. I believe that those using the methods described by Mr. Raught are in the minority, and therefore his statements are misleading and should not be accepted by Mr. Shirley.

It is true, as stated, that "twist drills as a rule are made tapering," but instead of being made "very nearly exact size near the shank" they are made very close to size at the point and taper smaller toward the shank from 0.00025 to 0.0015 in. per inch of length ("American Machinist Handbook"). If made oversize, there would be trouble with drills used through hardened bushings.

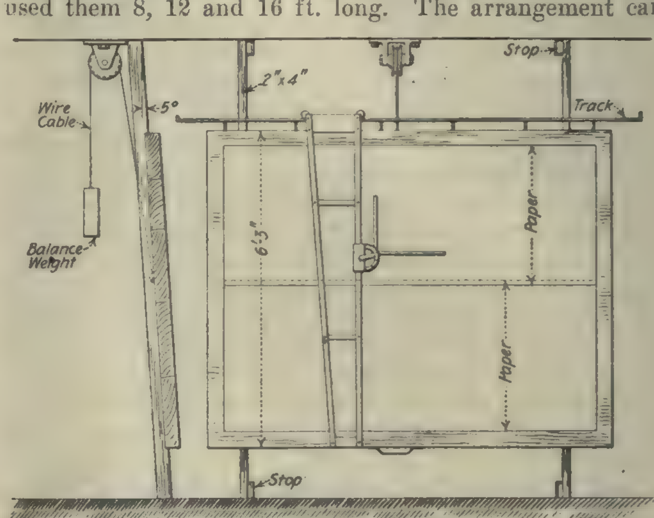
Regarding drills getting smaller with use, I think this is misleading also. If properly sharpened and kept sharp, there will be very little wear on the circumference of the drill. Most of the decrease in size is due to the taper ground on the drill by the maker.

Cleveland, Ohio. R. W. GREEN.

Drawing Board for Large Drawings

After reading Mr. Favor's article, page 887, Vol. 45, on an arrangement of drawing board for handling large drawings, I should like to suggest a method of making large layouts that I have used for a number of years and find very satisfactory.

The outfit consists of a large board and a standard make of drafting instrument, as shown. The board can be made any length to suit the individual case. I have used them 8, 12 and 16 ft. long. The arrangement can



ARRANGEMENT OF THE BOARD

be raised or lowered by using the foot in the stirrup fastened to the bottom edge.

The paper, after two strips the required length have been cut and pasted together, is held on the board with a few thumb-tacks placed about 12 in. from the top edge. It is then dampened with a piece of waste dipped in water, after which the edges are coated with mucilage, the tacks are removed, and small wooden strips are nailed on, to hold it until dry and ready to use. When fastened to the board in this manner, the paper gets very tight and makes a good smooth surface to draw on.

Waynesboro, Penn. H. E. BEARD.

Who Ever Discards a Micrometer?

In an article by W. D. Forbes, on page 1132, Vol. 45, mention is made of a man who threw away a micrometer because it was worn out. A few weeks ago I had need for some small clamps to hold a piece of work that I was laying out for the toolroom. I borrowed these from one of the tool makers and noticed that one of the clamps looked rather peculiar. On further investigation I discovered that it was a micrometer that had become worn out. The owner, hating to throw it away, had cut off the shank part, run a tap through, and put in a square-head setscrew. The result was a good, handy clamp.

Pawtucket, R. I. RICHARD W. DICKINSON.

Specifications and Inspection

By A. L. Haas

There is little need to emphasize the importance of a specification. Many are the firms which have recently found to their cost that clauses considered of little moment at the time of tender have a knack of becoming the essence of the contract. The text of such a piece of literature is vital when the parties to the contract cannot agree and the disputed clauses have to be legally interpreted, whether before an arbitrator or elsewhere. As is clearly evident, the term specification is built from another word—specific; and as anything nebulous cannot be specific, clarity and freedom from ambiguity are essentials.

The purpose of a contract specification is manifold: It should first state the limits of the work to be performed; it should have reference to definite performance, with clauses concerning workmanship and quality. In most cases it includes penalties for nonperformance or delay, although these may be the subject of another document termed conditions of contract. Thus there is recital of the work to be done (this can be definite and exact), limitations restraining the manner of its performance, and penalty clauses for breach of agreement. In its precise legal meaning only a lawyer can determine what a contract is, and the penalties that can be legally imposed for its breach. There are ponderous legal tomes dealing with the subject. Commercial cases that come before the courts are largely concerned with disputes of the sort indicated.

Certain Things Taken for Granted

Since contracts of an engineering character are made between technically qualified people, a great deal is inferred that is customary in the trade; certain things that are usual must be taken for granted, for both vendor and customer are rightly assumed to have knowledge of usual practice. For example, it is very difficult to specify workmanship save in a general sense. What would condemn some classes of mechanism would be fine limits and first-class workmanship elsewhere. In the case of material it is usual to specify physical tests, and in a finished machine or power unit definite performance. Still, many specifications simply state "to be of best materials and workmanship," which throws the responsibility on what is customary and usual. Under such a clause great powers and considerable responsibility are cast upon the individual acting as interpreter, and most of the troubles incident to working under a specification are due to difference of opinion between vendor and customer, or customers' representative, concerning this clause.

In placing an order where there is established confidence there is no necessity for an elaborate specification, but even in such a case there is need for explicit description and instructions that admit of no misinterpretation by either side. Every firm has experience with the type of order that needs correspondence or a telephone message to clear up doubtful points, and there is little excuse for this where the requirements are simple. There is still less excuse where a foreign contract is concerned. Some orders of this kind are extremely puzzling to fill. Definite statement of requirements is necessary, and it should be kept in mind that cables, even in code, are expensive.

An enormous volume of business is transacted by simple order, both commercially and between private individuals, in which neither specifications nor contracts are involved. Where, however, a public body or the state is concerned—where, in other words, public moneys are in question—competitive tenders and definite specifications are the rule.

All private purchase of the first type is one of personal selection by means of stock list, catalogs or in actual person. A selection is made by the purchaser, who asks for the article by maker's description. Wrong description is of course fraud, and every firm of repute is careful to avoid trouble by exercising care in compiling its lists. More catalogs, however, contain an exonerating clause with a printed promise to refund unless the purchaser is satisfied. There is, however, little legal redress available, certainly none without costly process, unless palpable and clear fraud has been perpetrated.

So long as commercial reasons are purely economic, the lowest price will always count. If properly drawn up with intentions and clauses clear, a specification should in theory at least enable competitive bids to be obtained from a number of sources, each tenderer quoting for the same thing or identical terms, as regards performance. Hence, the necessity after the contract is entered into for insistence upon its entire performance. Any other course is manifestly unfair to the unsuccessful firms.

The importance of the specification being thus established, it is evident that it needs preparation by a competent hand. Even when drawn up by an expert, the advertisement always states that the lowest or any tender need not be accepted.

A firm must produce credentials as to ability; these are partly financial and partly technical. If a firm has a past bad reputation from any cause, it is wiser to avoid its employment. A great deal of work dependent upon specification is transacted with selected firms who have given proof of their capacity. Such practice may of course be abused; but it has sprung up quite naturally from a desire to avoid trouble and delay incident to and resulting from unreliable contractors, who, like the incompetent inspector, take shelter behind the letter rather than the spirit of the contract.

Disputes Due to Different Interpretations

The more definite the specification the less the likelihood of dispute. The ruling out of the unreliable contractor lessens trouble, but the crux of the whole question of specifications lies mainly in the hands of the individual who interprets from the customer's side. Someone qualified must act, and to avoid legal process it is usual to provide an arbitration clause in the event of dispute and place the carrying out of the contract in the hands of an engineer of known reputation. In spite of the provisions a great deal yet rests with the precise individual, inspector, clerk of works or what not who is in actual contact with the job in hand.

Experience, judicial spirit and real qualification are essential and necessary, but no matter how qualified or naturally fitted, tact and discrimination come only by experience. Insistence upon the nebulous clauses read in the light of personal prejudice is a frequent cause of trouble. A spirit of hostility on the side of the inspector, or maybe on both sides, and the position of both is rendered unnecessarily difficult.

The purpose and duty of the inspector are not simply to detect and prevent fraud and the contravention of the clauses of the contract; if this were all, he would merely be a sort of technical policeman. Although the foregoing are among his duties, if he fulfill his proper functions, the inspector relieves the manufacturer of subsequent responsibility for quality and workmanship and insures that the requirements of the contract are filled. An independent trained intelligence brought to bear solely for checking is of value to maker and customer.

No matter what system is in force or however perfect the organization, the principal cannot, even if he would, personally check details. The inspector is to some extent a check upon the work turned out, in a general sense; and a valid mistake brought to notice enables the management to stop a leaky place in its methods. A wrong shop order may be given, a clerical error may become expressed in indelible steel, a workman may mistake his instructions or a draftsman make a slip—and the mischief passes unnoticed. When, however, the job is independently checked, working from the original documents, such error—undesired by all parties—comes to light.

The business of an engineering concern is so complex, so sectionalized, so diverse that reliance must be placed upon subordinates whose interest, however honest in intention, is to conceal mistakes and rectify errors without bringing them to notice. Where such misjudgment comes to light under outside inspection, it is certain that it cannot be concealed; and in place of resentment there should be a contrary attitude that the job will be corrected before dispatch.

It is impossible to consider the question of specifications apart from the more personal one of interpretation and inspection. Unless the instructions are clear, it may involve considerable trouble all around. In this wise the first essential of all specifications is explicit statement in the clearest terms, made binding upon both sides to the contract.

Damnatory Clauses Relatively Unimportant

The damnatory clauses are among the least important, though to read most documents of the kind it might be supposed they were of primary importance. It is the ambiguous and nebulous clauses that have to be interpreted in the light of the inspector's experience.

After all, where mechanism of any kind is concerned, the best test is one under working conditions. It is remarkable how an inferior job having poor workmanship will condemn itself under such test; that is to say, the best test is one of use and fitness for the duty normally imposed upon it. Durability is another consideration for which nothing but a guarantee of free replacement, usually for a definite term and dependent upon inferior material or workmanship, is of much worth.

In a case where contingent liability may result from failure in such wise as to endanger the public safety, legislation specifies safeguards in the public interest. In the case of boilers, for instance, the statutory regulations in the majority of cases insure that a positively dangerous steam raiser may not be built. The state here steps in and provides the specification. Unfortunately, such statutes were brought into being largely by the existence of disreputable makers devoid of scruples, who from economic reasons of low cost only turned out articles of a dangerous character. No doubt the type of firm penalized regards such interference with its profits as restraint of trade, but all good firms welcome the limitations as working for their interests.

Law is for the wrongdoer, not for the inoffensive citizen, to whom the penalties imposed for crime are of little moment. In a similar manner rational specifications and legal enactment do not trouble the reputable firm in a threatening sense.

Specific instruction relieves the good manufacturer of responsibility, enables him to compete on even terms. The accompanying inspection tends to raise the level of workmanship; and although a specification is a double-edged weapon, unless misinterpreted by an unqualified man it is a document to be welcomed.

Removing a Faceplate

By C. H. Willey

In turning a piece of heavy work on the faceplate of a 48-in. swing lathe the carriage, through accident, fed under a corner of the work, which was revolving at about 85 r.p.m. The machine was brought to a full stop. Nothing broke, but the faceplate was driven on the spindle so tight that it was feared that the sleeve would have to be turned off by a special rig.

The spindle was secured in the back gears, with iron straps clamped around the spindle cones, and heat was applied with a torch to the faceplate sleeve. Then an attempt was made to pull off the faceplate with a bar and chain falls, but it refused to budge.

One suggestion was to try taking it off in the same manner that it was driven on. Fear was held that the gear teeth might break, the faceplate would be broken or the spindle sprung. But the foreman was persuaded to try it. A short bar of steel was bolted to the plate near the circumference, and the back gears were put in. The lathe was run backward until it was running about 85 r.p.m., and then a short chunk of 2-in. round brass held in blacksmiths' tongs was shoved between the piece bolted to the faceplate and the lathe bed. The faceplate brought up with the same force with which it was driven on, and off it came. Blocking was arranged for it to land on in case it ran off the spindle. Not a mite of damage was done, but it was a big chance.

An Automatic Clock Oiler

By J. A. R.

For the past 14 years I have had to attend to the oiling and cleaning of some six or seven clocks, with the exception of one particular clock that I was told did not need oiling, as it always kept good time. Upon further investigation I was informed that for oiling this clock a method is followed that has been used for over 60 years.

The oiling system consists of a small uncorked bottle filled half-full of sperm oil and left inside the clock. Such an oiling system does not sound very logical to me, yet I know it to be a fact that this clock has not been cleaned or oiled in 18 years. I would like to hear what some of the other readers say about this. Can it be possible that the uncorked bottle of oil has anything to do with oiling the clock?

Editorials

The Need of Rational Inspection

The various questions of rifle contracts, which are attracting considerable attention at present, are so closely tied up with the problem of inspection as to warrant a little survey of the whole situation, especially in view of the fact that it is the plan of our own ordnance bureau to place what are known as "educational orders" in the near future. The great stumbling block in many such cases, and it applies to contract work of various kinds, is that we have no standards of inspection; and worse yet, in many army contracts the specifications require far more than is actually necessary.

There is, of course, a perfectly good reason for this; two in fact. The first is that unscrupulous contractors have supplied inexcusably bad material and workmanship for the enlargement of their bank account and, second, because there are few cases where the man who draws up the specifications knows much about the practical production of such parts in large quantities.

The many fuse and shell contracts of the past two years have shown this, unless we attribute some of the requirements to the desire to have a loophole for the rejection of nearly all munitions when the supply became sufficient for the needs. This assumption seems to have been borne out in some shops by the rejection of parts when completed at a rate faster than the inspector could handle them.

There is great need for improvement in the design of most war material from the viewpoint of economical manufacture. And while rigid inspection is made necessary by the few who would not hestitate to pass defective munitions for their own gain, a mechanism that functions properly should not be held within too close limits in its unimportant parts. What if clearance cuts do vary ten or even twenty thousandths? They fit nothing but the atmosphere, which is never in the least disturbed at the discrepancy. Why demand close limits on a bayonet blade that fits nothing but the scabbard and the body of its victim? He never complains at the exact size or shape of the puncture it produces.

Any desired limits of accuracy can be secured if we are willing to pay the price. But they should be no closer than necessary, and there should be a complete understanding as to the kind of inspection that is to be provided. In fact the personnel of the inspecting force is a serious problem in any shop. But whatever the limits, they should be distinctly understood and the cost counted. Contracting to turn out work to the satisfaction of the purchaser's inspector is about as unbusinesslike a proposition as one can well imagine. Having the purchaser's inspector the czar of production, is playing the game with the cards marked.

As stated before, the limits of any piece of work can be as close as necessary, but in the name of common sense, of economy and of the lives of those engaged, these limits should be as large as proper functioning will allow. And there is great room for improvement along this line in every ordnance bureau in the world. The contractor should be required to furnish proper material and workmanship in all cases, but we should first know what is proper and not demand more than is necessary. And no contractor should undertake to supply arms or ammunition without knowing exactly what is required and guarding himself against being asked to supply more than he bargained for.

It is safe to say that the rifle makers who have been caught this time will see that future contracts are properly guarded. They owe this not only to themselves, but to the industry, in order to prevent false misconceptions as to the failure of our plants to meet their obligations.

Scrapping $150,000 Worth of Special Tools

The article on the scrapping of jigs and fixtures aggregating $150,000, on page 187, forcibly calls attention to one of the reasons why shop managers are not anxious to change the designs of product any more often than necessity demands. Mr. Stanley points out very clearly the enormous cost of discarding fixtures for a comparatively small output, as well as the futility of trying to save the old tools. True, there may be cases where a few fixtures can be rebuilt, where some of the bushings and locking clamps can be utilized; but these are few and far between, and it is necessary to exercise considerable self-restraint to avoid making these apparent savings come on the wrong side of the ledger.

It is experiences like these that make it necessary to delay bringing out a new model until the old one has paid for its tool and jig expenditure, if profits are desired. On the other hand, we must avoid waiting too long, and it may even be necessary to forego profits for a time to prevent falling behind in the commercial race.

This, in common with all other manufacturing problems, is answered by balancing one detail against the other, the cost of new tools against the loss of profits, and not only for the present year, but for the years to come.

This is why the inventor is seldom a safe man to have in charge of a shop. His desire for new models, for the very best machine that can be made, regardless of the cost of tools and fixtures, makes him a constant source of danger where the stockholders have any regard for profits, as most of them have. Let the inventor experiment and invent, but keep his hands off the reins of management, if profits are considered at all desirable.

Prevention of Fire Losses

The circular recently issued by the National Board of Fire Underwriters again calls attention in a forcible manner to the enormous fire losses that we suffer year after year. The total for 1915 in the State of New York alone is well over $20,000,000, quite a tidy sum if put to

constructive uses, such as good roads or other public utilities, instead of having it wiped out of existence as a total economic loss.

The origin of these losses is carefully analyzed into causes that are strictly preventable, partly preventable, and unknown, the first two being subdivided into specific causes. Those considered strictly preventable, which it is believed could have been largely avoided by inspection to show the danger, total up to $4,358,618, or 21.7 per cent. of the whole. The partly preventable foot up to over $6,370,000, or 31.9 per cent. These causes include electricity, fires from sparks and spontaneous combustion, and it is believed that at least half of them are easily preventable. As these three items total about 9 per cent. of the whole, or $1,800,000, they are surely worth careful consideration.

Foundry fires, due to hot or molten metal, total only $5634, an almost negligible quantity in such a grand total. Matches and smokers are responsible for a total of 8.3 per cent., or more than $1,650,000—a lamentable toll to pay for the carelessness of individuals in a single state.

Perhaps the most dangerous feature is the large total of unknown causes, $9,346,286, or 46.5 per cent. Unknown dangers, whether in nature or in fire hazards, always constitute the greatest menace. These dangers are probably largely preventable, did we but know them. This condition makes the city or state with a large percentage of fires from unknown causes an object of suspicion from the fire-hazard point of view, as it shows that the authorities are lax in making investigations as to causes. This factor must also be taken into consideration when comparing the statistics of different states. The report compares New York, New Jersey and Pennsylvania; and if we omit the fires from unknown causes, New Jersey seems to set us a fine example. When, however, we observe that there were 62.2 per cent. of fires from causes unknown, as against 46.5 per cent. for New York and 47 per cent. for Pennsylvania, the case is very seriously altered. It is much the same as with waste of any kind —unless we know the causes, it is difficult to cope with the problem.

But entirely aside from the causes, think what these figures mean! An annual fire loss in New York State alone of over $20,000,000! What a valuable work could be done with this sum each year, in reducing the number of factory accidents and in harnessing mountain torrents. With these waters utilized for electric power, even the pioneers on our frontier might have electricity in their homes, not to mention the use of this current by the railways and for other purposes in the now sparsely settled states.

The real answer to the problem is the education of the individual, especially to make him see and realize his responsibility to the other fellow—which means the community. It is not enough to know that a fire loss caused by a carelessly thrown match is paid in full by an insurance company. The real loss falls on every one of us, because we, as a people, either directly or indirectly, pay not only the fire loss, but the insurance company's profits as well. When we can all realize our individual responsibility in matters of this kind, fire losses and all other economic disaster will be decidedly less. And if fire statistics can help us to see and realize this, they are indeed valuable.

Boys in the Trades

In the January report of the Bureau of Employment of the New York State Industrial Commission appears one especially significant item that should command the serious consideration of all employers. The report states that "the demand for boys for office, errand and factory work cannot be filled. The bureau has had many requests from factories in various industries for boys and young men to learn trades. It has been found possible to fill but a small proportion of these calls."

A condition such as is set forth in the foregoing paragraph cannot long exist without causing a decided shortage in the supply of mechanics; this shortage, in fact, is already a problem of consequence in many quarters. As there has been no appreciable falling off in the crop of boys, it is plainly evident that other avenues of employment are proving more attractive; and if the manufacturer wants to keep up his supply of labor, something must be done to attract and hold the boy.

No matter what one may think about the foolishness of the boy who fails to grasp the opportunity to learn a trade when it is presented to him, the fact remains that he does not; and if there is to be a sufficient supply of skilled or semi-skilled workmen, a way must be found of attracting the desirable kind of boy. Many industries are competing for boys and the one that offers the greatest inducement gets the greatest response.

While it is well known that the machine business affords a better future than many of the other trades, it cannot be gainsaid that the prospect of immediate financial reward acts as a lure. Whatever it is that attracts boys to other lines of work must be considered, and met or offset in some way, if the machine industry is to get boys enough to fill the ranks in years to come. Old ideas and prejudices may have to be discarded, but even that may not be altogether a disadvantage.

Some Costs of War

The enormous cost of war, to say nothing of the economic and human loss, is brought home by the recent controversy as to the cost of shells. Consider first that the cost of a single projectile for a 16-in. gun is equal to the wages of an average mechanic for a year and that this does not count the gun or the powder. Not only is this year's work destroyed in an instant, but it in turn may destroy many times this amount of the labor of others, besides robbing the world of the product of those it kills.

There is another cost that is less spectacular, but more far reaching—the reduced efficiency of those who survive, whether wounded or not. This was very noticeable after our own Civil War, and there is no reason to suppose it will be less in evidence now. And this feature may prove more of a factor in the economic struggle after the war than we realize.

Men who have been in the trenches, who have lived in the open, who have seen death and disaster strike rich and poor alike, are not likely to settle down to factory work and factory hours with their old-time vigor. This result is bound to reduce production far below the estimated volume. Many will never be the workers they were before, and their country and the world at large will be losers thereby, even though it does reduce the competition after the war.

Shop Equipment News

One-Inch Swaging Machine

This machine, though smaller, is made along similar lines to those previously built by the Etna Machine Co., of Toledo, Ohio. It is intended for the usual run of small

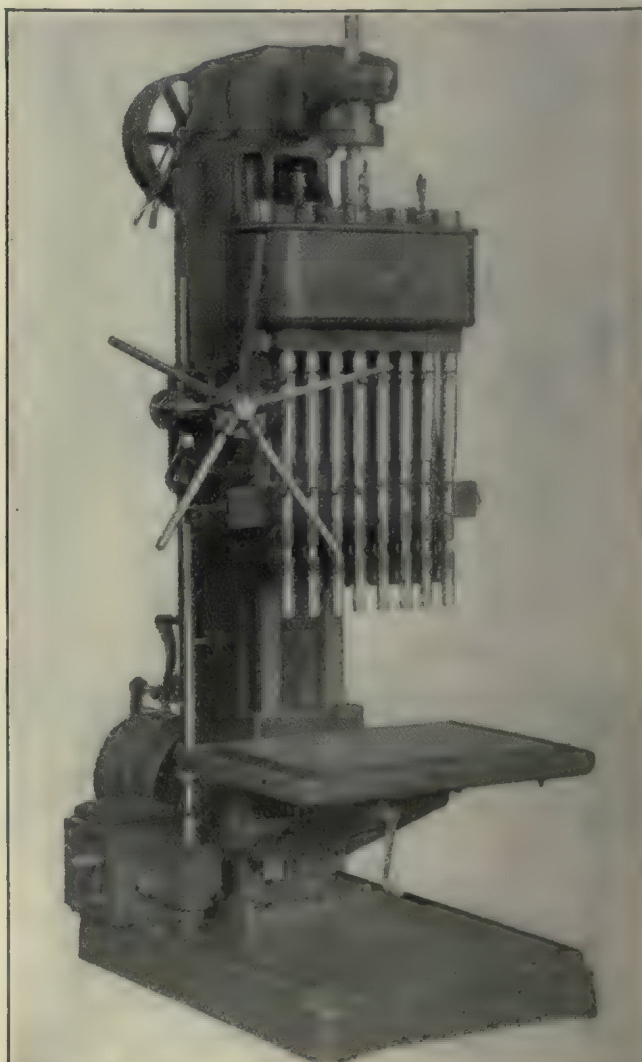
ONE-INCH SWAGING MACHINE

Capacity, 1 in. in diameter; length of die, 3 in.; flywheel, 28x4½ in.; intended to run 400 r.p.m.; height of center from floor, 36 in.; countershaft tight and loose pulleys, 10x4½ in.; drive pulley, 16x4½ in.; floor space, 26½x33½ in.; weight, about 2000 lb.

swaging work, such as pointing tubing or solid material under 1 in. in diameter, and it is known as the Etna No. 2 Swaging Machine. It will also swage any tapers that can be handled with a comparatively short die.

Two Models of Multiple-Spindle Drilling Machines

The two drilling machines here shown, made by the National Automatic Tool Co., Richmond, Ind., are known as their Straight-Line Models 40 and 41. The general description applies to both. They have a wide range of speeds and feeds. The spindles are adjustable anywhere on the rail and also have a 2-in. up and down adjustment for drills of different length or for uneven wear of tools. They have a constant-speed drive, six changes of positive gear feeds, three changes of speeds of a sliding transmission type, centralized control, one-nut adjustable arm, and universal joints guaranteed for two years. The base is heavy and has a large working surface. It is heavily ribbed, both lengthwise and crosswise, and further reinforced where the column is supported. A large channel is provided for overflow of lubricant. The column is of heavy box section and has a wide face in which a heavy

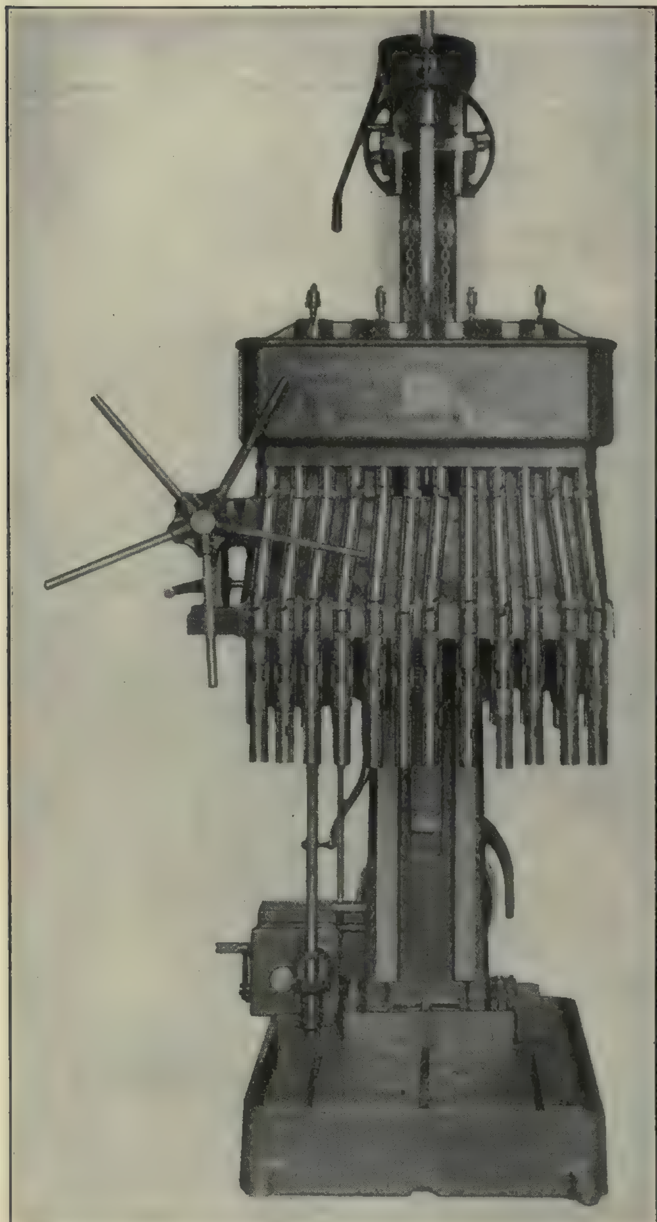


MODEL 40 STRAIGHT-LINE DRILLING MACHINE

Length of rail, 26 in., bored for 4, 6 or 8 spindles; center of spindles to face of column, $15\frac{1}{16}$ in; top of base to bottom of spindles, 46 in. maximum and 16 in. minimum; height of table from floor line, minimum, 36 in.; size of table, 30x34 in.; work surface of base, 28x31 in.; extreme travel of head, 30 in.; travel of head with adjustable table on column, 17 in.; size of upper joints, 2 in.; spindle center distance, minimum diameter of spindle, plus ⅛ in.; vertical adjustment on all sizes of spindles, 2 in.; drill speeds, 103, 154 and 211, and by changing back gear these may be doubled; drive-pulley speed, 650 r.p.m.; nine feeds available per revolution of spindle, ranging from 0.0079 to 0.0343 in.; feed in inches per minute, 1.27 to 8; size of tight and loose pulleys, 16x5¼ in.; head driveshaft pulleys, 16x5¼ in.; floor space, belt drive, 66x80 in.; motor drive, 66x98 in.; capacity, through solid cast iron, twelve 1-in. holes; steel, eight 1-in. holes; cored holes, up to 2½ in. in cast iron and 2 in. in steel, with the same number of spindles; net weight, 10,000 lb.; domestic crating material, about 1000 lb.; foreign, about 1600 lb.; boxed, about 375 cu.ft

steel rack of coarse pitch is secured. Handholes at both top and bottom provide easy access to the counterweights.

Steel gears cut from solid bar or made from forgings are used throughout. They are of wide face and coarse pitch and are generated on gear shapers. They are also tested for accuracy within close limits on a special gear-testing machine. All gears that revolve on studs or shafts are bronze bushed. The feed box, located at the base of the column, provides six positive gear feeds that are taken from the constant-speed drive by means of spirals. Feed gears revolve at a moderate speed in a bath of oil and are keyed to shafts that run in bronze bearings. Ball thrusts are provided to minimize friction. The power for the feeding head is transmitted by means of a vertical shaft directly connected with the feed box through a worm and bronze worm gear. Pulling down on the feed lever engages, and pulling up disengages, the power feeds. The gear box is located on top of the column and gives three changes of speed.



MODEL 41 STRAIGHT-LINE DRILLING MACHINE

Length of rail up to 60 in., bored for 24 spindles, with 1-in. upper joints; other specifications the same as for Model 40

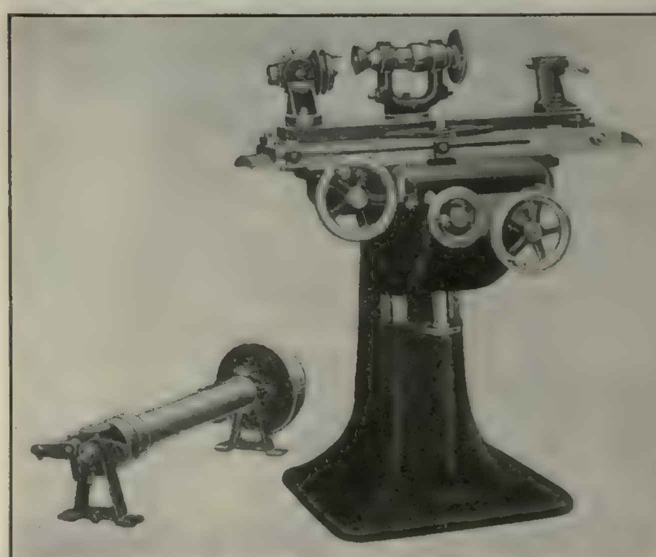
All bearings are mounted on Hyatt high-duty roller bearings, except those that are bronze bushed. A reversing mechanism controlled from the front is furnished for tapping, when desired. This is located above the main driving gears on the gear box.

The improved spot-facing mechanism is located on the rail in place of the standard feed mechanism, when so desired. The construction of this mechanism permits hand operation for spot facing, counterboring or countersinking and also by throwing in the regular feed mechanism. An adjustable work table, which is easily elevated, may be used. A rotating table can also be provided. The arm is adjusted by the one-nut mechanism, which has been previously described in our columns. The universal joints are made of only five parts, each milled from the solid and carefully heat-treated. The four pins on the center block are milled integral with it, eliminating inserted pins or screws. The maximum working angle of these joints is 35 deg., and it is impossible for the operator to set them more than this. Extra equipment includes lubricating pump, extra-high columns, special bases for motor drive and the like. The motor recommended is one of 15 to 20 hp., running about 1200 r.p.m.

Universal Grinding Machine for Tool Sharpening

The machine shown herewith, which has recently been placed on the market by the Acme Grinder Co., Cincinnati, Ohio, is of the universal type, being especially intended for tool sharpening and small special grinding of similar nature.

The headstock swivels in all directions and is provided with graduations for indicating the angles. There is also a vise that swivels in all directions. The vertical screw for elevating or lowering the knee has a ball thrust bearing in order to reduce friction. The countershaft is equipped with Gurney ball bearings, and the headstock is driven by means of a round belt running on grooved pulleys. Other attachments are provided, when required, for use on special jobs.



UNIVERSAL TOOL-GRINDING MACHINE

Arc Welding on Malleable Iron

By Robert Mawson

The arc electric welder is used on malleable iron castings for two purposes: First, for adding material that has been either swept away in the mold or is lacking because of a mistake in the design, and second, to save castings that have blow-holes or sand-holes. If metal could not be added to make a sound repair, castings would often have to be scrapped; a poorly patched casting would be condemned for appearance' sake, and one with unsound joints would be weak and tend to fracture.

FIG. 1. WELDING A BOSS ON A BRAKE SPIDER

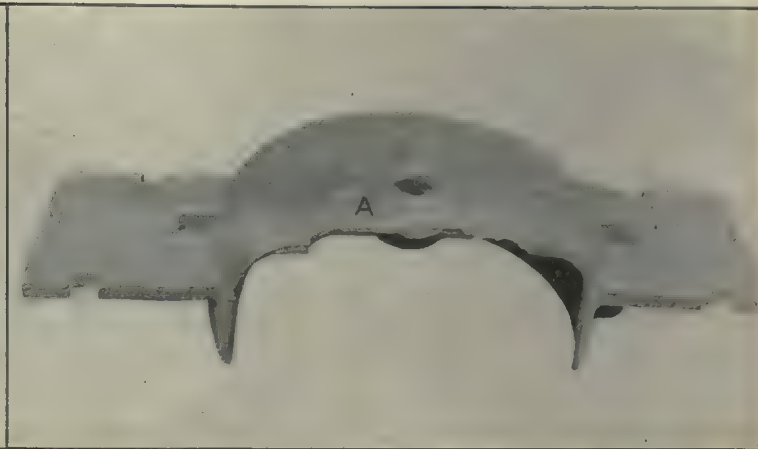


FIG. 2. A DEFECTIVE SWITCH STAND

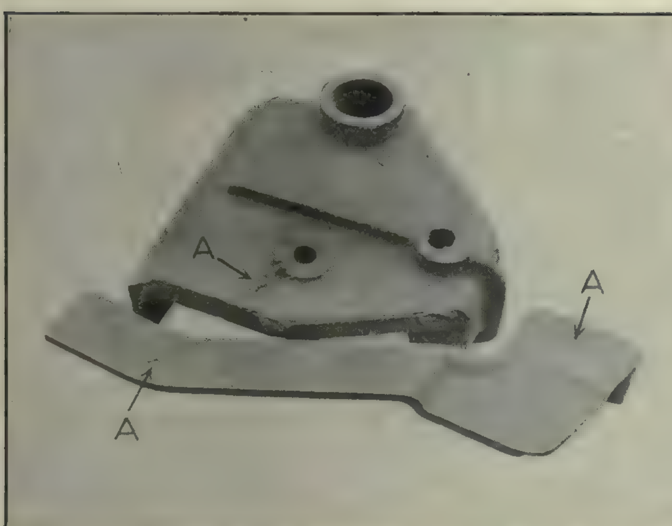


FIG. 3. DEFECTIVE ENGINE PARTS TO BE SAVED

FIG. 4. TWO CASTINGS REPAIRED BY ARC WELDING

For both purposes mentioned the Dayton Malleable Iron Co., Dayton, Ohio, is using an arc-welding outfit manufactured by the Lincoln Electric Co. The current used is 60 volts and 100 to 150 amp., depending on the amount of metal added during the welding operation.

In Fig. 1 are shown two castings of an automobile brake spider where welding has been done to advantage. The piece *A* has come from the mold with a boss missing on the flange at *B*. On the other piece, at the left in the illustration, may be seen a boss that has been added at *C* by welding. On parts such as this a boss can be added only by welding or brazing, for various machining operations are necessary on the flange of which the boss is a part. A mechanical repair would not be practical.

In Fig. 2 is shown a switch stand that has a large surface blow-hole, a sufficient defect to reject it for appearance' sake. In Fig. 3 are seen two other castings rejected for the same cause. The upper is a drawbar carrier and the lower an automobile-engine support.

Sometimes these castings come from the mold with sand-holes that reach entirely through one of the walls. The filling of such holes is performed quite as easily as the repair of the surface defects shown in these illustrations. Sometimes it is found that sand has gathered in the blow-hole and has not been removed by the sand-blasting operation. Under such conditions this sand must be removed and the surface of the metal cleaned and prepared prior to the welding operation. This is done by removing the wire used as the electrode during the welding operation and substituting for it a carbon electrode. When this piece of carbon is applied to the casting with the current on, the sand is burned out and the surface prepared for the following operation.

The two parts seen in Fig. 4, which are similar to those illustrated in Fig. 3, have had defects corrected by arc welding. After welding, the surfaces are ground off. If care is taken to have the holes and surfaces clean and free from sand and if the weld is properly performed, no trouble will be experienced during and following the machining operation.

New Publications

Handbook for Machine Designers, Shop Men and Draftsmen—By F. A. Halsey. Second edition. Five hundred and sixty-one 8¼x11-in. pages; illustrated; indexed; cloth bound Published by the McGraw-Hill Book Co., New York City. Price, $5.

This is the second edition of Mr. Halsey's well-known handbook. The rapid accumulation of essential information in the field of this book during the brief period of three years has made extensive additions and revisions necessary. The first volume had a total of 494 pages. The new edition has 67 pages more. The title has been modified by adding the words "Shop Men." This has been done more clearly to indicate the nature of the material included. In the revision gaps in the information presented in the first volume have been filled and some subjects have been rewritten in the light of additional information. The original scheme of the book—that is, the profuse use of charts and graphical plotting—has been continued.

In looking through a second edition the reviewer searches for those topics which were not found in the first edition or those which have been extensively revised. The preface gives such a list, which in spite of its length is quoted herewith: "Thrust bearings, knife-edge bearings, roller bearings, critical speeds of shafts, riding and steel belts, geometrical progression of speeds, strength of spur and herringbone gears, gaging, gear teeth, cutting bevel gears with rotary cutters, modified addendum of bevel gears, axial thrust of bevel gears, skew bevel gears, practice with friction gears, worm gears, roller chains, friction clutches, spiral springs of the watch-spring type, wire system of measuring screw threads, properties and strength of wire, capacity of horizontal tanks, weirs, standard pipe tables, pipe flanges and fittings, measurements of tapers and dovetails, forming and other tools, press fits, balancing revolving parts, floating lever, velocity and force relations in link work, permissible cost of special shop equipment, weight of solids of revolutions, diameter of shell blanks, power consumed by drilling machines, Taylor cutting speeds, hardness tests, heat treatment of steel, temperature equivalents of temper color, material for steam boilers and proportions of riveted joints, discharge capacity of safety valves, properties of superheated steam, steam pipe coverings, approximate beams of uniform section, strength of columns, materials and construction for resisting shock."

In several of the new sections and in the last one of the book are incorporated a number of new tables. A study of this list shows that the revision has included considerable material of a purely shop nature, which is justification for the change in the title noted above.

Selling Your Services—Published by the Sales Service Co., New York. One hundred and seventy-six 5½x8-in. pages. Price, $1

This volume takes up a subject which is vital to all technical men, in a manner that at once appears thoroughly comprehensive and logical. There have appeared fragments of literature dealing with certain phases of the technical man's problem in marketing his services, but it is believed that this book is the first attempt to treat the subject as a whole, and in a way that reduces the problem to a simple selling basis

It is on the latter point that the book makes its strongest appeal, for it starts out on the premise that a man's services are just as much a product as any other commodity, and therefore subject to the same aggressive selling principles that have been found successful in modern merchandising. The chapter headings are so significant that they are listed to give the reader at a glance an idea of how carefully the whole subject has been analyzed: The Purpose of the Book, Keep Working, Know Thyself, Your Best Prospect—Your Present Employer, Why Go with a Competitor? Make Good Use of Your Experience, Reach the Real Buying Factors, Help Wanted, Situation Wanted, The Employment Agency, The Circular Letter, The Personal Call, The News Item, What Is Your Appeal? Make Your Letter of Application Compel Attention, Make Your Letter "Eye Sweet," Prove That You Can Be of Service, The Salesman's Letter, The Sales Correspondent's Letter, A More General Letter, The Bookkeeper's Letter, A Letter That Accomplished the Unusual, The Engineer's Letter, The Foreman's Letter, Do Not, Why Neglect the Follow-Up Letter? Good Follow-Up Letters, Hustle While You Wait, Make a Prompt and Good Appearance for the Interview, Meet Your Prospective Employer's Point of View, The Eternal Question—The Salary, During the Interview, Keep Your Case Alive.

While primarily designed to stimulate the reader's thought in the direction of adapting selling principles to the problem of improving his condition or securing a job, the book contains many definite, concrete suggestions bearing on the various steps to be taken in developing a sales campaign covering one's services. Actual examples of successful letters of application, situation-wanted advertisements, circular letters, follow-up letters and other parts of a campaign for the purpose discussed are given and many new angles to each step suggested

Judging by the discussions that have appeared in our columns on certain phases of this general problem, the book should prove of value to all who are interested in making the most of their opportunities.

Handbook of Machine-Shop Electricity—By C. E. Clewell. Four hundred and sixty-one 4x6¾-in. pages; 315 illustrations; indexed; flexibly bound McGraw-Hill Book Co., New York City. Price, $3.

Unless one stops to consider the many uses of electricity in the machine shop, it is doubtful if he has any idea of their number. This little handbook has been written with the realization that there is an enormous amount of electrical equipment in daily shop use, and that no convenient electrical handbook has ever before been adapted to that field. Thus the topics taken up in this book are those that apply in one way or another to the practical selection, application and use of electrical equipment in machine shops. The matter has been presented in handbook style, as being the most convenient form.

For convenience, the matter has been divided into 10 sections with these headings: Abbreviations, Terminology and Units; Circuits; Costs; Communication and District Control; Current Supply, Generators and Transformers; Electrochemical, Soldering and Welding Applications; Heating and Magnetic Apparatus; Lamps and Shop Lighting; Measuring Instruments and Measurements; Motors and Applications.

The feature of the first section is a condensed dictionary of electrical-machinery parts. The principal members of generators, motors and auxiliary apparatus are covered by means of illustrations and a brief sentence of description. The second section takes up circuits, first from a general viewpoint and then more specifically for both direct and alternating currents. Types of standard fittings and arrangements are illustrated, and numerous tables of standard supplies are included, as that for "standard sizes for knobs," on page 48.

The third section is somewhat unusual in handbook preparation, for it gives some 30 tables of unit costs for electrical supplies and apparatus. Included are generators, lamps, motors, motor supports, small electrical fittings, switchboards, transformers, wire, wiring and shop lighting. Such information should be of especial value in preliminary estimating

Section 4 takes up those devices that are found in every shop in which electricity is used for communication or for distant control. The information is such as is needed to select such apparatus and install it. Systems included are alarms for sprinkler service, annunciators, electrical clocks, counters, door openers, fire-alarm systems, shop whistles, speed-limiting devices, telephones, time-keeping apparatus, watchmen's systems and others.

Section 5 takes up generators, transformers and apparatus for current supply for both direct and alternating current. Chapters 6 and 7 deal with special applications of electricity in shop practice, as electroplating, soldering, welding and heating and magnetic devices. Many of these are minor applications, and not infrequently they are worked out in the shop where they are used.

The final three sections deal with shop lighting, measuring instruments for electric current and shop motors and their application. Professor Clewell's connection with lighting practice is well known to readers of the "American Machinist." In this short section he has attempted to condense the essential information for the selection of a lighting system in the shop and its installation and upkeeping. The largest section of the book is the final one, dealing with motors and their application. Eight pages are given to the power requirements of machine tools, and about 50 pages to motor applications.

The book should be of service in the hands of anyone who has to do with the selection, application and maintenance of electrical equipment in the machine shop.

Awakening of Business—By Edward N Hurley. Two hundred and forty 5x7¾-in. pages; cloth bound. Published by Doubleday, Page & Co., New York, N. Y., for the Associated Advertising Clubs of the World. Price, $2.

This stimulating and tremendously interesting book is a message to American business men from Chairman Hurley, of the Federal Trade Commission. The preface states plainly that the views expressed are those held by the author and are in no sense those of the commission of which he is a member. The preface gives the purpose of the book as follows:

"The time has come for stating some plain truths and for stating them in a plain way. The message of this book is not a message of congratulation, but of warning; not a message of criticism, but of construction; not a message for the other man, but for you. It is my hope that this book may assist business men in bettering business conditions and in working out sound methods of coöperation; that it will inform them of Government activities in their behalf, and bring about a close harmony between them and the Government."

The first three chapters of the first part of the book deal with the need of the knowledge of costs on the part of American business men. The estimate is given that 90 per cent of the manufacturers of the United States are pricing their goods arbitrarily, either upon a basis which will get rid of the goods as soon as they have been manufactured, or upon the basis of what competitors' products are bringing. With this estimate as a text, convincing arguments are put forth for the need of proper cost accounting, and a plea is made for planning and routing systems to lay out the work and keep it going through the factory. All this is directly in line with the best of our knowledge of industrial management.

Chapter 4, comprised of only five pages, is devoted to merchandizing. It contains helpful hints and suggestions in regard to advertising, display, the handling of seasonal goods, reputation, and the necessity of courtesy and tact.

With Chapter 5 begins that part of the book which business men will read with the greatest interest. The matter of trade associations is taken up. The trade associations of Europe, particularly Germany, are presented in a way to show their advantages and how they increase the force of competition of foreign manufacturers when they meet Americans in foreign markets. The truth is plainly taught that we must arrange for similar associations if we will meet the competition that will face us at the end of the present war. Beyond all this the way is pointed toward associations of manufacturers in this country to achieve many desirable objects which are lawful under our antitrust laws.

The statement is made, "There are more than 600 independent associations of manufacturers, producers and business men in Germany today, about 5000 subsidiary organizations, influencing the industrial system of the country."

The second part of the book has the title "Government and Business." In six chapters it points out that the Government has done a great deal for the farmer, the railroads and the banker, but very little for the manufacturer. It makes a plea to do away with the suspicion that exists between Government officials and business men, and states that both public and private efforts should be united in the work of perfecting American business.

Finally, an appendix gives the text of the law creating the Federal Trade Commission and the provisions of the Clayton Act which concern the work of the commission.

The book cannot be too highly commended for the reading of manufacturers and business men at this particular time.

Personals

Andrew Banse, general superintendent of the Federal Pressed Steel Co., Milwaukee, Wis., is away on a four months' leave of absence.

A. V. Farr has resigned as advertising manager of the S K F Ball Bearing Co., Hartford, Conn., to become manager of the Hess Steel Corporation, Baltimore, Md.

George W. Knopf has established offices in the Pennsylvania Building, Philadelphia, where he will specialize in the design and construction of industrial plants.

C. G. Tarkington has resigned from the Snyder Electric Furnace Co., Chicago, and has taken charge of the branch office of the Haynes-Stellite Co., in Pittsburgh.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting, fourth Wednesday of each month. J. A. Brooks, secretary, Brown University, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City

Object and Method of Taking Time Studies for Rate Setting*

BY DWIGHT V. MERRICK†

SYNOPSIS—The object of time study and the steps necessary to analyze a job. The method of eliminating abnormal time observations is shown and a formula and chart are given for fatigue allowance. Finally, the way is shown by which a study is checked in the shop before being put into effect.

The original object of time study was to determine how long a time a first-class man required for the performance of a given piece of work. Considered in the sense in which it is used today, time study has for its objects (1) the determination of possible improvements in conditions, equipment, etc., necessary to the performance of a given piece of work; (2) the determination of possible improvements in the actual performance of the work by the worker; (3) the setting of tasks or the determination of a unit time in which a given piece of work should be completed. The taking of time studies may be divided into several divisions: (a) The survey or study of the work and of all the conditions that influence the performance of it. (b) The analysis of the work into its elements. (c) The observing and recording of time that elapses in the performance of any and all of these elements. (d) The study and analysis of the records obtained in (c). (e) The determination of a fair time for the performance of each of the elements of the work. (f) The preparation of an instruction card from the time-study records that includes the determination of an allowance for fatigue and unavoidable delays in the course of the work.

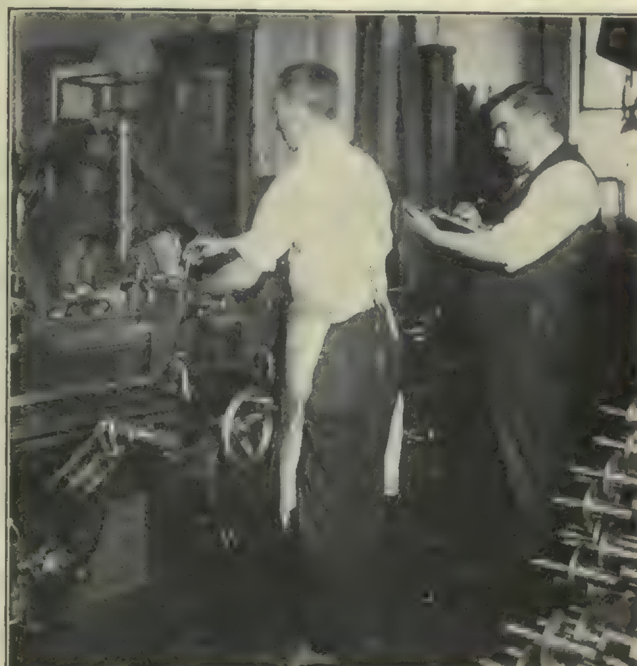


FIG. 1. OBSERVER TAKING TIME STUDIES

The time study proper comprises only the items (b) to (d) inclusive. The term, however, has been extended to include the utilization of time studies in the establishment of tasks and fixing of unit times for the different classes of work, and it is in this broader meaning of the term that we would consider that which follows.

It is proposed below, to outline the steps followed in taking a time study and to point out some of the precautions that must be observed if the results of the studies are to be depended upon. The worker performing the work on which a time study is being taken will be known as the operator, while the person taking the time study is known as the observer. The operator should be a first-class man, highly skilled in his work, and of perhaps a little better than the average ability. Fatigue and other allowances, as explained later, bring the results of the studies within the range of ability of the average worker.

It is obvious that the observer should, in all cases before beginning a time study, acquaint himself with the character of the work and with all the conditions that affect it. He should observe the conditions under which the raw material is furnished to the operator and the facilities that the operator has for disposing of his finished product. He should familiarize himself with the quality of work demanded, including the degree of finish and the limits of accuracy required. He should ascertain that the necessary equipment is provided and available and also that there is sufficient power to drive to the best advantage the machinery that is being time-studied. If, during this preliminary survey, it appears to the observer that certain conditions are abnormal, they should be corrected before any attempt is made to start time studies. In short, the observer should aim to establish standard conditions, which can be repeated at any time in the ordinary course of work, and the best sequence of events in the conduct of the work (see Fig. 1, which shows a good layout). The time required for the performance of any given piece of work depends upon two groups of factors—those within the control of the operator and those not within his control. The first group comprises the handling of the work at his machine or work place, and the manipulation of the necessary tools and fixtures. The second group includes the supply, quality and quantity of raw material, the tool equipment, etc. Time study relates to the items of the first group, but it is futile to expect much, if any, improvement by means of time study on the items of this group, unless means are provided to adequately control the items of the second group.

The time studies necessary to the operation of any particular factory may be taken in two ways: (1) If the product of the factory does not vary from day to day and is made by repeating the same operation or set of operations day after day, it probably will be wise to take a study of each operation as a job complete in itself. These are known as operation time studies. (2) If the product varies from day to day, each item of it being

†Consulting engineer, New York City.

made by grouping a series of unrelated operations, the grouping never or seldom being twice the same, then an attempt should be made to determine the several operations that are grouped and regrouped to form the various jobs. Time studies should then be taken of these operations, and these studies can then be combined in such a manner as to fix a time for the performance of practically every job that may enter the factory. These studies are usually made on the operation of machines, and in such cases are known as machine or hand tool time studies. Such studies here include studies of hand or assembly operations which are repeated many times on different jobs.

The observing and recording of the time and the study and analysis of the results as a rule are the same with both methods.

The first step in the taking of a time study is the analysis of the job as a whole into its elementary divisions. The observer lists these divisions of the work in the order of their occurrence, splitting the job up into a greater or less number of more or less minute operations, depending upon the character of the work and the conditions surrounding it. It may be desirable or necessary in certain cases to analyze each operation down to the most elementary unit, while in other classes of work it would be perfectly satisfactory to group several such minute elements together to form a subdivision of the whole operation. For instance: In studying the operations in a lathe, a cutting tool would be inserted in and removed from the tool post several times during the course of the work. If a study is being made to determine the length of time required for certain cutting operations, that is, if we are studying the work itself and not the machine in which the work is being done, it probably would be sufficient to enter the time required for inserting the tool in the tool post as a single item; viz.:

Put tool in post.................................0.30 min.

On the other hand, if we are studying the lathe with a view to determining the best method of handling it and the tools pertaining to it, it would be desirable to analyze this operation of putting the tool in the tool post still further as follows:

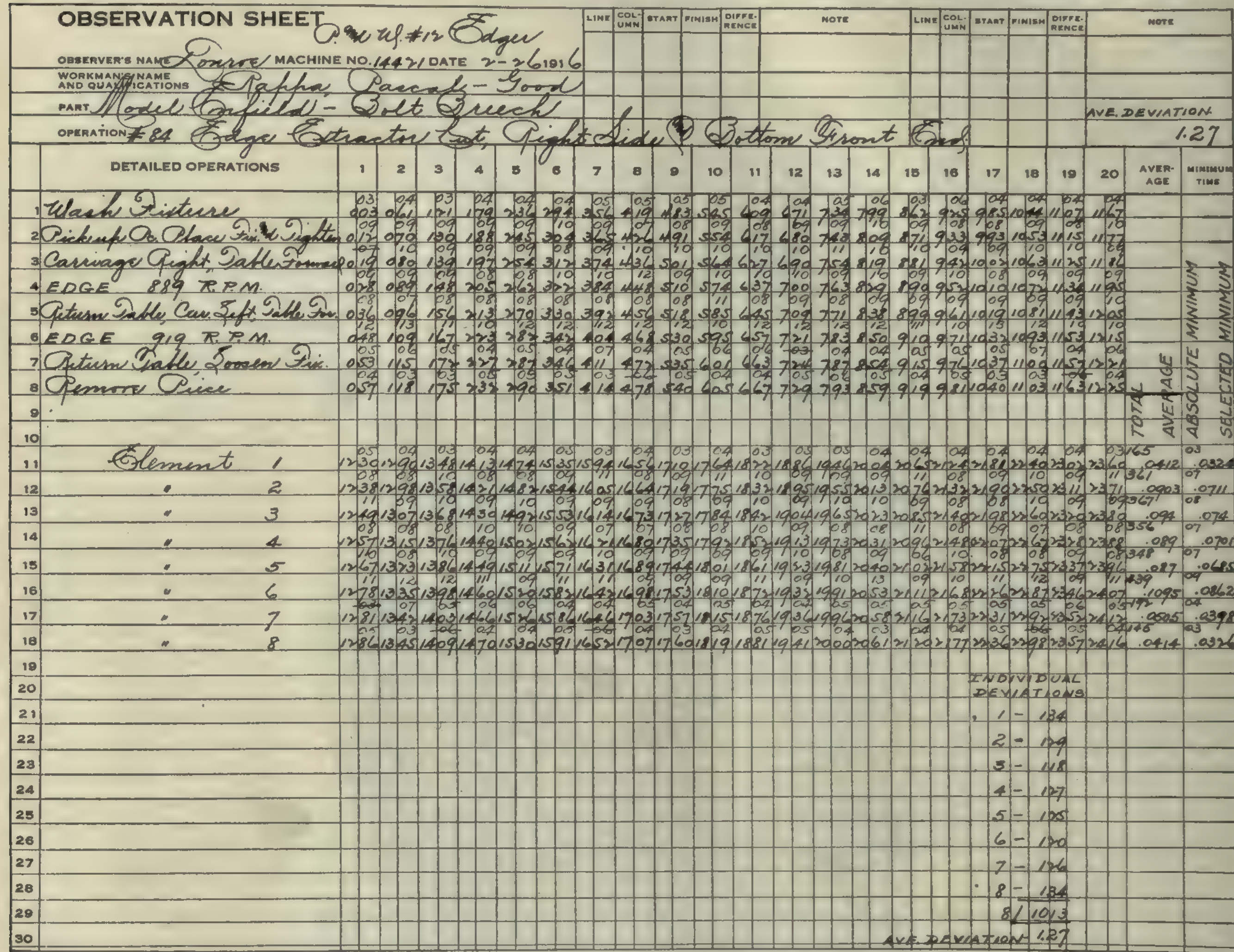


FIG. 2. SPECIMEN TIME-STUDY OBSERVATION SHEET

Get tool from tool stand	0.03 min.
Measure height of tool	0.06 min.
Put packing in tool post	0.07 min.
Put tool in post	0.03 min.
Set tool in position	0.03 min.
Tighten tool-post setscrew	0.08 min.
Total	0.30 min

In general, the following rule may be established for grouping the elements: When the time intervals of the individual elements are extremely small, it is best to group them and treat the combination as a single element. There are several reasons for this, chief among them being the difficulty of accurately observing and recording the items that follow each other with an interval of only a few hundredths of a minute between. An error in reading the stop watch may easily equal the elapsed time

for the performance of the particular element under observation. If it is absolutely necessary to obtain the elapsed time for every small element, this may be done by grouping several elements and then observing the time in the cycle, according to the method developed by Carl G. Barth and described by Frederick W. Taylor on page 1438 of "Shop Management," published by the American Society of Mechanical Engineers. Having determined upon the subdivision of the operation, the several elements are listed on the record sheet in the order in which they take place, as shown in the illustration, Fig. 2.

The observing and recording are done with the aid of a stop watch whose dial is divided into one-hundredths of a minute, the hands of which are so arranged as to permit of their being stopped and restarted from the same point without being set back to zero, if desired. The observation sheet is usually carried on a board that has a pocket on the upper edge into which the stop watch fits. The board is of such size as to conveniently be carried upon the observer's left arm, and the position of the watch is such as to bring the work, watch and observation sheet in the same straight line with the observer's eye.

The procedure followed in taking and analyzing a time study can probably be best explained by examining an actual study and tracing it through its various stages. The particular study selected for this purpose is one taken to determine the time required to perform an operation complete in itself, thus falling within class (1) mentioned before. The method of observing, recording and analyzing the data, however, is the same in studies in class (2), and the following explanation will suffice for both.

The standard form of observation sheet is shown in Fig. 2. In the space at the top are recorded the data that are necessary to the identification of the operation. The particular operation in this case is the edging or profiling of the bolt breech of a military rifle, and the observer has analyzed it into eight detail operations or elements, which he has listed in the column at the left of the sheet. On the reverse, Fig. 3, he has noted the details of speeds, feeds, material used, etc., made sketches of the pieces and the tools, and recorded all other information that may prove useful in working up his observations after he has left the machine at which the study was made. It will be noticed that the reverse of the blank has on it printed notations of the subjects on which information should be secured when the time study is taken. It has been found advisable to have these printed memoranda, for the reason that if the time-study man trusts to his memory as to the data necessary for him to secure, he will frequently overlook one or more important items. This will necessitate a second trip to the job, or the omission of the information altogether, as often it cannot be secured after the job has been completed and the set-up for it disassembled. When the items that must be observed are printed, and the observer is required to make an entry of one kind or another opposite each item, it will be a most careless time-study man that will come away from the job without full information. The notes and data that are recorded should always be as full and definite as possible. It should be possible, from the information recorded on the observation sheet, to reproduce at any time the conditions under which the study was made.

Referring now to Fig. 2, it will be noticed that each space opposite the several detail operations contains two

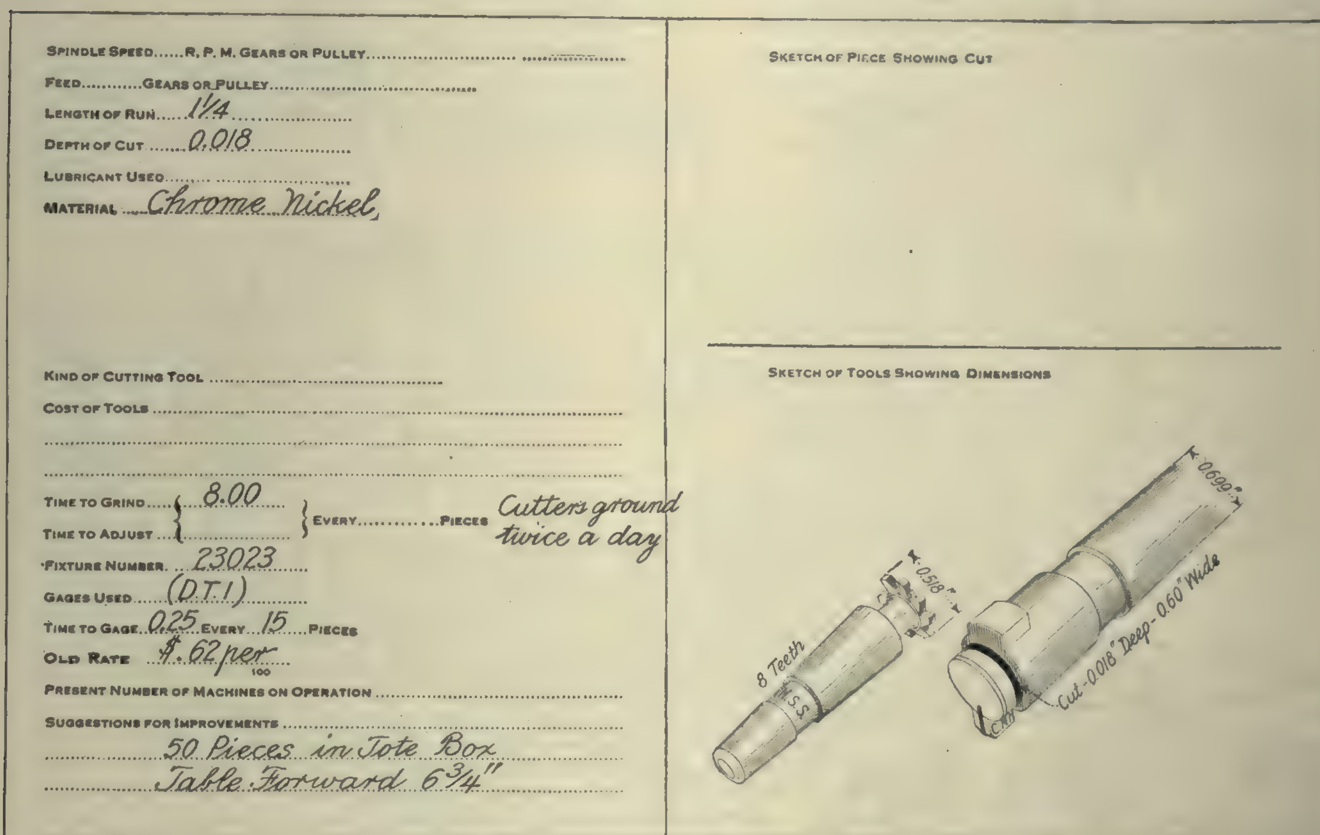

SPINDLE SPEED......R. P. M. GEARS OR PULLEY
FEED..........GEARS OR PULLEY
LENGTH OF RUN 1 1/4
DEPTH OF CUT 0.018
LUBRICANT USED
MATERIAL Chrome Nickel
KIND OF CUTTING TOOL
COST OF TOOLS
TIME TO GRIND 8.00
TIME TO ADJUST
EVERY..........PIECES Cutters ground twice a day
FIXTURE NUMBER 23023
GAGES USED (D.T.I.)
TIME TO GAGE 0.25 EVERY 15 PIECES
OLD RATE $.62 per 100
PRESENT NUMBER OF MACHINES ON OPERATION
SUGGESTIONS FOR IMPROVEMENTS
50 Pieces in Tote Box
Table Forward 6 3/4"
SKETCH OF PIECE SHOWING CUT
SKETCH OF TOOLS SHOWING DIMENSIONS

FIG. 3. REVERSE OF TIME-STUDY OBSERVATION SHEET

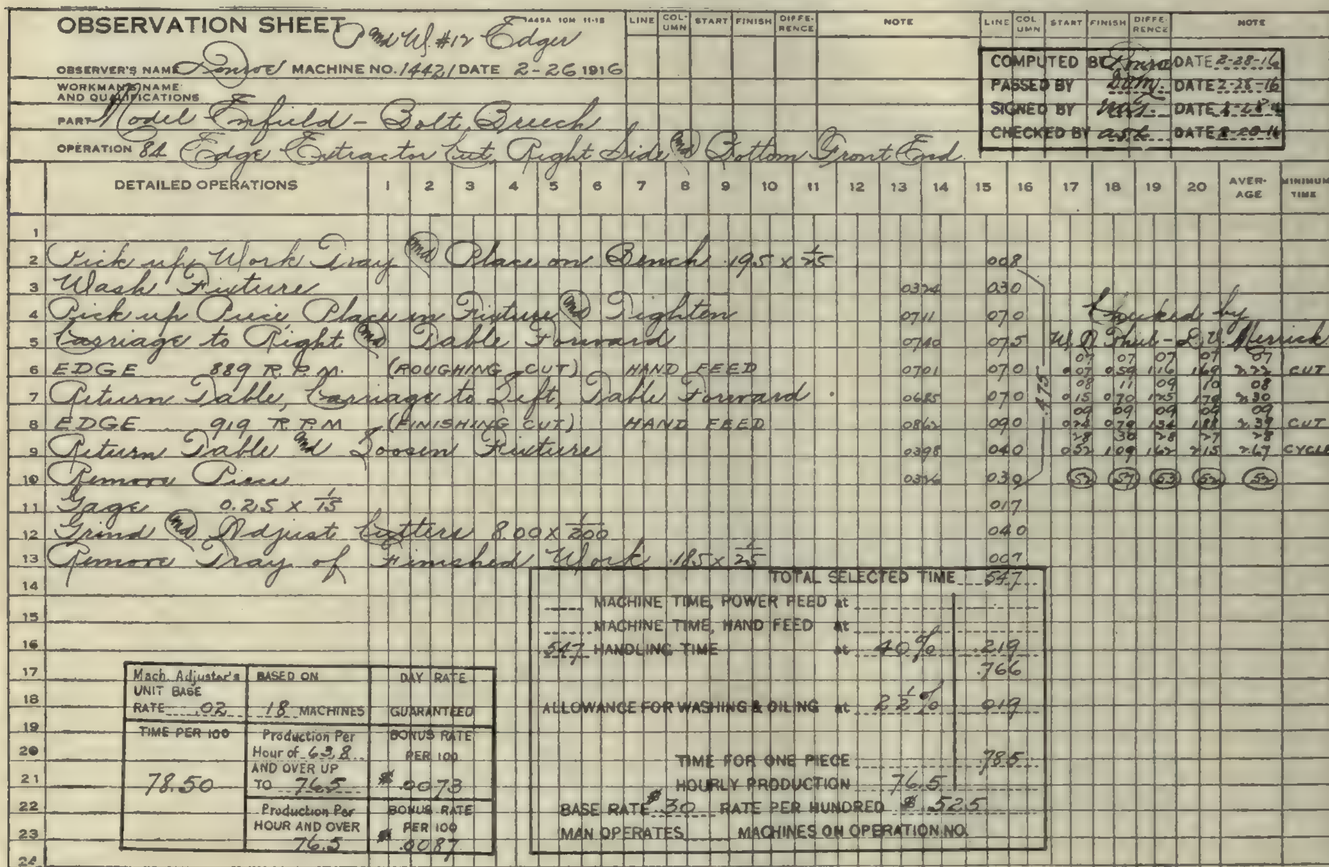
sets of figures. The larger ones in the lower part of the space are the "continuous times" that are recorded as the study is made. The observer starts his watch as the operator begins the first detail operation. At the completion of this, he, without stopping the watch, notes the elapsed time and records it in the first numbered column, the reading in the present case being 0.03 min. At the completion of the second detail operation, he again notes and records the elapsed time since the starting of the watch, the entry here being 0.12 min. This is continued until the operator has performed all the detail operations listed, the final entry being 0.57 min.

Having completed the first piece, the operator, without delay, begins work on the second one. The observations for this piece are recorded in the second numbered column as before. The observer may at the conclusion of his observations on the first piece set his watch to zero and record the details of the second piece without reference to those of the first, but it is more desirable to allow the watch to run continuously and to make all observations show the elapsed time from the beginning of the study. This was what was done in the present case, and it will be noted that the recorded times are continuous from one series of operations to the next. If during the progress of the time study, an interruption not connected directly with the work occurs, the watch may be stopped and restarted from the same point when work is resumed. In other words, the observer notes only those events that have a direct bearing on the work.

It is better, however, to allow the watch to run, and to make a notation in one of the spaces at the top of the sheet, giving the time at which the interruption began and the time at which it was ended. The advantage of this is that there is at the end of the time study a complete list of all interruptions that may be expected to the work, and provision can be made for their prevention in future work. Unfortunately for our present purpose, no such interruptions occurred in the study illustrated.

The number of complete operations that should be observed will vary with the nature of the work. If a comparatively long time is required for each of the detail operations, and it is evident that the operator has attained a rhythm that causes him to work at an approximately uniform rate of speed, then a comparatively small number of observations will suffice. The best results will be obtained if the operator is permitted to work a sufficient length of time to attain this rhythm before the observations are started. On the other hand, if the detail operations are all of short duration, introducing the possibility of errors in the reading of the watch, or if the operator shows that he is not proceeding uniformly as regards speed of working, a large number of observations must be made, until there are sufficient to eliminate the errors under the law of averages. The exact number that are to be made in any case calls for the judgment of the time-study man. In any event, where the average time for detail operations is under one minute, twenty complete observations should be made if this is possible.

Having completed his observations at the job, the observer next determines the "individual times" of the detail operations, by the process known as "taking differences." This consists in subtracting the starting time from the finishing time of the first detail operation, the finishing time of the first from the finishing time



OBSERVATION SHEET — M.W.J. #12 Edger

OBSERVER'S NAME Lenroe MACHINE NO. 1442/ DATE 2-26 1916

WORKMAN'S NAME AND QUALIFICATIONS

PART Model Enfield – Bolt Breech

OPERATION 8th Edge Extractor Cut, Right Side and Bottom Front End

COMPUTED BY ... DATE 2-28-16
PASSED BY ... DATE 2-28-16
SIGNED BY ... DATE ...
CHECKED BY ... DATE ...

	DETAILED OPERATIONS	14	16
1			
2	Pick up Work Tray and Place on Bench 19.5 x 1/25		008
3	Wash Fixture	0374	030
4	Pick up Piece Place in Fixture and Tighten	0711	070
5	Carriage to Right and Table Forward	0740	075
6	EDGE 889 R.P.M. (ROUGHING CUT) HAND FEED	0701	070
7	Return Table, Carriage to Left, Table Forward	0685	070
8	EDGE 919 R.P.M. (FINISHING CUT) HAND FEED	0862	090
9	Return Table and Loosen Fixture	0398	040
10	Remove Piece	0316	039
11	Gage 0.25 x 1/15		017
12	Grind and Adjust Cutters 8.00 x 1/200		040
13	Remove Tray of Finished Work 18.5 x 1/25		007

Checked by W. D. Thib – L. V. Merrick

CUT — CUT — CYCLE

TOTAL SELECTED TIME .547
MACHINE TIME, POWER FEED at
MACHINE TIME, HAND FEED at
.547 HANDLING TIME at 40% .219
.766
ALLOWANCE FOR WASHING & OILING at 2½% .019
TIME FOR ONE PIECE .785
HOURLY PRODUCTION 76.5
BASE RATE $.30 RATE PER HUNDRED $.525
MAN OPERATES MACHINES ON OPERATION NO.

Mach. Adjuster's UNIT BASE RATE .02	BASED ON 18 MACHINES	DAY RATE GUARANTEED
TIME PER 100 78.50	Production Per Hour of 63.8 AND OVER UP TO 76.5	BONUS RATE PER 100 $.0073
	Production Per HOUR AND OVER 76.5	BONUS RATE PER 100 $.0087

FIG. 4. SUMMARY OF THE TIME STUDY RECORDED IN FIG. 2

of the second, etc. These individual times are the time required for the completion of each of the several elements, and are entered on the observation sheet opposite the particular element involved and above the record of the "continuous" or elapsed time made while the time-study observations were under way (see Fig. 2).

Taking now, for example, the seventh detail operation, "Wash Fixture," we have a set of values ranging from 0.03 to 0.07 min. as the time for performing this operation on the 40 pieces on which the time study was taken. The item 0.03 min. in columns 12 and 1 in the second, or lower, group is stricken out as being due to an error or an abnormal condition and the remaining times are averaged, the average value 0.0505 being entered in the column allotted for that purpose.

The striking out of abnormal values, either excessively higher or lower than the average of all the individual times of the same element, is a detail that calls for fine judgment on the part of the time-study man. Such variations may be due to an error in reading the watch, or to an abnormal condition of the work that is not likely to recur in the ordinary course of events. While no general rule can be laid down for the elimination of these abnormal items, minimum or maximum isolated items 25 per cent. less or 30 per cent. greater, respectively, than an adjacent item should usually be rejected.

Having determined the average, the abnormal readings being eliminated, the individual times used in determining the average are scanned and the minimum individual time ascertained. This is divided into the average, the quotient being designated as the "deviation." The above procedure is followed for each of the detail operations, and the individual deviations are listed as shown in the illustration. These are then totaled and divided by the number of deviations. This quotient, usually, though incorrectly, called the average deviation, is a factor that divided into the average of the individual times for a detail operation will give the "selected minimum" time for that operation. The "selected minimum" time is not the time in which it is expected that the operation will be performed in practice, but is rather an ideal which might possibly be reached by an exceptional operator working under unusually favorable conditions.

In many cases the deviations of the several elements of a cycle show quite wide variations. The deviation factor reconciles these variations and furnishes a convenient way of reducing the several averages to a common standard. It also takes into consideration the influence that the several items in a cycle may have on any particular item. The value assigned to an item considered by itself may be quite different from the value it would assume when it is considered as a part of a series of items.

A shorter method of finding the deviation factor is to divide the sum of the averages by the sum of the minima. It is, however, desirable to note the fluctuations of the several individual deviations from the deviation factor, since those elements that show the widest deviation are those upon which the greatest improvements may reasonably be expected.

A large number of studies seem to indicate that the times for the various elements as determined from observations on one operator will agree closely with those obtained from observations upon another operator doing the same class of work. This is true even if the corresponding elementary average times for the two operators show an appreciable variation.

It is evident from the foregoing that the selected minimum elementary time as determined by the time study represents an exceedingly high standard of performance on the part of the operator. It would be unfair and unwise to expect the operator to continue at such a rate throughout the day without any rest or relaxation. In fact, *it is not expected that an operator will attain the minimum time,* except under unusual circumstances. Therefore, in setting tasks or writing instruction cards from the data gathered by time study, an allowance is made to bring the time for a job within the ability of the average first-class workman. This allowance is a percentage of the sum of the elementary times that enter into the operation. It depends both upon the nature of the work and on the amount of work in a single complete operation or cycle of operations.

Based on the data from a vast number of time studies on a great many varieties of work the curves in Fig. 5 have been derived. These curves are a guide to the percentage that should be added to the sum of the times of the elements making up an operation. The curves show the allowances that should be made for several classes of work, the differentiation between these classes

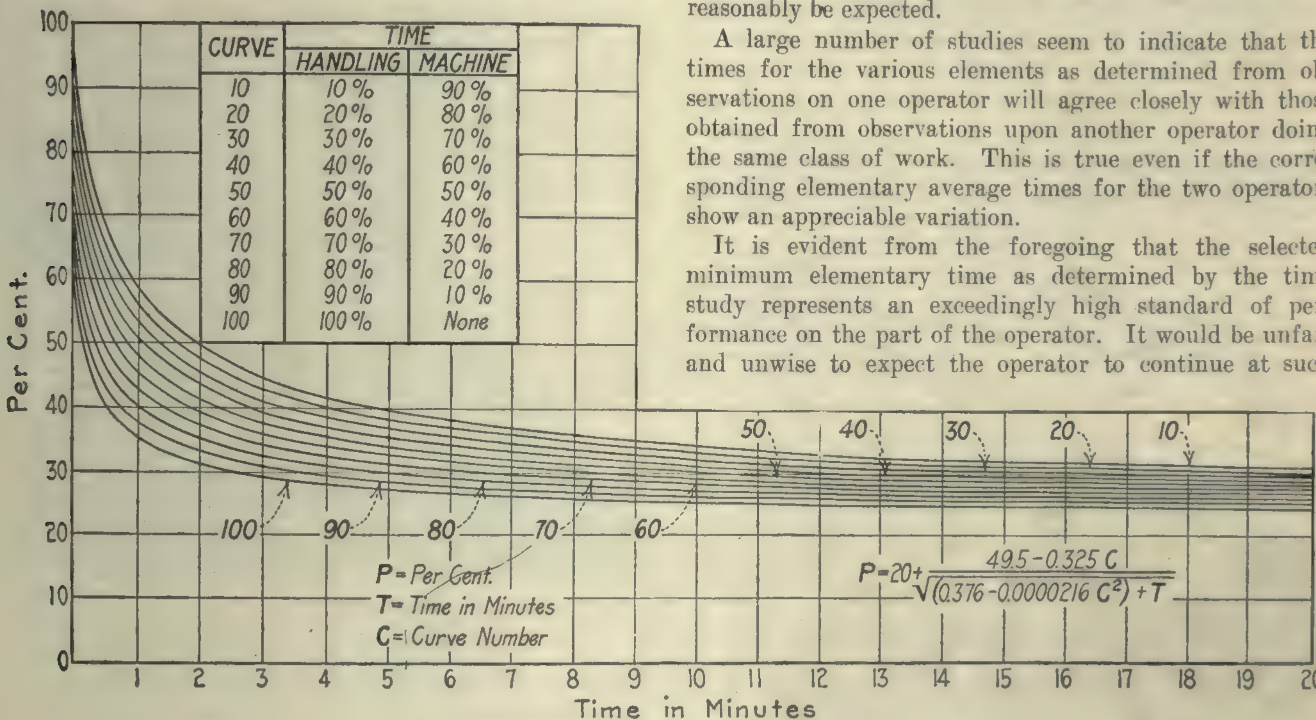


FIG. 5. CURVES OF DELAY ALLOWANCES

being the relative percentage of machine time and handling time in the operation.

The mathematical expression for these curves, derived by Carl G. Barth, is as follows:

$$P = 20 + \frac{49.5 - 0.325C}{\sqrt{(0.376 - 0.0000216C^2) + T}}$$

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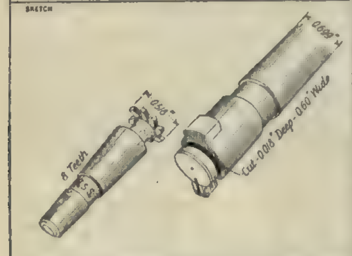
INSTRUCTION CARD

NO.	DETAIL INSTRUCTIONS	FEED Amount	FEED Sym.	SPEED R.P.M.	SPEED Sym.	Prepara-tion Time	Time Work Should Take
1	Pick up work tray and place on bench .195 x 1/25						.008
2	Wash fixture						.030
3	Pick up piece, place in fixture and tighten						.070
4	Carriage to right and table forward						.075
5	EDGE (ROUGHING CUT)	Hand		889			.070
6	Return table, carriage to left, table forward						.070
7	EDGE (FINISHING CUT)	Hand		919			.090
8	Return table and loosen fixture						.040
9	Remove piece						.030
10	Gage .25 x 1/15						.017
11	Grind and adjust cutters 8.00 x 1/200						.040
12	Remove tray of finished work .185 x 1/25						.007
							.547
	.547 Min. (Handling time) at 40%						.219
							.766
	Allowance for washing up and oiling machine at 2.5%						.019
							.785

WHEN WORK CANNOT BE DONE AS SHOWN, REPORT MUST AT ONCE BE MADE TO THE MAN WHO SIGNED THIS CARD. DATE 11/11/16 SIGNED DVM

SKETCH



NAME OR SYMBOL OF PART	BOLT BREECH ENFIELD
DRAWING NO.	
OPERATION	EdgeExtractorCutRight SideAndBottomFrontEnd
OPER. NO.	84
KIND OF MATERIAL	3.5% Nickel Steel
MACH. NO.	P&W#12Edger
LEADER'S BASE RATE	
RATE FOR PREP'N	$.30
TIME WORK SHOULD TAKE MINUTES	
PREP'N	
TIME PER PIECE	.785
PRODUCTION PER HOUR	76.5
RATE PER 100	$.525
HELPER'S BASE RATE	
TIME WORK SHOULD TAKE MINUTES	
RATE FOR PREP'N	
TIME PER PIECE	
PRODUCTION PER HOUR	
RATE PER 100	

FIG. 6. INSTRUCTION CARD TO WORKMAN

in which P = percentage allowance; T = time of selected minimum, in minutes, and C = percentage of handling time per cycle.

Fig. 4 is a summary of the time study in Fig. 2. In the summary several additional detail operations appear. These are operations that are performed on a lot of pieces, and the total time for each operation on the lot is divided by the number in the lot to give the allowance for a single piece. The additional items are those in the numbered lines 2, 11, 12, and 13. The items in the summary are totaled, and the cycle of items that appear only in the original time study is also totaled separately. This total time is entered in the middle of the bracket embracing these items, as indicated in the summary.

Inasmuch as the job includes only handling time, curve 100, Fig. 5, is used to determine the percentage of allowance. The percentage, 40, is found at the point on this curve corresponding to the time of the cycle 0.475. Multiplying the total selected minimum time 0.547 by the percentage we obtain the allowance as 0.219 min. This is added to the total of the selected minimum times, and a flat shop allowance of 2½ per cent. of this total is then added to cover oiling the machine and washing at noon and night. The grand total 0.785 of the several items enumerated is the standard time in which the workman should do the job.

Before the time study is put into effect in the shop, it is checked by observing a few cycles and noting whether or not the workman approaches the selected minima of the detail operations. Any variation indicates an incorrect study, which must be revised. If everything

1800 2M 6-16

INSTRUCTION CARD

No.	DETAIL INSTRUCTIONS	SPEED		Time Work Should Take
	MACHINE ADJUSTER:-			

Should adjust, maintain, inspect and see that machines are properly oiled and kept in good operating condition.

He is to secure and prepare cutters for eighteen machines; to make every effort to keep the machines running and to eliminate lost time.

He is paid a piece work bonus for good work only, on each machine, in addition to the regular day rate.

(18 machines)

WHEN WORK CANNOT BE DONE AS SHOWN, REPORT MUST AT ONCE BE MADE TO THE MAN WHO SIGNED THIS CARD. DATE 11/11/16 SIGNED DVM

SKETCH

NAME OR SYMBOL OF PART	BOLT BREECH ENFIELD
OPERATION	EdgeExtractorCutRight SideAndBottomFrontEnd
OPER. NO.	84
KIND OF MATERIAL	3.5% Nickel Steel
MACH. NO.	P&W#12Edger
MACHINE ADJUSTER'S BASE RATE	
TIME PER 1000	78.60
FOR PRODUCTION PER HOUR OF	63.8
AND OVER, UP TO	76.5
FOR PRODUCTION PER HOUR AND OVER	76.5
MACHINE RATE	$.02
DAY RATE GUARANTEED RATE PER 1000	Bonus
RATE PER 1000	$.0073 Bonus
	$.0087

FIG. 7. INSTRUCTION CARD TO MACHINE ADJUSTER

GUARANTEE OF RATE

SHOP	NAME OF PART	MODEL
GUN E	BOLT BREECH	ENFIELD

OPER. NO.	OPERATION
84	Edge Extractor Cut Right Side And Bottom Front End(3.5% Nickel Steel)

	RATE PER 100
(P&W#12Edger)	$.525

THE COMPANY GUARANTEES THE ABOVE RATE FOR THIS OPERATION AS LONG AS THE METHOD DESCRIBED ON THE INSTRUCTION CARD IS IN EFFECT

JOHN DOE MANUFACTURING COMPANY

1897 5M 8-16 DATE 11/11/16 D.V.M.

FIG. 8. WORKMAN'S RATE GUARANTEE

is satisfactory, the various items of hourly production, wage, rate etc., relating to the operation are then added to the summary sheet, and the time study is complete. The details are then transferred to the instruction card (see Figs. 6 and 7). This is issued to the workman when he is assigned to the job. In the shop in which the above time study was taken a guarantee of the rate is also issued with the instruction card to the man. This guarantee is shown in Fig. 8. Mr. Taylor always regarded the issuance of an instruction card as a guarantee of the rate. The separate guarantee, suggested by former Naval Constructor J. E. Otterson, has been found to appeal more strongly to the workers.

Milling the Margin Stop

By Frank A. Stanley

SYNOPSIS—The machine detail illustrated herewith in the various processes of milling is known as the "margin stop rail" and is formed in a Z-section milled from the solid stock in pairs, the two pieces being split in a straddle-milling operation. Following this a series of rack teeth are cut the entire length of the work at one operation by a gang of cutters in a Lincoln type of miller. The tools and the order of operations insure the work coming out rapidly and accurately.

The accompanying illustrations show the process used by the Noiseless Typewriter Co., Middletown, Conn., in successive milling operations upon the margin stop rail for its typewriters. This part is in the form of a Z-bar—

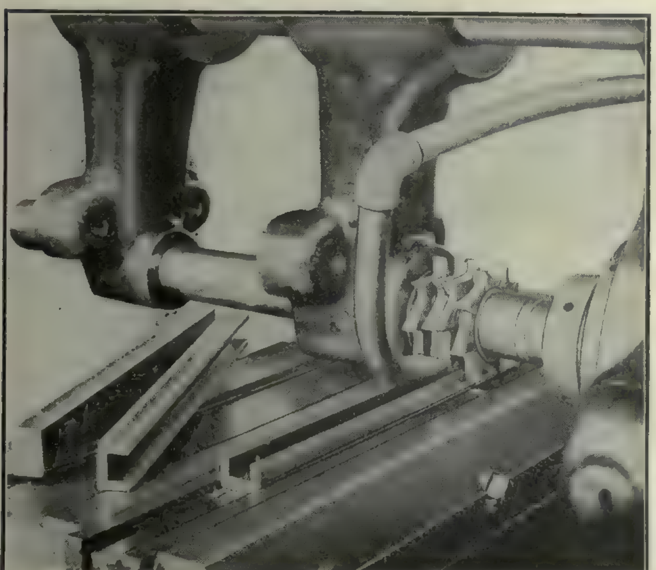


FIG. 1. FIRST OPERATION IN MILLING BLANKS FOR MARGIN STOP RAILS FOR NOISELESS TYPEWRITER

that is, it is a Z-section with rack teeth cut all along one of the edges. It runs the full length of the machine and is made in various sizes to suit the widths of different typewriters. Its progress through the successive stages of milling is clearly brought out by the illustrations, which show the form of cutters and fixtures as well as the work in different states of evolution.

This margin stop rail is made in pairs from a piece of steel 1/8 in. wide by 5/8 in. thick. Fig. 1 represents a blank piece of steel as cut off from the bar preparatory to milling and also shows the channel-shaped piece after the first milling operation. This indicates the method by which the part is shaped to produce two finished pieces in a single operation.

Fig. 2 shows diagrammatically the two operations of shaping this blank bar for the two rails, and in conjunction with other illustrations presents the successive steps very clearly.

Thus at *A*, Fig. 2, will be seen the bar of stock cut off to length and a section 1/8x5/8 in. held in the vise jaws, one of which is arranged to act as a supporting parallel underneath the work itself. Both jaws are cleared at the edges, opposite the corners of the stock, so as to take a firm bearing upon the lower edge of the material, but do not come in contact with the corners, thus avoiding any burr or roughened spot that might prevent the work from being held properly. Both of these jaws are made with serrated or checked gripping surfaces, and they secure a very strong bite upon the bottom of the blank. The work is thus gripped securely, then passed under the four cutters in the gang, Fig. 1, which mills it to the section shown at *B*, Fig. 2.

Referring to Fig. 1, it will be seen that the cutters are of very coarse pitch. The two that mill out the

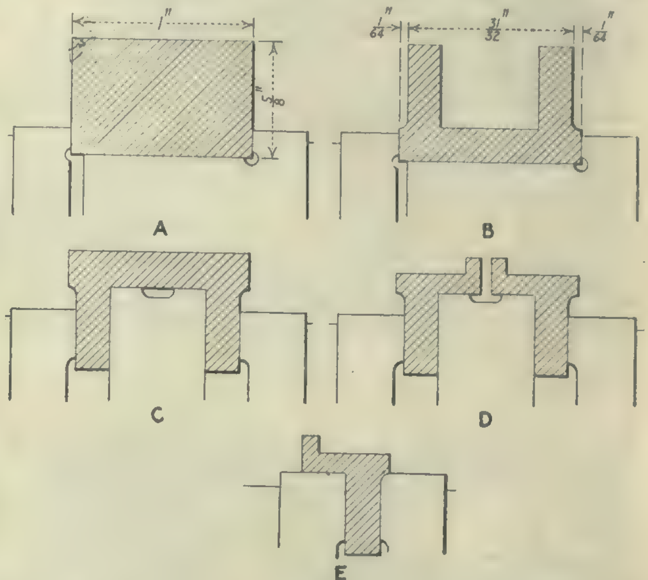


FIG. 2. SUCCESSIVE STRADDLE-MILLING OPERATION ON MARGIN STOP RAILS FOR NOISELESS TYPEWRITER

channel at the center are made with teeth which are staggered as to width, so that one wide tooth on one cutter matches a narrow tooth on the opposite cutter, and so on around the periphery. In this way the cutters may be packed out to maintain a definite width of gap in the work, and at the same time leave no fin, as the staggered arrangement of the teeth provides for the finishing of the bottom of the work smoothly.

The outside cutters, which are really straddle mills, are kept the right distance from the inner pair of the cutters by hardened and ground washers of exact thickness. Thus the work passed under the gang, Fig. 1, emerges, as indicated in sketch *B*, Fig. 2, with the two upright ribs milled to the right thickness.

The milling of the other surfaces here means the removal of $1/_{64}$ in. of stock, leaving an overall measurement of $\frac{31}{32}$ in. The bottom edge of the bar, which is gripped by the chuck and which is not touched by the cutters, has a width of about $\frac{3}{16}$ in. The appearance of the piece as it comes from this gang-milling and straddle-milling operation is well brought out in Fig. 1 and in the sketches *B* and *C*, Fig. 2.

The operation at *C*, Fig. 2, is shown in Fig. 3, where a pair of straddle mills and a central splitting cutter are engaged in shaping the work to the form shown at *D*, Fig. 2, and splitting the piece so that the two margin

stop rail blanks are separated one from the other in this cut.

Fig. 3 shows one of the parallels for supporting the work with a similar parallel in the machine and the work under the cutters. This vise jaw, like the others on corresponding operations, and the parallels are adapted jaws are set up as at *C*, Fig. 2, they grip the work securely without danger of its springing inward, as it simply clamps tightly against the parallel, which then forms a suitable support for milling away the top, forming the edges of the rib and splitting the two pieces apart as clearly indicated at *D* in Fig. 2, and also in Fig. 3.

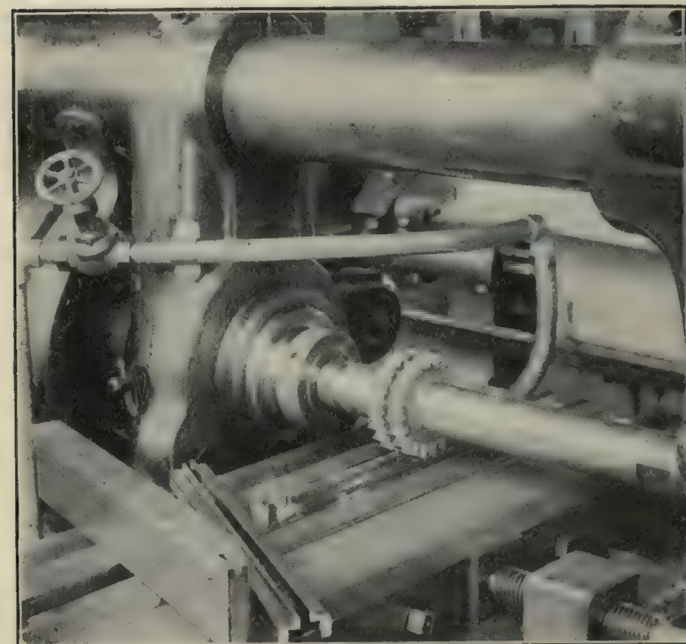


FIG. 3. MILLING THE UPPER RIBS AND SPLITTING THE TWO MARGIN STOP RAILS APART

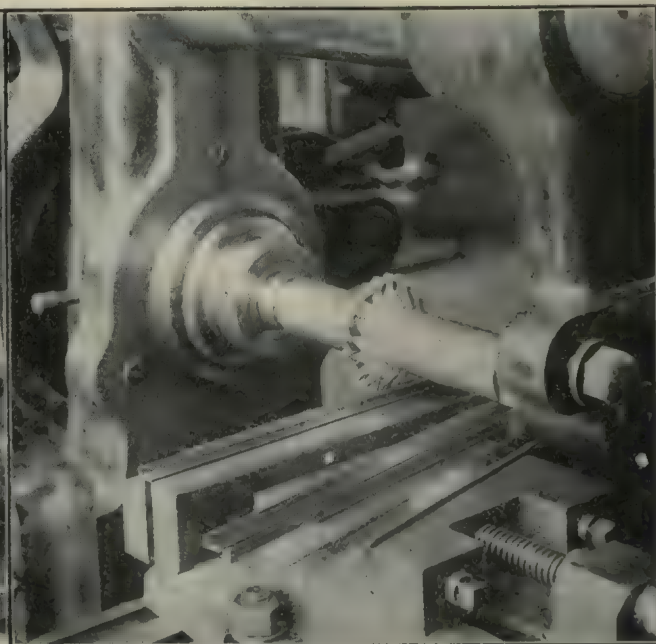


FIG. 4. FINISH MILLING OPERATION ON THE MARGIN STOP RAIL RIB

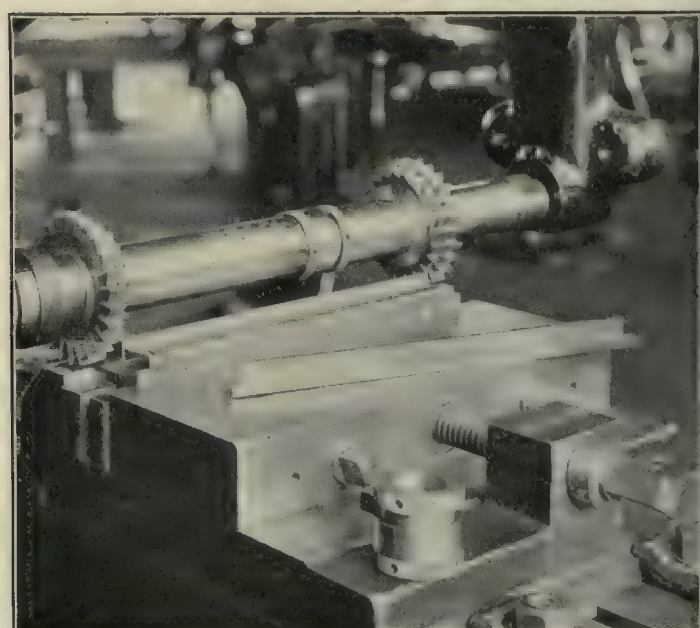


FIG. 5. STRADDLE-MILLING OF ENDS OF MARGIN STOP RAIL

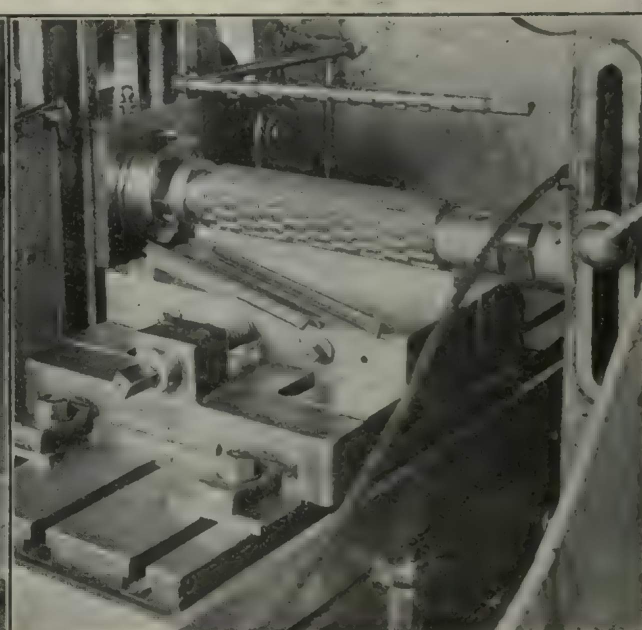


FIG. 6. GANG MILLING OF RACK TEETH IN MARGIN STOP RAIL

for handling different lengths of work to suit different widths of typewriter carriages; in this case the standard width of work is shown under operation.

At *D*, Fig. 2, is shown the method of gripping the work bottom side up, while it is resting upon the parallel whose upper surface is cleared at the center, so that it supports under the inner corners, while the vise jaws themselves take a firm grip about midway down the side surfaces of the work. The channel milled in the material is an exact fit for the parallel, so that when the vise

Fig. 4 shows one of the margin stop rails gripped in another vise for the final operation of straddle-milling the rib on the upper edge. This operation is accomplished with one narrow-face mill and one angle cutter that will cut well down in the corner of the rib and still not interfere with the flat surface of the stock. At the same time a mill in between these cutters brings the top edge of the rib to a clean surface of the right form. For this operation the work is gripped as indicated in the sketch *E*, Fig. 2.

The two stop rails seen on the top of the vise in Fig 4 have the teeth already formed, to illustrate the appearance of the completed teeth, which are milled in a Lincoln type of miller, where a gang of 10 cutters is shown set up side by side to cover the entire length of the job at one pass. These cutters are made to cover a space of 10 teeth each, and other cutters may be added for longer bars, where necessary for wider typewriters.

The straddle-milling of the top rib of the margin stop rail has been shown at this point to bring these similar types of cutting operations together, in order to show each in its relative importance. As a matter of fact, there is an operation of milling off the ends, which comes into the process before the final milling of the top rib at *E*, Fig. 2. This other operation is illustrated in Fig. 5, where two pairs of widely spaced straddle mills are shown for finishing the ends of the stop rail to the form indicated. This work consists in cutting away the body of the material for 1/4 in. at each end, leaving a space for drilling the holes by which the rail may be attached to its position on the carriage of the typewriter.

It will be noticed that the arbor carrying these two pairs of mills is fitted with an adjustable collar near the center, so that the overall distance between the two sets of cutters may be maintained at all times by a simple adjustment of the collar. The vise jaws in which the work is gripped for this crossmilling operation are provided with gaging surfaces at either end, so that the cutters may be set exactly to bring the work to length, so far as the overall dimension is concerned.

The milling of the rack teeth is accomplished, as illustrated in Fig. 6, in a Lincoln type of miller. The gang of cutters, which cover the entire set of teeth in one pass, is made up of 10 separate cutters, each one covering 10 teeth. For longer margin stop rails for wider carriages other cutters are added to the gang, so that the entire job is provided for in one cut.

The method of gripping the work in the vise, Fig. 6, will be apparent upon inspection. It will be seen that the blank for this stop rail is so formed that it seats firmly upon the top of the vise jaws and cannot possibly tilt upward under the action of the cutter, even though the latter is built to extend the full width of the work, and finally applies a considerable degree of pressure to such a small part. Of course the feed is very light, and there is no possibility of the work being picked up or disturbed under the multiple-tooth cutters.

A feature of interest in connection with the battery of machines on which this rack-milling operation is accomplished is indicated in Fig. 6 and more clearly in Fig. 7, which is a general view in the miller department looking down from the battery of rack millers in the foreground. As there shown, the tables of the machines are completely inclosed by an oil guard, which while it positively prevents the spraying of oil all over the shop floor, at the same time gives ready access to the cutters and to the work. This guard is curved at the back of the machine as well as at the front—a point brought out in the general view, Fig. 7, although not seen so clearly in the small detail in Fig. 6. The latter shows the surface of the guard at the rear, but does not give an idea of the height to which it is extended in order to prevent oil from being thrown all over the floor at the back of the machine.

FIG. 7. MILLER DEPARTMENT AT THE NOISELESS TYPEWRITER PLANT, SHOWING A CONVENIENT ARRANGEMENT OF OIL GUARDS ON LINCOLN MILLERS

The guards are easily removable, as they are hung on wire rods carried over screws tapped into the miller heads. To remove the guards, it is only necessary to swing up the supporting rods, when the whole affair may be taken off at once. It is just as quickly replaced and thus in no way hampers the actions of the man responsible for setting up the job or for the regular operation of the machines.

Although the machines in Fig. 7 are shown so small as to make it impossible to pick out individual jobs in

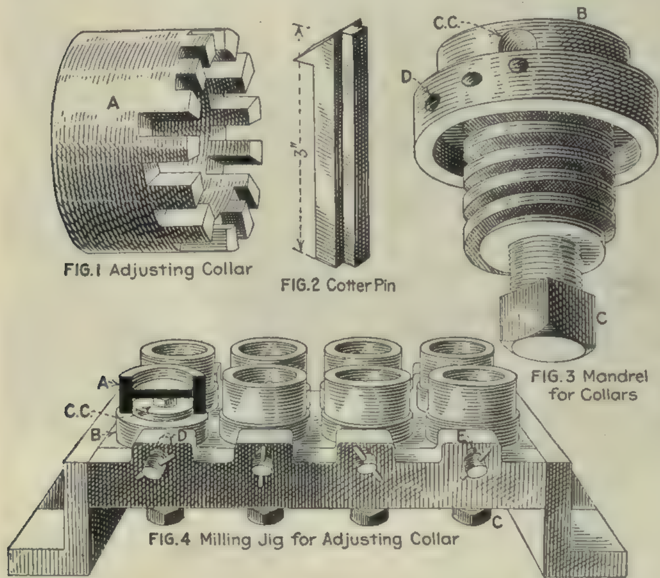
each case, there are always a large number of important operations going on in this department, and many of these will be described in articles which are to follow. This department, like all the other sections of this typewriter factory, is well organized in all respects. Its equipment comprises many special machines and fixtures, which will be appreciated by those who follow up the various articles on the practice of this shop. It has not been necessary here to go into details of other jobs lately appearing in the milling department, as this article has been confined more particularly to the handling of the work on stop rails. There are, however, a large number of interesting special attachments for these machines, and many features of one kind or another well worthy of illustration. They will be dealt with in detail later on.

Machining Adjusting Collars

By T. P. Terry

The illustrations show fixtures I designed a short time ago for machining the adjusting collars and cutters used on munition work.

The collars, Fig. 1, have seven slots from 0.2 to 0.5 deep in steps of 0.05 in. across the face. They were



FIGS. 1 TO 4. THE COLLAR, COTTER PIN AND SOME OF THE TOOLS

turned from mild-steel bar in the turret lathe and present no unusual feature. For milling the slots accurately I designed the fixture shown at Fig. 4, which holds eight collars. Fig. 3 shows one of the eight arbors. It is threaded the required pitch corresponding with the depth of the slots, the collar portion having seven locating holes for dividing purposes and also for locking the work by means of screws *E,* Fig. 4. The collars were locked in place on the arbor by means of screw *D* and crosspins *CC.*

With two cutters on the miller arbor set central with the collars, the milling of these slots was a simple matter, and after being once set no further adjustment of the cutters was necessary, the fixture itself looking after the dividing and depth of slot. This arrangement also insured the slots being the correct depth from the back face of the collars, which was most important, any variation of the width by the turret lathe being unimportant.

No attempt was made to break records, but the average output was upward of 200 collars per day.

With these collars were a corresponding number of cotters, as shown at Fig. 2, these being made from ½x1-in. bright drawn bars. The bars were first sawed into lengths of 6⅛ in. suitable for two cotters, after which they were placed in a standard 1-in. key fixture as shown at Fig. 5.

The stock was removed with three milling cutters as shown; two fixtures were used, operating upon sixteen cotters at one time.

After this operation the cotters were placed in a similar fixture, Fig. 6. This was also standard and was cut

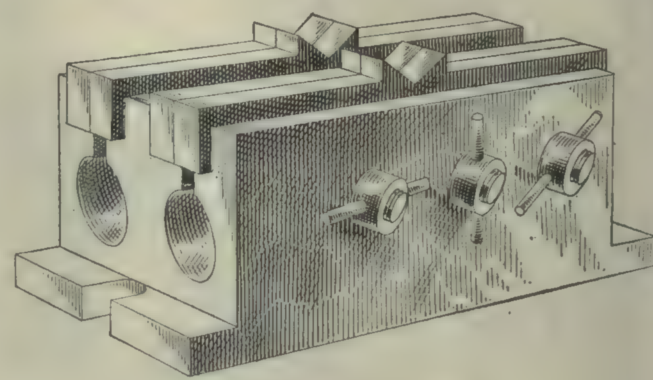


FIG. 5. KEY FIXTURE

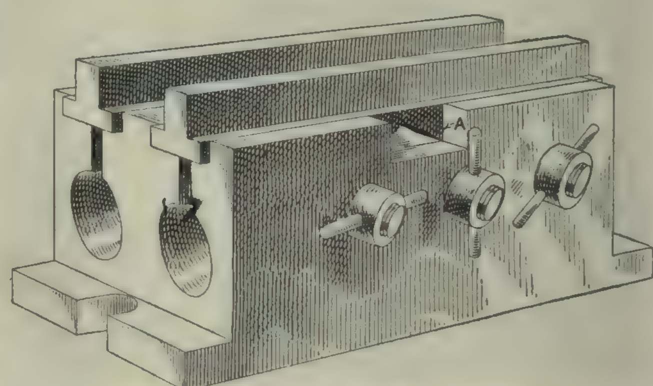


FIG. 6. MILLING BACK OF KEYS

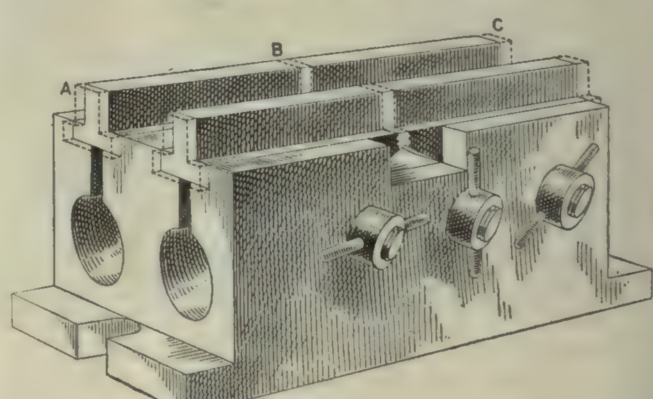


FIG. 7. CUTTING THE TWO KEYS APART

away as shown at *A,* to allow the cotter heads to drop down. Two of these fixtures were used operating on eight cotters at once. The fixtures were then placed across the table and three slitting saws used for parting the cotters and trimming to length, as shown at *A, B* and *C,* Fig. 7, completing the cotters in three operations besides the sawing off.

World Trade Conditions After the War

SYNOPSIS—Excerpts from a report presented at the fourth National Trade Convention, held in Pittsburgh. The loss to iron- and steel-making and metal-working machinery in Belgium is placed at $145,000,000; in France, at $220,000,000. It is also estimated that $150,000,000 worth of machinery must be replaced in Russian Poland. The report ends with general conclusions as to how the work of rehabilitation will be conducted.

Destruction of property was brought about by two distinct agents—(1) the fighting, (2) deterioration in consequence of disuse. Destruction by actual fighting is generally confined to limited fields. Fighting has destroyed property by bombardment and ensuing fires, by intentional incendiarism and by intentional destruction. It is a peculiar fact that in most cases where fighting has taken place there has been a certain respect for large industrial enterprises, and it will be shown later that even in the zone of most violent fighting frequently large industrial enterprises have remained practically unhurt.

Destruction by disuse can be less well defined than the former. It has taken place all over Europe. The losses incurred by disuse are still increasing, and they will grow as long as the war lasts.

Location of Destruction

Military destruction in Europe in consequence of actual fighting is found in all the theaters of war. In the western theater it commenced with the entrance of the German troops into Belgium. Germany entered Belgium in several places along the German-Belgian and Luxemburg-Belgian frontier. From there the German troops spread in the form of a fan in the direction of Liege, Namur and Charleroi, closing in again near Brussels and finally concentrating their forces on Antwerp. Fighting on a big scale took place only in the southern part of Belgium. When the German troops arrived near Brussels, the resistance of Belgium had already concentrated more to the north and military destruction in the center of Belgium was less.

Following the occupation of Belgium, German troops entered France in two lines. Here intermittent fighting took place, reaching Amiens in a northern drive, and in a southern drive a point 60 mi. from Paris. From these two points the Germans were thrown back in a series of heavy battles to the positions they practically held until the beginning of the recent Allied drive. In all cases very heavy destruction of property occurred, including such cities as Arras, Amiens, Reims, etc. The area of France fought over contains more than 3000 cities, villages and hamlets. It is a narrow strip running from the coast to Verdun and farther on to points across the German frontier.

In the eastern theater of war East Prussia suffered much at the war's beginning, mostly through destruction of agricultural property. Poland, twice fought over, has suffered in agricultural districts, and industries of the cities have suffered in consequence of the removal of machinery. Galicia has endured heavy destruction in public and private property. The destruction in the Balkan States is primarily of agricultural character. About Roumania little is known. In northern Italy the destruction is understood to be confined to a limited territory.

Difficulties in Estimating Loss

All estimates here made are approximate and as such can only give a superficial impression of the approximate demand for rebuilding purposes which will arise from the countries in question.

Loss of life and property has been so complete that reconstruction on old lines will be impossible. On the other hand, the more elastic economic system of the world has made it possible for all countries to carry on a certain amount of industrial and economic work which has relieved the situation. In all the European countries at war the return of peace will not mean a return to the conditions of the time before the war, but upbuilding on a new basis. The total destruction of private and public property is estimated to be as follows:

Western theater of war	$3,735,000,000
Eastern theater of war	2,250,000,000
Total	$5,985,000,000

What proportion of this property Europe will undertake to replace immediately with permanent structures and equipment depends upon too many undetermined factors to forecast. The financial condition of the warring powers when peace comes, the ability and willingness of the rest of the world to extend credit, the labor supply, the inter-relation of tariffs and the control of shipping—all are yet unknown factors. Some industrial authorities anticipate that wherever a temporary structure such as a bridge will serve, it will be utilized, permanent replacement being deferred to a more prosperous day. Machinery replacements, on the other hand, will probably be effected for the immediate attainment of maximum efficiency. Similarly, the share of the United States in reconstruction will be determined by these factors. All the nations affected are protectionist in policy and may be expected to foster domestic production in the interest of national credit.

America's Part

The United States can assist in two ways in the reconstruction of the territories affected: (1) By giving financial accommodation; (2) by selling American commodities. In both cases it will be necessary to distinguish between the accommodation rendered immediately after the cessation of hostilities, needed for rebuilding purposes, and the permanent accommodation given in future times in the ordinary course of business.

The new commercial relation that may spring from the war in Europe must be considered from the standpoint of (1) temporary trade, (2) permanent trade.

In Belgium and the French territory the destruction of private dwellings is large, especially in the rural districts where fighting has taken place. Inspection of a number of photographs of destroyed villages shows, however, that even in villages which have been under fire much is left that can be used in rebuilding. Foundations, in many cases, have remained intact. In Belgium and France houses in the villages are built on different

principles than prevail in the United States. The buildings consist in most cases of a frame of wooden beams, the intermittent spaces being filled in with a mixture of broken stones and clay bound with straw. The roofs are covered with firebrick shingles. Weatherproof paint is used. The more modern buildings are as a rule constructed on the same principle, using bricks for the filling of the spaces between the beams. Slate shingles are used frequently instead of firebrick shingles. In France older farm buildings were of heavy stone walls with so-called French windows opening sidewise.

As a rule, the materials for houses were obtained from near-by sources. Quarries throughout northeastern France and Belgium supply a good stone for building foundations, and the slate quarries produce the shingles used. Brick making is a widely distributed local industry.

The destruction of farm implements and machinery in northeastern France is said to be large. The same is the case in Belgium.

Roads, Bridges and Railways

The roads of northern France and Belgium are macadam roads, having tarred surfaces in a few cases. Roads were destroyed frequently by the retiring troops and have been seriously damaged by heavy gun fire and excessive use. In many cases the lower foundations may be found practically useless and require entire renewal.

Upkeep of the roads is the duty of municipalities in Belgium and France, done usually on a community basis under authority of road inspectors. Road renewal and repair will form a heavy item in the annual budgets of the smaller villages. Road-building materials are mostly found in the local quarries. Modern asphalt highways are found only in the cities, most villages being satisfied with flag and cobblestones.

Many bridges were destroyed. After the entrance of the German troops in Belgian territory the Belgians blew up a number of the most important road bridges, and several important railway bridges were destroyed for military reasons. In France the retreating French troops also blew up bridges, while those which were left were destroyed by the Germans during their retreat after the battle on the Marne. The destruction of bridges can be regarded as complete in every fighting zone. Their rebuilding will be a heavy item in reconstruction. The bridges destroyed were in most cases iron bridges built on the same principles as those in use in America.

When the Germans entered Belgium and northeastern France, they found much railway material and many locomotives. Railroad tracks were partly destroyed. All has been repaired for the use of the army and the civil population. The great service to which the Belgian and French railroads were put for military purposes has made it necessary to keep that material efficient, but the copper and brass fittings of the locomotives have been removed to relieve the shortage of those materials in Germany. The actual loss of railroad material both in roads and in rolling stock most likely will be very large.

Damage to industrial plants is heavy in cities that have been under bombardment. Generally, however, it seems to be much smaller than could be expected, considering the danger to which the high structures and buildings were often exposed. The greatest enemy of industrial property has not been military operation, but rather the enforced idleness of machinery and buildings. In several cases mines have been flooded. Mining machinery and buildings suffered where fighting took place. The damage from the latter, however, is not very large. The furnaces of the big iron smelters were damaged by gun fire in several cases.

The districts where fighting has been going on in Belgium and in northeastern France constitute one of the most important industrial parts of Europe. They contain large coal and iron mines. The steel works of Longwy, Micheville, Pont à Mousson, Senelle-Maubeuge, are among the most important of France. Homecourt, Saint Chamond, Assailly, Montlucon, all industrial centers, were in the fighting line.

Of the smelting furnaces of Belgium 29 are lying in the Hennegau, 23 near Liege, 7 in the province of Luxemburg. Belgium extinguished the fires of her furnaces at the end of July, 1914.

The following industrial cities of northeastern France are suffering from the war: Arras (chemical industries), Bapaume (textile), Douai (glass and textile), Lille (cotton and linen industry, silk spinning and weaving, nail making, chain making, small iron-ware manufacture), Loos (textile), Maubeuge (furnaces and iron industry, quarries), Neuve Chapelle (spinning), Rathel (woolen weaving), Reims (woolen industry, champagne industry, machine and machine tools, tools, general textile), Senlis (rifle making and paper), Soissons (ceramic industry, iron smelting and foundries, canning). The industrial cities of Belgium which have suffered from the war are Aershot (laces), Alost (textile), Andenne (ceramics and coal mining), Antwerp (large industrial and commercial center), Charleroi (coal mining, iron foundries, smelting), Diest (textile), Dinant (cotton goods, copper ware, iron hollow ware), Hasselt (textile), Huy (paper, machines, iron foundries, iron and coal mines), Liege (surrounded by coal mines and iron-smelting industries; copper foundries, machinery industry, guns, ammunition, textiles; has a large arsenal making heavy armaments, rifles, etc.), Louvain (laces, paper, dyeing, dyes and colors), Namur (iron foundries, cutlery, textiles, machine building, wire works), Verviers (machines, textiles, copper ware, iron foundries, chemicals), Visé (tanning, quarries, knit goods), Ypres (dyeing, tanning and leather industry).

Raw Materials

The destruction of stocks of raw materials is very extensive. Not only have large stocks been destroyed to prevent their falling into the hands of the invading armies, but also the bombardment of cities has been responsible for great losses.

Germany removed part of the machine equipment of certain Belgian and French manufactories to Germany during 1915 to obtain certain raw materials, like copper, or to furnish German plants with additional machinery. It is impossible to make even a general estimate of the value and number of machines taken away in this way from the two countries. It is assumed that the order applied especially to machines containing copper, nickel and other rare metals. This would mean, among others, electrical machinery and motors.

According to the New York *Times* of Mar. 6, 1915, the Federation of Belgian Sheet and Iron Manufacturers protested against the seizure of $3,000,000 worth of machinery in Belgium and its removal to Germany. Also raw materials were seized. The same paper reports under Sept. 15, 1915, a protest of the Belgian Government against Germany's removing part of railway tracks in Belgium for use in Poland.

Estimate of Financial Value or Loss

Several attempts have been made to estimate the financial loss caused by the war in Belgium and northeastern France. These estimates were mostly made in the early part of the war.

During February, 1915, the Central Committee for the Agricultural Restoration of Belgium and northeastern France in London estimated the total loss of agriculture in Belgium at $280,000,000, of which $150,000,000 was lost in crops and stock. The loss of France was estimated to be approximately the same. The French Government during March, 1915, estimated the approximative destruction of farmhouse property with more than 100,000 houses without, however, giving a value.

An article in *The Americas* of July, 1916, stated: "Henri Mason, of Brussels, estimates the total loss of Belgium in buildings, equipment, stores and loss of trade with $1,060,288,000." Billiard, in "La Belgique Industrielle et Commercial de Demain" of Dec. 15, 1914, states the loss of Belgium at $5,000,000,000. A German economist gives $1,026,567,000 as the probable loss of Belgium. Later, according to *The Americas,* the Belgian estimate rose to $1,200,000,000 loss for Belgium. The French authorities have given $2,500,000,000 as the probable loss of France, while German authorities have figured the value of destroyed buildings to be $130,000,000.

The Americas estimates $2,825,000,000 as the probable industrial loss of Belgium and France in consequence of the war. Using these figures as a basis and allowing also for losses of agricultural, governmental and city property, a grand total of $3,735,000,000 is obtained.

	Belgium	France	Total
Buildings	$200,000,000	$150,000,000	$350,000,000
Industrial machinery	800,000,000	550,000,000	1,350,000,000
Agricultural buildings and dwellings	100,000,000	100,000,000	200,000,000
Agricultural implements, machinery, etc	30,000,000	30,000,000	60,000,000
Crops, livestock, etc	125,000,000	175,000,000	300,000,000
Industrial raw materials and ready stocks	525,000,000	375,000,000	900,000,000
Railroads	125,000,000	100,000,000	225,000,000
Government property, bridges and roads	75,000,000	125,000,00	200,000,000
Private and public, city property not included	75,000,000	75,000,000	150,000,000
	$2,055,000,000	$1,680,000,000	$3,735,000,000

The loss of machinery approximately may be distributed among the different industrial groups as follows:

	France	Belgium
Mining	$120,000,000	$180,000,000
Iron and metal industry	145,000,000	220,000,000
Food industries	42,000,000	10,000,000
Chemical industry	20,000,000	20,000,000
Textile industry	141,000,000	190,000,000
Electrical industry	50,000,000	130,000,000
Woodworking and furniture	23,000,000	35,000,000
Paper making	9,000,000	15,000,000
	$550,000,000	$800,000,000

To start again the industries in the occupied territory it will be necessary to rebuild destroyed plants, to equip them with machinery and to supply raw materials. There has been a considerable lack of industrial labor in the French occupied territory since the occupation. The reservists in northeastern France have joined the colors, and the actual fighting has driven away a considerable part of the population which either has retreated with the French army or has been removed by the Germans from the territory under military control. It is therefore not unlikely that the French industry in northeastern France after the war will have considerable difficulty to obtain sufficient labor. This will lengthen the time between the war's end and the restoration of industrial activity.

Industries cannot at peace return at once to full operation. Reopening of manufacturing plants will be gradual. Neither France nor Belgium will require at once all the raw materials, machinery and industrial buildings to be replaced. Conditions will be somewhat different in agricultural districts where production has been continued. Fields must be worked immediately the owners return. Agricultural machinery, seeds and building material will be in immediate demand. After the Balkan War it took approximately one year to rebuild destroyed villages. It will require longer in France and Belgium because of labor losses not replaceable from neighboring states. Fifty per cent. of the agricultural buildings should be finished during the first year. Agricultural machinery will have to be replaced at once. The type of the machinery first needed will depend upon the season of the year when the armies are mustered out. Plows of all descriptions should dominate in the first orders. The immediate demand for building material for cottages and farm buildings should reach a value of approximately $100,000,000, while $40,000,000 should buy the agricultural machinery for the two countries.

Rebuilding the Industrial Plants

The rebuilding of industrial plants will occupy more time. A good many new industrial buildings in northern France and Belgium may consist of temporary structures. The total expense for these structures will most likely not be larger than one-third of the total value of the former buildings; and $65,000,000 for Belgium and $50,000,000 for France should be sufficient to help the two countries over the first period after the war, as far as building material and cost of construction are concerned. The same percentage possibly will apply to industrial machinery with the exception, however, that most likely the items for electrical machinery and construction will be heavier. Not only has electrical material suffered more in consequence of seizure of copper by Germany, but delicate electrical machinery deteriorates more rapidly than the less complicated machines of other industries. Cable lines may have to be relaid entirely. The greater use which will be made in both countries of electrical motive power for agricultural and industrial purposes will necessitate equipment even more extensive than formerly. The entire electrical equipment destroyed may have to be replaced at once after the war. The immediate needs of the two countries during the first year after the war may be as follows:

	Belgium	France
Agricultural buildings	$50,000,000	$50,000,000
Agricultural machinery	20,000,000	20,000,000
Industrial buildings	65,000,000	50,000,000
Mining machinery	60,000,000	40,000,000
Iron-industry machinery	70,000,000	50,000,000
Food-making machines	3,000,000	10,000,000
Chemical machinery	6,000,000	6,000,000
Textile machinery	65,000,000	50,000,000
Electrical machinery and equipment	130,000,000	50,000,000
Woodworking machines	20,000,000	18,000,000
Paper-making machinery	5,000,000	3,000,000
	$494,000,000	$347,000,000

The same applied to railroads, to ordinary roads, bridges and to other government property of which at

least two-thirds will have to be placed in working order as soon as possible after the war would cost $175,000,000 in Belgium and $300,000,000 in France.

According to German reports 50 per cent. of the industries of Belgium are at work a part of the time. It is impossible to say how much these industries produce and whether their production can be used for the Belgium industry after the war. It may be possible to utilize at least 50 per cent. of the Belgium industry for the supply of the new machines and other articles needed. Nevertheless, Belgium may be compelled to import about $100,000,000 to $120,000,000 worth of industrial machinery, approximately six times as much as her highest import during one year before the war.

France is better able to take care of her ruined industries and villages in the north than Belgium. A large percentage of French industry lies in present occupied territory. That in other parts has been greatly increased since the beginning of the war. France has bought much machinery in this country during the last two years and gradually replaced equipment in certain factories. Many of these machines finally will go to northern France. It is therefore likely that France will be able to replace three-quarters of the destroyed machinery either by its own production or by using machines imported during the war. This would mean an outlay of about $60,000,000 abroad.

The Eastern Theater of War and Germany

Germany has not been invaded to such an extent as France and Belgium. Destruction following military operations took place only in a small part of Alsace Lorraine and in eastern Prussia. The destruction in Alsace Lorraine was small and will be repaired easily. Eastern Prussia suffered more heavily during the first months of the war when heavy fighting took place and much property was destroyed by the first invading and then retreating enemy army. The industrial loss of eastern Prussia is not of sufficient importance to affect seriously the productive capacity of Germany. The agricultural population has been more seriously injured. Many villages have been destroyed completely, others damaged. Heavy damage was inflicted upon bridges, roads and governmental property, including railroads.

Germany has repaired a great part of the damage. No material influence on the German imports after the war is expected to result from this work. Germany, however, has suffered during the war economically in a different way from that of the Allied nations. She and her allies have been cut off from the world's market. As Germany was dependent for many of her raw materials from foreign supplies, the result of the interruption of her foreign trade is a nearly complete exhaustion of her stocks of all those raw materials that had to be imported. The same applies also to foodstuffs.

With regard to machinery and industrial materials opinion differs. Much machinery has been destroyed either by being overworked during a period of excessive economic pressure or by dismantling so as to extract essential raw materials. Copper has been taken from the locomotives and electrical machinery, which Germany must replace in order to resume industrial progress. Germany is an industrially highly developed country. She can make nearly all machinery used in her industries. Therefore, she may be expected to buy only what is necessary; but she will give machinery preference before any other industrial product, as by the possession of machinery she will be enabled to produce a greater proportion of the industrial goods formerly imported. The yearly bill paid by Germany for imported machinery was approximately $30,000,000. It is most likely that after the war it will have to be doubled.

Russian Poland

The loss of Polish industrial property will be large. Poland has several important industrial centers, of which only Warsaw and Lodz may be mentioned. The other Russian provinces under enemy occupation have cities of industrial and economic importance. The industrial loss in some of these cities is estimated at more than 50 per cent. of all available machinery. On the other hand, it is said that the loss of industrial buildings is not so large, the Russians and Germans having been satisfied with a removal or destruction of the machinery.

Estimating the total value of the machinery in use in Russian Poland and the occupied provinces before the war at $300,000,000, this would mean that approximately $150,000,000 worth would have to be replaced. A careful estimate of the loss of Poland and the occupied Russian provinces by the war on the lines of the estimates for Belgium gives the following result:

Private dwellings, agricultural buildings and machinery	$300,000,000
Industrial buildings and machinery	225,000,000
Industrial raw materials and stocks	200,000,000
Railroads, government and public property	150,000,000
	$875,000,000

These figures are borne out by Russian estimates, which value the total and immediate requirements of Russia for rebuilding purposes at $600,000,000.

Russia has been a very heavy buyer of industrial machinery of all kinds in the United States. Her total import of machinery seems, however, to be less than usual. Most of the new machinery has gone into other parts of Russia; nothing can be spared for Poland. Russia herself manufactures little machinery; at least all the more complicated machines are imported. Therefore, the bulk of the Polish machinery business will have to go abroad. The increase in the imports of machinery into Russia and Poland should therefore be heavy.

Conclusions of the Report

Coöperation, replacing individual, endeavor may be the general industrial result of the war in Europe. To shorten the period of reconstruction the following policies have been proposed or discussed:

1. Rebuilding the destroyed buildings and factories with governmental aid in money and materials.

2. Supply of necessary machinery and raw materials for industry by governments.

3. Allocation of labor through governmental employment agencies.

4. Monetary assistance to manufacturers and artisans.

5. Distribution of seeds, animals and machinery to farmers.

6. Restriction of imports to necessity and control of shipping in conformity with such policy.

In some cases governmental aid may be replaced by municipal assistance.

To carry out this program, governments will have to make reconstruction loans. Parts of these loans will be placed abroad, where they can be used in payment for

supplies to be bought from the lending country. This will prevent further declines of the exchanges without necessitating in the future the transshipment of large gold payments.

To secure best results for the money expended, buying of building and raw materials will be done on a national coöperative basis. This will entail a continuancy of the practice of having foreign buying agencies as now introduced by the nations at war in the neutral markets. All imports of Germany will be done under governmental control.

To rectify their foreign exchanges and to secure an income for their industries independent from the home market, European nations have announced their intention further to support the foreign trade of these industries by a program especially suited to that purpose. This program includes:

1. The granting of special rebates in buying materials and for transportation.
2. Coöperative exporting by groups of manufacturers.
3. Special financial assistance to exporters.

In England a bank for the extension of foreign trade has been formed. Also, the Government has indicated its willingness to support the creation of new industrial enterprises by special financial grants. In France preparations are made to make more general the use of motor power in medium and small industries by a better utilization of the hydro-electric power of the country. In Germany the introduction of an electrical-power monopoly has been discussed with the same object in view. Steps so far taken indicate the following tendencies in this direction:

1. Exclusion of as much as possible of the profit of the foreign exporter.
2. Elimination of the necessity of buying raw materials and partly manufactured articles abroad, especially from now enemy countries.
3. Replacement, where possible, of manual labor by mechanical energy and a larger employment of machinery.

By carrying out this program the European nations hope to counteract at least partly the destructive influence of the war on their labor resources and to lower their cost of manufacturing so far that they will remain competitive even under the unfavorable economic conditions created by the war.

Simeon North's Two Old Shops and Another

By Joseph W. Roe*

An article in the *American Machinist*, page 109, Vol. 41, showed the influence of the machine shops operated by Eli Whitney, in New Haven, and by Simeon North, at Berlin and Middletown. A picture of the old Whitney shop was given, but neither of the North shops was shown. A pilgrimage recently gave the writer an opportunity to see and photograph all that remains of these.

The older of the North shops is no longer standing. The property, located on Spruce Brook, just north of Lamentation Mountain, a few miles southeast of Berlin, Conn., was purchased by Simeon North in 1795. It adjoined his farm and comprised at that time an old sawmill, millyard and dam. Here he first made scythes; later, pistols. Sometime before 1808, North built a factory addition of two stories and a basement, the latter being used as a forge. The site of the building is shown in Fig. 1. The original dam still furnishes the passage for a roadway.

FIG. 1. SITE OF NORTH'S FIRST FACTORY, BERLIN, CONN.

The factory was on the downstream side of the road in the foreground of the picture, and to the right of the present culvert. The only evidences of the shop, which once had so wide an influence, are a few fragments of the foundation, overgrown with underbrush. In 1857 a flood swept away the shop and most of the dam. A smaller dam has since been built on the upstream side and shows through the opening under the roadway. The stream has been drawn upon above for the water-supply of the City of Meriden and has now shrunk to the proportion of a small brook. The motorist of today spins across the culvert with little realization that it was a power site for one of the most famous of American gun shops.

In 1813, with the growth of his business, Mr. North purchased 50 acres on the West River a mile and a half southwest of Middletown. Here he built a shop that is now owned by the Rockfall Woolen Co. This shop was one of the largest and best equipped in the country, represented an investment of more than $100,000 and em-

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ployed about 70 men. When the wise men of Middletown expostulated at its size, North told them that he was going to build a shop large enough "to furnish Uncle Sam with guns for all time to come." The main three-story build-

FIG. 2. "PHŒNIX" BUILDING, NORTH'S MIDDLETOWN FACTORY

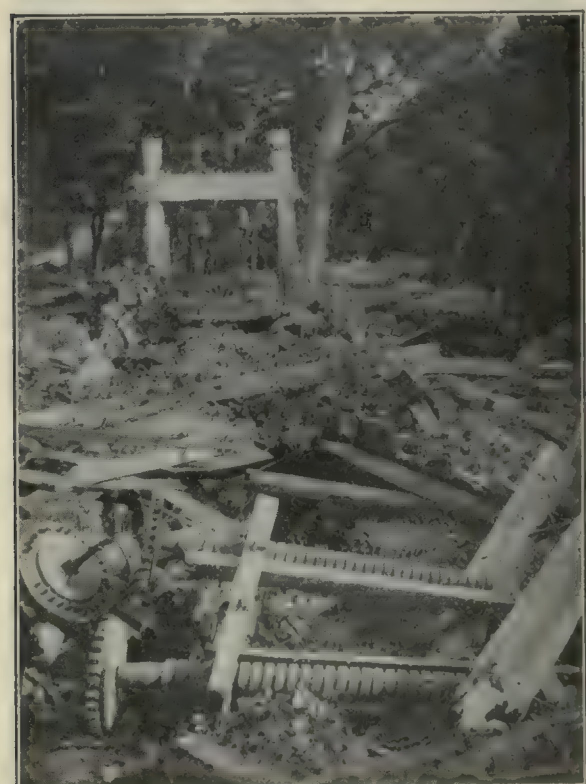


FIG. 3. RUIN OF OLD HARDWARE SHOP

ing has been largely rebuilt, but the foundations and parts of the front and end walls, of Flemishbond brick, were retained and are still in use. The only one of the original buildings standing unchanged is the two-story one shown in Fig. 2. It is across the street from the main building and is now used as a storehouse. This used to be known among the workmen as the "Phoenix" building, because Colonel North used to pay off his men there with money that he drew from the Phœnix Bank in Hartford, where he kept his payroll account. For many years Colonel North operated both factories, the Berlin shop being run by his son, Reuben North, until 1843, fourteen years before the shop was swept away in the flood referred to, and the Middletown shop by Coloned North himself until the time of his death, which occurred in the year 1852.

FIG. 4. WOODEN SCREWS AND GEARS

FIG. 5. FRAMES FOR TRIP HAMMERS

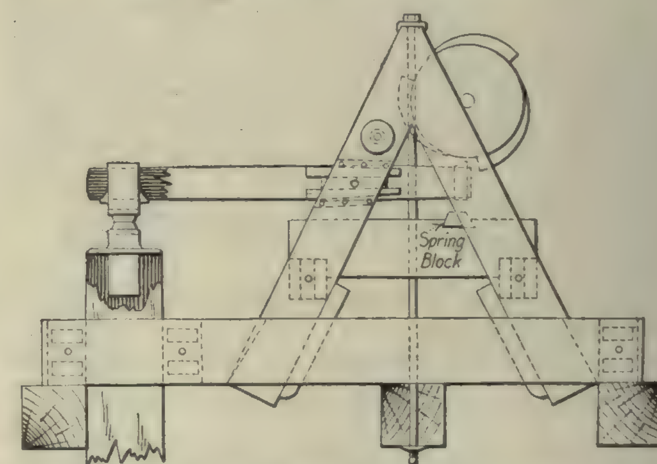


FIG. 6. DRAWING OF TRIP HAMMER

Another old shop, of less interest historically, but more picturesque as a ruin than either of the above, is located on the Saugatuck River, about eight miles north of Westport and Southport, Conn. It was used for the manufacture of hardware, mainly axes and other edged tools.

In Figs. 3 and 4 are shown parts of the ruins. The machinery seems to have been mostly of wood, and Fig. 4 shows some of the old screws and gears with mortised teeth. The frame in the background of Fig. 3 looks suspiciously like a cider press; but its use is uncertain, and no one in the neighborhood seems to know anything definite about it.

A few rods farther down the stream was another building located at a second dam. Within its foundations are two A-shaped frames with bearings carrying wooden drums, having three cast-iron cams. In the foreground are some timbers that appear to have been helves of trip hammers. A portion of what may have been the base of the anvil is still evident, but the anvil itself has long since gone. A few months ago the writer ran across a drawing, shown in Fig. 6, in some old records of the Sheffield Scientific School, made sometime before the Civil War, which shows clearly a hammer similar to the remains of the ones shown in the ruins of the shop in Fig. 5.

The old frame and gears, buried in the woods and tangled with vines, remind one of the last of Shakespeare's seven ages of men, "Mere oblivion," literally "sans eyes, sans teeth, sans everything."

Machining Operations on a Twelve-Cylinder Automobile Engine

By Robert Mawson

SYNOPSIS—The article describes the jigs, fixtures and machine tools used and the methods followed in machining the principal parts of a modern twelve-cylinder automobile engine. The operations on the crank case, cylinder, connecting-rod and cylinder head are shown in detail. Cutter speeds and feeds and machining times are given. The block and dynamometer tests of the engine are also described.

The Weidely Motors Co., Indianapolis, Ind., manufactures a twelve-cylinder automobile engine, a phantom illustration of which is shown in Fig. 1. The cylinders are placed in a V-position and have removable heads. The cylinder bore is 2⅞ in. with a stroke 5 in., giving a displacement of 389.5 cu.in. The weight of the engine without ignition or carburetor is 750 lb. From the illustration it will be seen that the cylinders are made in blocks of three, separate from the crank case. Both the cylinders and the pistons are made of semisteel.

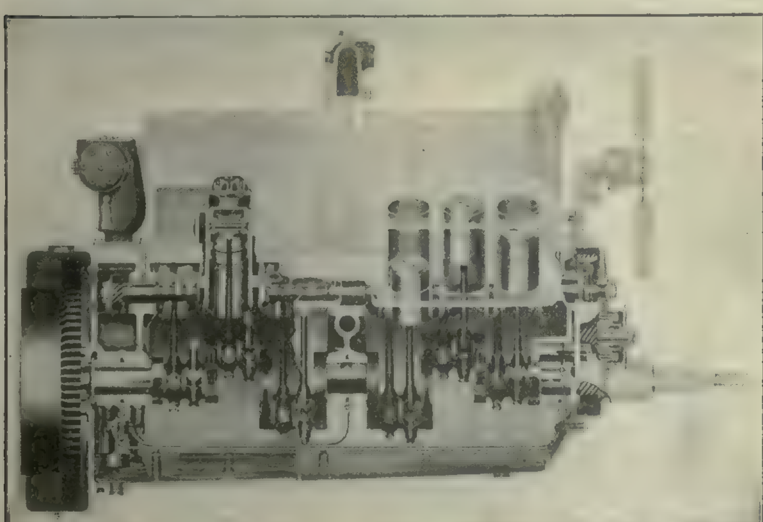


FIG. 1. PHANTOM VIEW OF TWELVE-CYLINDER ENGINE

The crank case is made of aluminum and is cast in two sections, all the bearing caps for the working parts being fastened to the upper section. The lower section of the case is used only as an oil reservoir and guard for the operating mechanism.

Only one camshaft is used on the engine and it is placed above the crankshaft. The intake and exhaust valves are operated by means of push rods and overhead rocker arms from this one shaft. An interesting feature of the crankshaft, which is of the three-bearing type, is the oil holes that are drilled to the connecting-rod bearings. Oil is forced through by means of a pump, so that all the bearings and the crank and connecting-rod are positively lubricated.

The first operation in machining the upper section of the crank case is to mill the parting line. The casting is placed on the fixture that is shown in Fig. 2 resting on angular surfaces, which are designed to suit the 30-deg. faces of the piece. Holding-down bolts and straps are then tightened on the inside of the case, the bolts being tapped into the fixture. A 24-in. diameter cutter fitted with 18 inserted blades is used for the milling operation. The cutter operates at 250 r.p.m. with a feed of 0.064 in. per revolution. The machine is a Brown & Sharpe miller. The angular surfaces on which the cylinders are attached are then machined as shown in Fig. 3. The casting rests on the already machined parting-line surface, is located against stops and is strapped as shown. The fixture is provided with an index pin A that fits in two places in the revolving member of the fixture. Two bolts B swing in slots and are tightened to assist in holding the moving member against any vibration. The cutter used is 12 in. in diameter, has six blades and runs at 250 r.p.m. with a feed of 0.064 in. per revolution. This operation is performed on a Becker vertical miller. The crankshaft main-bearing bolt holes are then drilled on a radial drilling machine, the fixture shown in Fig. 4 being employed. The casting rests on the angular surfaces in a cradle attached to the machine table. The jig is provided with taper straps that are tightened inside the walls of the case by means of the knurled-head screws A, to locate the jig in position. The endwise position is determined by an adjustable screw stop B. The time required to perform this drilling operation is 10 min. on each case.

The cylinder holding-down bolt holes are drilled as shown in Fig. 5. The jig rests on the 30-deg. angular surfaces and is located by means of adjustable screws on the side and end. Sixteen holes are then drilled, the operation being performed on a Fox 24-spindle drilling machine. The average time required for a crank case, which means drilling two surfaces, is 6 min. The jig is provided with two large eye-bolts *A* so that it can be conveniently handled.

The machining of the valve-tappet guide holes, as shown in Fig. 6, is performed on an Andrews drilling machine. The jig is located by pins that fit into holes machined in the previous operation. This jig is also designed with eye-bolts for convenience in handling. The 24 holes are machined in each case in 20 min. It will be noticed that the jig is moved to two positions for the drilling of one side, as the holes are too near together to enable all twelve spindles to be operated at the same time without interfering badly with each other.

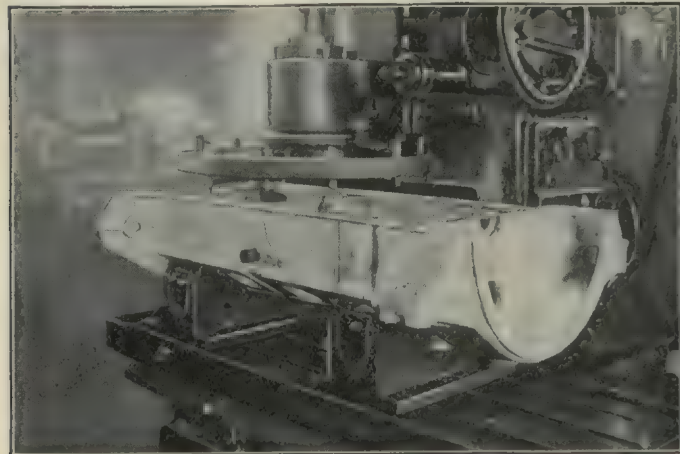


FIG. 2. MACHINING PARTING-LINE SURFACE ON THE CRANK CASE

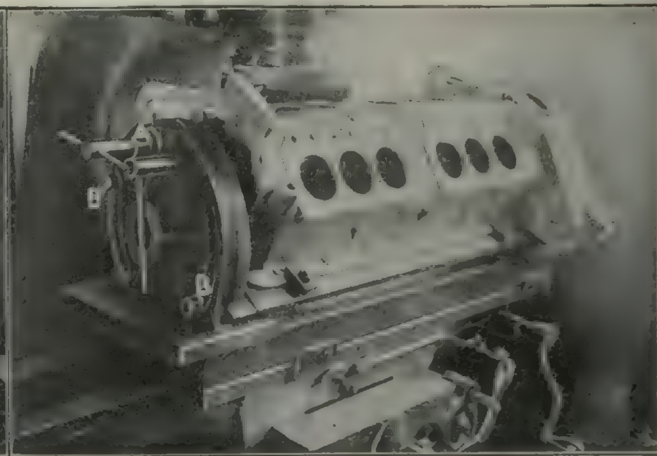


FIG. 3. MACHINING ANGULAR SURFACES ON THE CRANK CASE

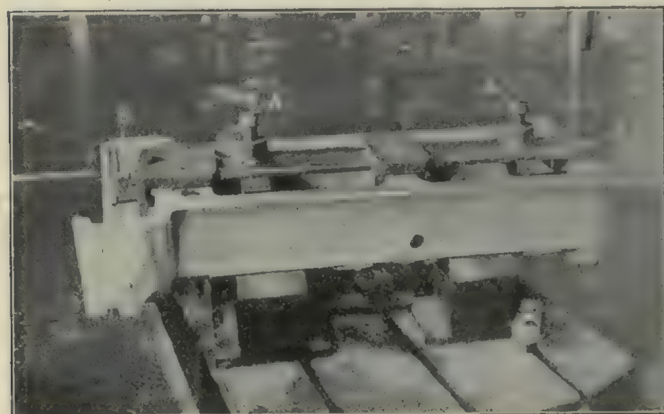


FIG. 4. DRILLING HOLES FOR CRANKSHAFT BEARINGS IN THE CRANK CASE

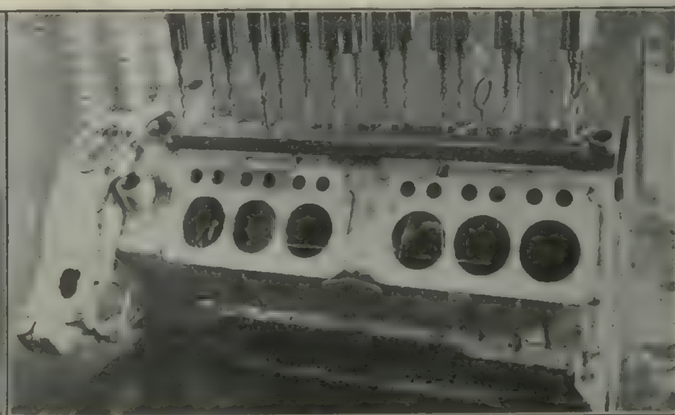


FIG. 5. DRILLING CYLINDER HOLDING-DOWN BOLT HOLES

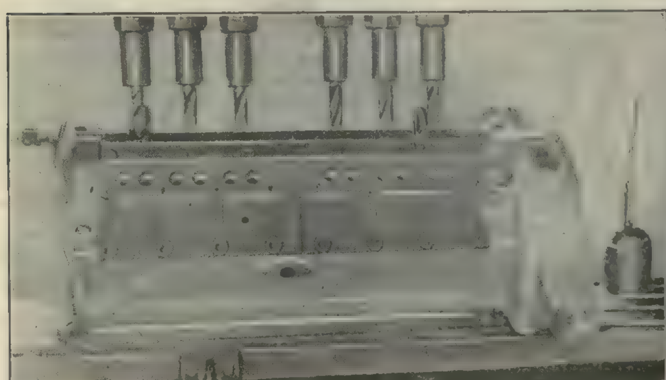


FIG. 6. DRILLING VALVE-TAPPET GUIDE HOLES

FIG. 7. BORING THE CRANK CASE

The three bearing caps that have been machined previously are now fastened to the crank case by means of bolts, and the casting is placed in the fixture shown in Fig. 7. Here it is bored for the crankshaft, intermediate gear, pumpshaft and camshaft. The boring bars are guided in long bushings in the fixture. The American lathe on which this operation is performed is provided with two heads and two sets of bars. The time required to bore a case complete is 1 hr. 15 min.

The finishing of the upper surface of the cylinder head is performed on a Beaman & Smith machine, shown in Fig. 8. The casting is held by a pipe placed through the cored hole. Eye-bolts are then slipped over each end of at each end. A similar cutter operating with the same feed and speed is used for this second milling. The production of this machine is 3½ finished heads per hour under the average conditions that here prevail.

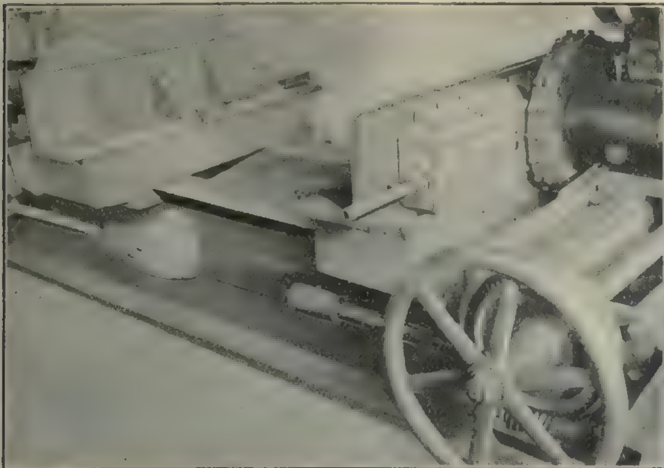


FIG. 8. MILLING UPPER SIDE OF CYLINDER HEAD

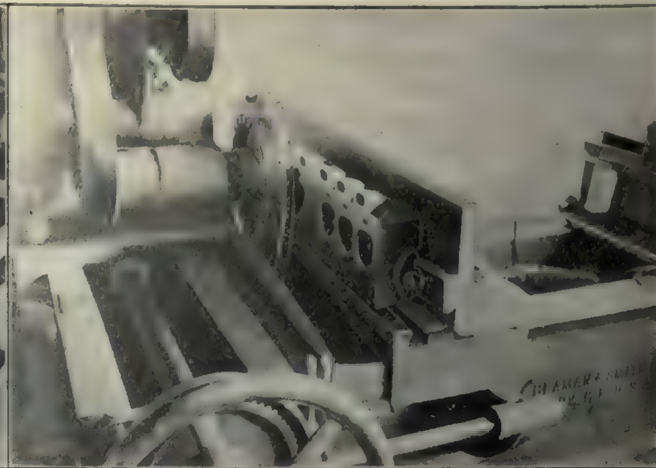


FIG. 9. MILLING LOWER SIDE OF CYLINDER HEAD

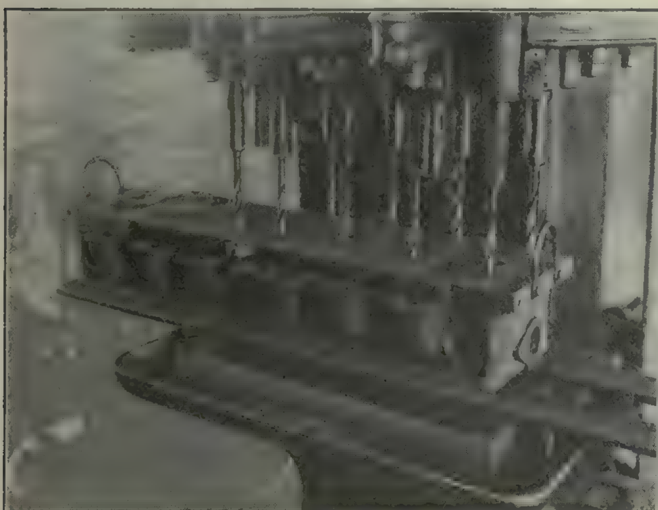


FIG. 10. DRILLING HOLES ON CYLINDER SIDE OF HEAD

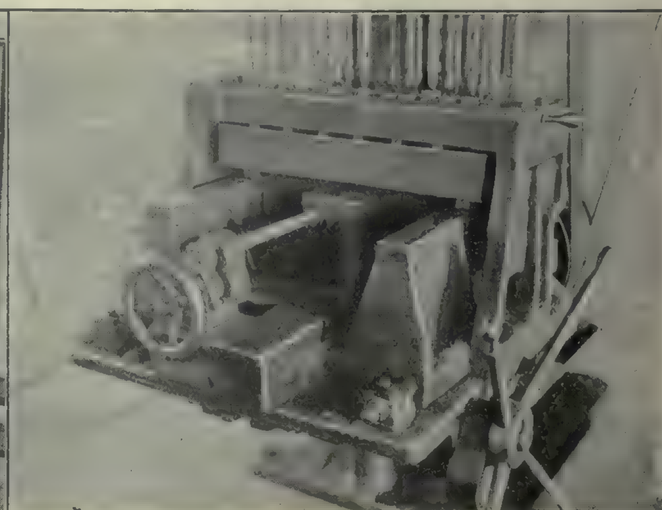


FIG. 11. MACHINING UPPER SIDE OF CYLINDER HEAD

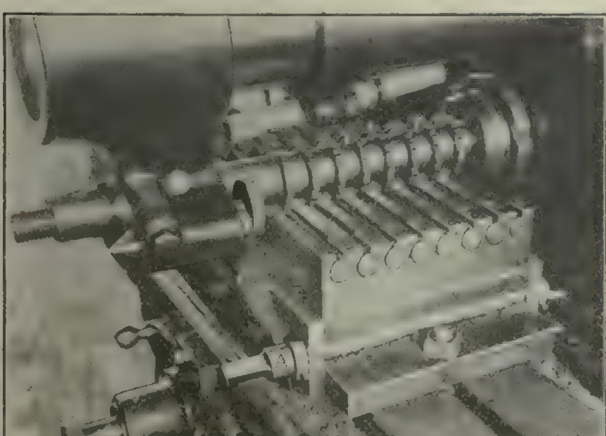


FIG. 12. MILLING VALVE ROCKER-ARM SHAFTS

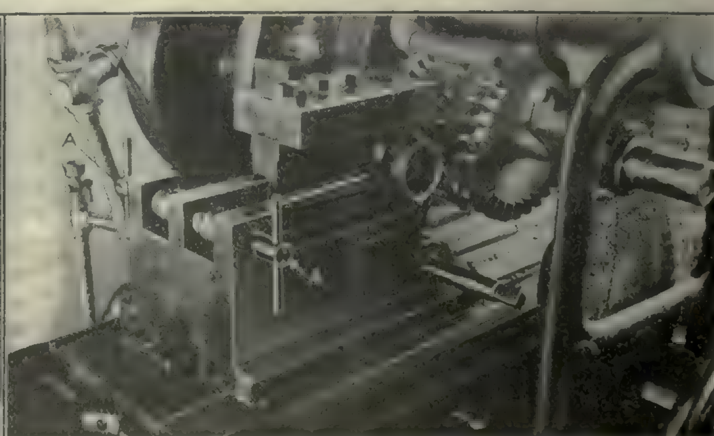


FIG. 13. MILLING LARGE END OF CONNECTING-ROD

the projecting pipe, and as they are drawn back the casting is securely held. The milling cutter used is 16 in. in diameter, is provided with 18 blades and runs at 17 r.p.m. with a feed of 0.12 in. per revolution. The head is then placed on the other fixture of the same machine, being held against the milled surface by means of straps

The holes on the cylinder side of the head are then drilled as shown in Fig. 10. The casting is placed on two steel strips and the jig placed over it. The jig is located by adjustable stops at the side and end. Seventeen holes are then drilled, the time required being 12 min. A special Foote-Burt machine is used for machin-

ing the valve-shaft and valve-tappet guide holes, as shown in Fig. 11. The casting is placed on locating pins that fit into holes machined in the preceding operation. The casting is pushed back against a locating stop and the holes drilled for the valve shafts, and the holes for the valve-tappet guides bored and counterbored. The tools are guided through bushings in the jig plate. The time required for the operation is 25 min.

In Fig. 12 is shown the operation of milling the keyways in the valve rocker-arm shafts. The shafts, eight in number, are placed in the fixture and slid back against a stop plate. The fixture is provided with slots at the forward end between each shaft. When the screws A, one at each end of the fixture, are tightened, sufficient pressure is provided to hold the shafts securely. Eight slots are milled with cutters 3 in. in diameter by ¼ in. thick, running at 80 r.p.m. with a feed of 0.03 in. per revolution.

The first operation when machining the connecting-rod is shown in Fig. 13. The forgings, the fixture being designed to hold two, are located at the large end against projections on the upper and lower sides. The rod is located and held at the other end by the screws A, which are made with a cone end to fit the die imprint, or spot, in the rod. The cutters used are 10 in. in diameter, the center one being provided with inserted blades. These cutters run at 25 r.p.m. with a feed of 0.03 in. per revolution.

The small end of the connecting-rod is milled in the next operation. The rods, two in number, are placed on plugs A and held by means of a wedge (see Fig. 14). The small ends of the rods rest on the post B. The rods are held against the post by means of the clamp C, which is operated by the knurled pin screw D. The gang cutters are 6 in. in diameter and are correctly spaced to machine both sides of the small bosses. The cutters run at 40 r.p.m. with a feed of 0.03 in. per revolution.

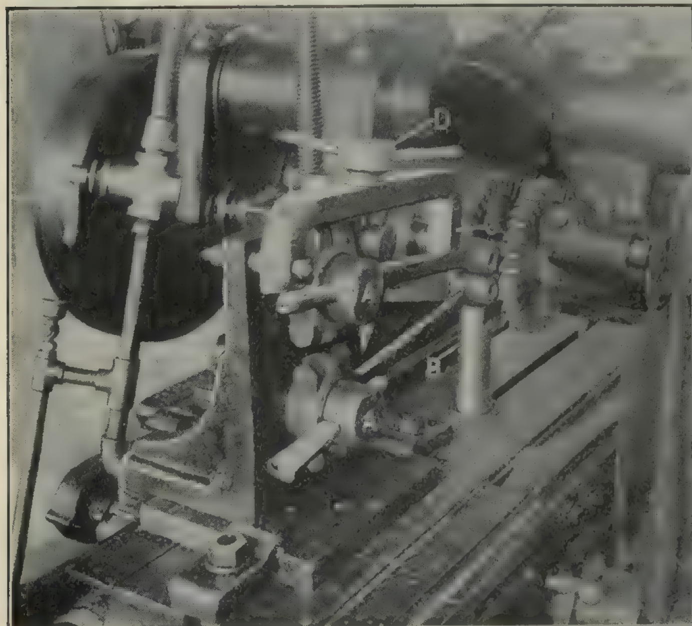


FIG. 14. MILLING SMALL END OF CONNECTING-ROD

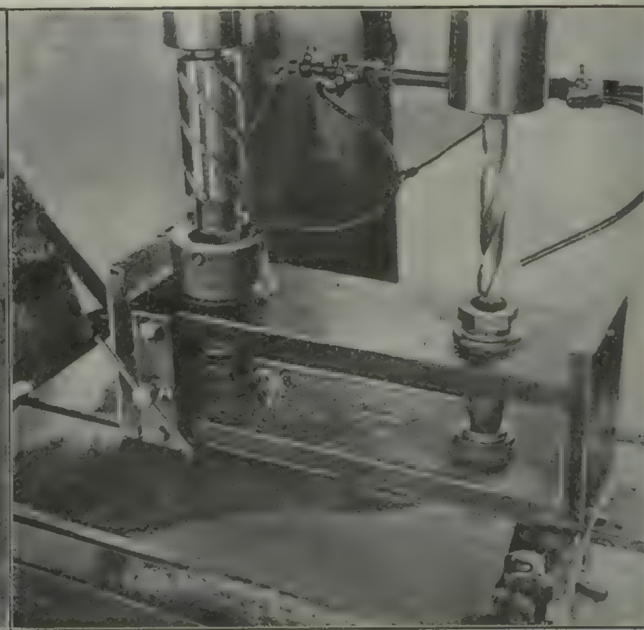


FIG. 15. MACHINING CRANKSHAFT AND WRISTPIN HOLES

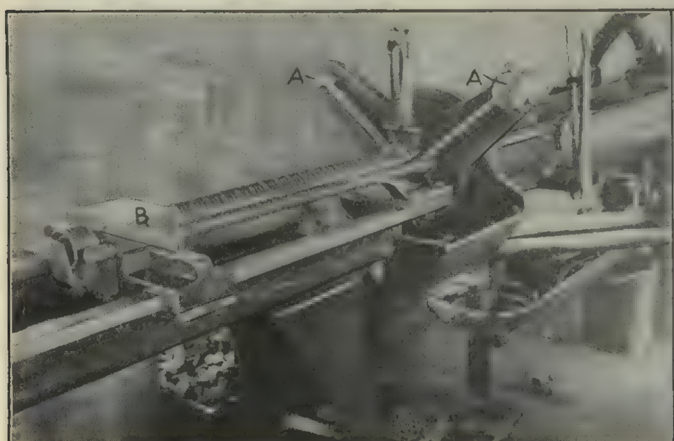


FIG. 16. BROACHING THE CONNECTING-RODS

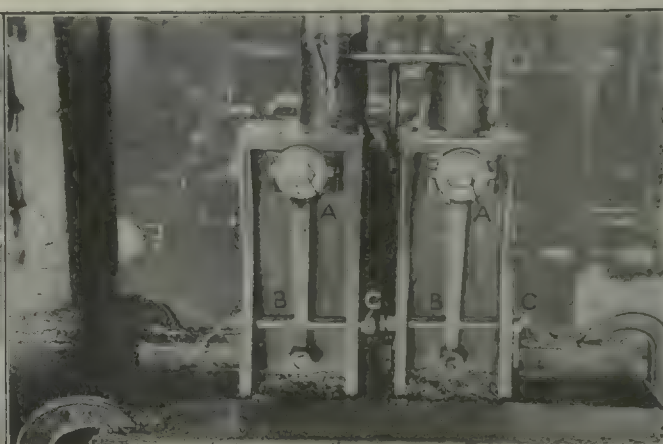


FIG. 17. DRILLING BOLT HOLES IN CONNECTING-RODS

The crankshaft and wristpin holes are machined on the connecting-rod as shown in Fig. 15. The rod is located at the wristpin end by a cup bushing, and at the large end the piece is forced back against an adjustable stop by the pin-headed screw A. The hole at the wristpin end is drilled and the large hole bored, the tools being guided through long bushings. The time required for this operation is 5 min. Both holes are then broached in the two-spindle Lapointe broaching machine shown in Fig. 16. The wristpin hole of one rod and the crankshaft hole of another rod are broached in one opera-

tion. The rods are located on pins A so that the correct distance between the broached holes will be obtained. The broaches are supported at the outer end in long bearings B to overcome any tendency to spring. The production for this operation is 40 rods per hour, each rod having to be reversed so that both holes are broached.

The bolt holes in the rods are drilled in jigs, as shown in Fig. 17. The rods are located on plugs A and held in position by open washers and nuts. The correct location for the holes is obtained by the adjustable screws B, the rods being forced against them by the pin-headed screws C. Two $\frac{7}{16}$-in. holes are drilled and reamed in each rod, the production being 8 per hr. A Sipp drilling machine is used for this operation.

To form the cap at the large end the rods are then sawed apart in the special machine shown in Fig. 18. Eight rods are located on the semi-circular plugs A and held firmly by means of straps at the upper ends. The saw B is mounted on a vertical shaft that runs in long upper and lower bearings. The fixture is kept revolving by means of a worm that meshes with the wormwheel C. By this means the sawing operation is a continuous one, the only work being that of placing the rods on and taking them off the fixture. As the cap is sawed from a rod a wire is placed through one of the bolt holes and the two parts are kept together for assembling the engine. The production for this operation is 15 per hr.

The only operations performed on the cylinders at the factory at the present time are finish-boring and reaming. All other work is being done outside. The finish-boring and reaming operations are performed on Foote-Burt machines, as shown in Fig. 19. The cylinder is located on pins that fit into previously machined holes. The clamp A is tightened on the cylinder by means of a handle at the upper end of the arm B. The boring-tool reamer is at C. The fixture is provided with three stops D and is slid along until the lever E comes in contact with one of these stops, when the cylinder will be in correct alignment for the machining operation. The time required for either finish-boring or reaming a cylinder is 12 min.

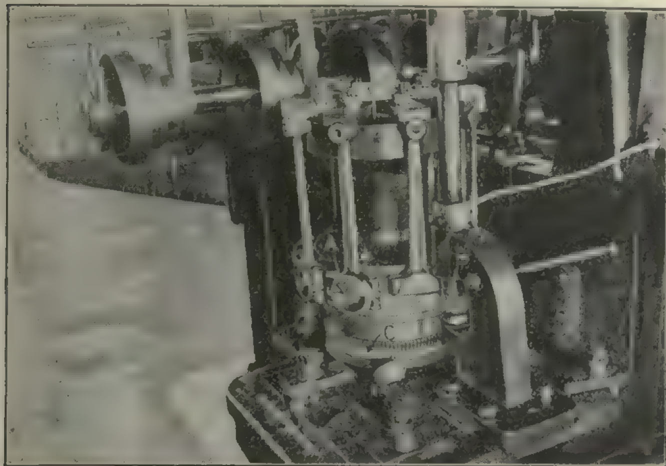


FIG. 18. SAWING CONNECTING-RODS

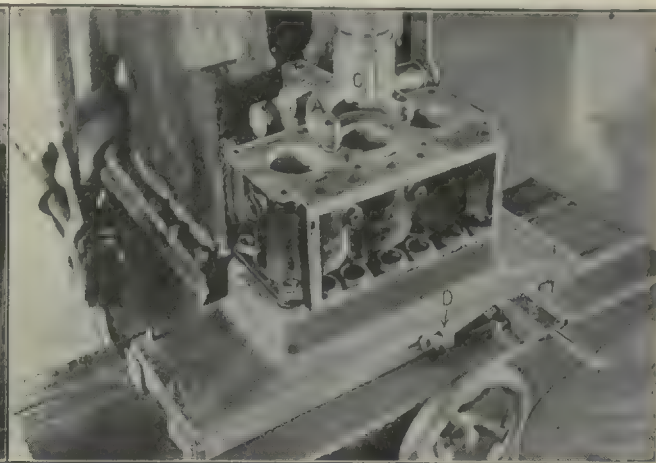


FIG. 19. REAMING THE CYLINDER

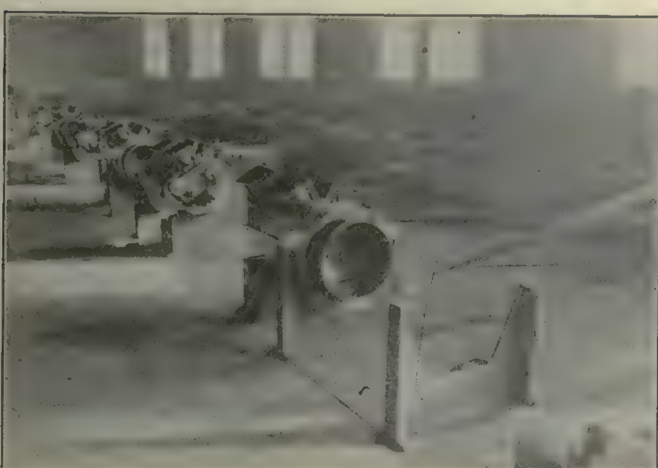


FIG. 20. LAPPING-IN THE ENGINES

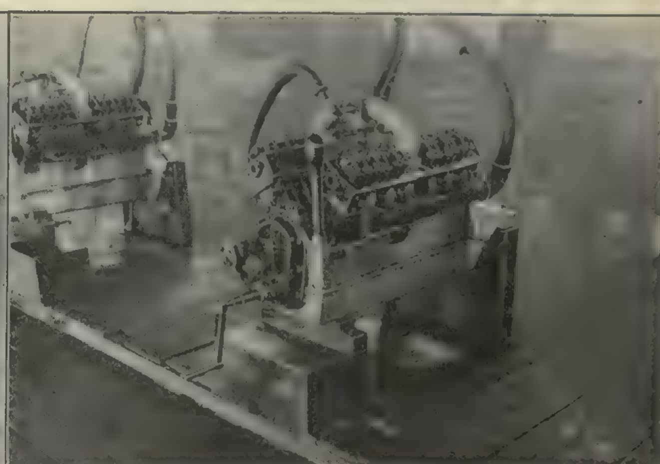


FIG. 21. ENGINE ON BLOCK TEST

After an engine has been assembled, the cylinders are lapped for 12 hr., the flywheel being driven by means of a belt from a horizontal shaft. A view in the department where this lapping is done is shown in Fig. 20. It will be seen that the valve mechanism of the engine is removed. Oil is placed in each cylinder and the lapping continued until a smooth surface is obtained on the pistons and cylinders. After each engine has come up to the inspector's demands on this running-in, the valve mechanism is mounted in position, the only part now left off being the cylinder-head cover.

The engine is then placed on the stand shown in Fig. 21 and given a block test. Here necessary corrections

and adjustments are made until the engine is mechanically satisfactory. Each engine is then tested for about 5 hr. at various speeds to see if any defect can be discovered either in material or workmanship. (As a matter of interest, some of these engines have been run as high as 3950 r.p.m. in this test, to prove their possibilities.)

After an engine has passed the block test, it is given a final dynamometer test, as shown in Fig. 22. Here the engine is in a condition similar to what it would

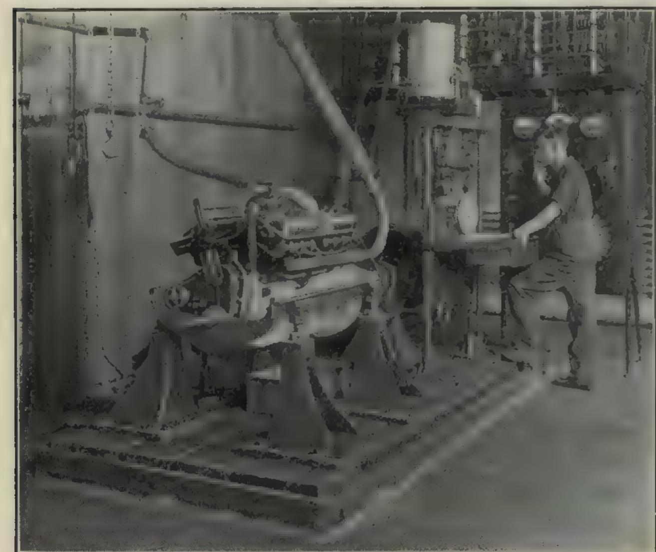


FIG. 22. DYNAMOMETER TEST OF ENGINE

be in when mounted in the chassis. It is tested for brake-horsepower at various speeds and also for gasoline consumption. If the engine comes up to the specified requirements, it is ready to be assembled in a car.

Cutting Internal Dovetails

The two attachments shown are being successfully used on the Potter & Johnston automatic lathe for producing a recess and dovetail (for babbitting purposes) in bushings and bearings having a hole from 3 to 5 in. in diameter.

Previous to using these attachments, the bushing or bearing is rough- and finish-bored and the end is faced with the cross-slide tools. The next indexing of the turret brings the attachment for cutting the recess into position. This attachment is operated by the advance movement of the turret as follows: As soon as the ring *R*, Fig. 1, reaches the bearing or bushing in which the recess is to be cut, the advance of that part of the attachment holding the cutting tool is stopped. The continued advance of the turret and shank *S* gives a sidewise movement to the tool.

When the turret has reached its extreme position, the cutting tool should have cut to the desired depth. In other words, the depth of the recess is governed either by the adjustment of the shank *S* in the turret or by adjusting the cutting tool itself. The locating of the recess from the face of the bearing or bushing is governed by the space blocks *B*. The return movement of the turret, helped by the two compression springs, will naturally start a sidewise movement of the tool holder in the opposite direction, withdrawing the cutting tool and returning the attachment to its neutral position for withdrawal.

To diminish the friction between the revolving work and the tool holder the ring *R* is equipped with a groove suitable for $\frac{5}{16}$-in. balls, the ring being shaped so it will eliminate the danger of chips falling into the groove; the

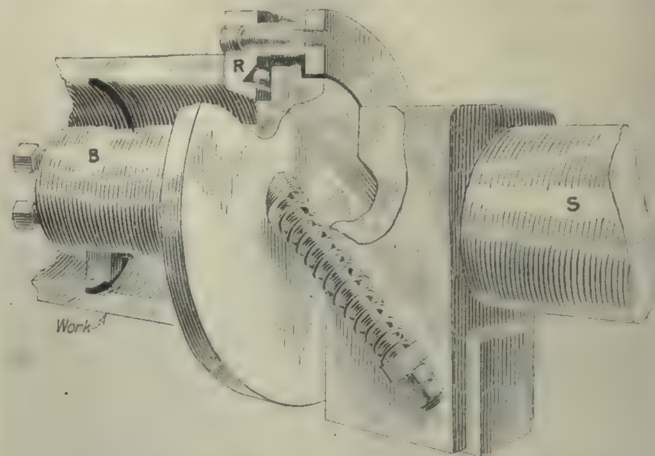


FIG. 1. ATTACHMENT FOR CUTTING THE RECESS

construction of this feature is easily detected from the illustration.

After cutting the recess, the turret is indexed to bring the attachment for cutting the dovetail into position. This attachment is also operated by the advance movement of the turret, although it is somewhat different in construction, as can be seen in Fig. 2. As in the case of the recess attachment, the advance movement of the cutting tool, the slide in which it is held, and the main head of the attachment stop as soon as the ring *R* reaches the revolving work. As the turret and bushing *C* continue

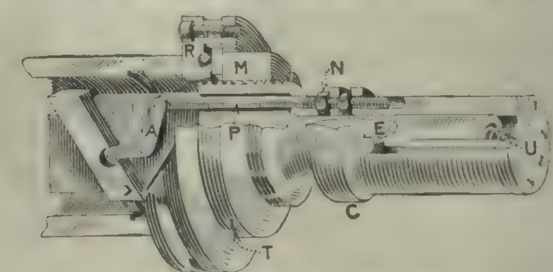


FIG. 2. ATTACHMENT FOR CUTTING THE DOVETAIL

to advance, the cutting tool is pushed sidewise in the desired angular direction through the action of rod *P* and arm *A*.

The full depth of the cut should be reached when the turret has come to its forward position, and may be regulated either by adjusting the bushing *C* or the two nuts *N*. The location of the dovetail from the face of the bushing or bearing is governed by the split collar *M*, this adjustment being secured by unscrewing collar screw *T* and turning the split collar to the right or left as desired.

When the turret starts to return, the heavy spring *U* will keep the ring *R* together with the main part of the attachment in contact with the work until the pin *E* has come to the end of the slot in bushing *C*, and by that time the cutting tool has been withdrawn from the work and the attachment is in neutral position. The pin *E* also serves to keep the main head from rotating in the bushing *C*. This is also equipped with a ball-thrust bearing.

C. H. EGEN,
Chief Engineer, Philadelphia Engineering Co.
Philadelphia, Penn.

Problems in Airplane Construction*

Very comprehensive was the paper on airplane construction, combining the experience of Capt. V. E. Clark, chief aëronautic engineer, United States Army; Capt. T. F. Dodd, Signal Corps, U. S. A.; and O. E. Strahlmann, engineer of the chief signal officer for department. It covers a wide scope and brings out some important problems in airplanes for military uses. Many of these same problems exist in airplanes for commercial or sporting purposes.

The paper discusses six types of machines. "Strategical-reconnoissance" machines should have a fuel capacity for a flight of at least 500 mi. without stop at an average speed of not less than 80 mi. per hr. This means a fuel load of between 700 and 800 lb. and a military load of about 600 lb., so that with a 200-hp. motor the complete airplane fully loaded will weigh over 3500 lb.

The "tactical-reconnoissance" machine should have a fuel capacity for a continuous flight of at least 250 mi. at a speed of not less than 85 mi. per hr. The military load will be about the same as before; but the fuel will weigh only 225 lb., and a power plant of 125 hp. will be sufficient, so that the complete machine will weigh about 2400 lb.

Slow Machine for Fire Control

The third type of machine is for field-artillery fire control. While this work can be performed by the type of machine just referred to, a slower machine will probably be more satisfactory, as one of its primary requirements is an extremely good field of vision. The motor can be of 125 hp. or less.

"Long-range bombing" machines present a more difficult problem, owing to the heavy load with which the machine must climb at the start. The fuel capacity should permit a nonstop flight of at least 400 mi. and starting with a load of bombs weighing 400 lb. The machine should be capable of defending itself from hostile aircraft, so as to operate independently of escort. It will require at least 250 hp., and 300 or even 350 would not be too great. With 300 hp. 900 lb. of fuel will be needed. The total military load will be about the same, making the total weight between 5000 and 6000 lb.

The "pursuit" machine is to attack and drive away all hostile airplanes of any of the three types already mentioned, to prevent them from accomplishing their purpose. These machines, which differ from the types mentioned in that they are solely occupied with events in the air, are at present divided into one- and two-man machines.

Fast Pursuit Machine

The one-man machine carries fuel for two hours at a full speed of about 130 mi. per hr. The pilot controls the machine and operates the machine gun or guns, usually aiming the gun by pointing his machine. The main features are rapid climbing, high speed and the greatest possible maneuvering or dodging ability. Low weight per horsepower is essential in the motor, even at the sacrifice of reliability to some extent. Between 90 and 130 hp. is desired. At present, the great majority of motors in this type of machine are of the rotary air-cooled design. The two-man machine carries fuel for three hours at full speed of 110 mi. per hr. It requires a motor of from 110 to 160 hp.; but as it is necessarily larger and less easily handled in quick maneuvering, it is losing popularity in favor of the one-man type.

The airplane for "over-sea reconnoissance" is a long-range airplane, which must carry fuel for six hours at 75 mi. per hr., or more. It must carry two men, a wireless transmitting set, and navigating instruments. The 300-hp. motor of the bomber is satisfactory for this, the greatest requirement being reliability and fuel efficiency. A similar short-range machine carries fuel for three or four hours at the same speed and has the same equipment. It is difficult to see, however, why a 200-hp. motor should be recommended when the only difference is the shorter period of flight.

Details of Construction

The paper then goes on to discuss the use and arrangement of two propellers, methods of reducing vibration, starting motors for engines, gasoline-supply systems, metal construction for airplanes, flexible piping, and muffler requirements. A good muffler that will be of light weight and not cause appreciable back pressure is highly desirable, as in military service a hostile airplane is usually first discovered by the noise of its exhaust.

Shock absorbers for landing gears, brakes to reduce the run of the airplane after touching the ground, landing gear that will fold into the body of the plane during flight and so reduce air resistance, gasoline-supply gage, fire-safety device and altitude adjustment for carburetors are other points under discussion.

A system of firing machine guns through the propeller, or more properly between the propeller blades, by operating the gun directly from the camshaft of the motor, is also mentioned. With this mechanism the firing pin of the gun should strike the primer at the instant the rear edge of the blade passes the line of fire of the gun, two-bladed propellers being used for this work.

Material for absorbing vibration for the support of radiators, a method of permitting the pilot to adjust the amount of cooling done by the radiator in order to compensate for changes in temperature of air or changes in speed through the air and variable canvas wings to allow for lower landing speeds are also discussed. Propellers with variable pitch angles are suggested to secure increased mileage with the same fuel supply; ignition systems, fuel supply and cooling systems are all treated in considerable detail.

Improvements in Design

Among the questions of design considered are the use of shims under the caps of crankpin and crankshaft bearings. This is held to be extremely poor practice, for, although not pointed out in the paper, the flying corps do not have trained mechanics to overhaul motors. The various suggestions seem to be very practical, but many motor engineers will disagree with the contention that a good job can only be secured by having the caps fitted solid to the crank case without the use of shims for taking up wear, where mechanics are available.

It is contended that many American crank cases are not sufficiently rigid in construction or built with proper care. This is attributed to some of the jigs for boring crankshaft and camshaft bearing seats not being as accurate as they should be. In some cases it has been found that pistons are not of uniform weight and are

*Abstract of paper presented at Society of Automobile Engineers' meeting.

not carefully made. Another cause of trouble is the lack of interchangeability of parts and careless workmanship, claimed to have been the great fault of this country. The oiling system should be by pressure to all important bearings, preferably from a gear pump. Screens should protect the suction pump. For engines that have push-rod and rocker-arm valve mechanism, means should be provided to reduce the friction on the exhaust-valve rocker-arm bearing, especially if the valves are more than 1¼ in. in diameter.

Ignition Systems

All military airplanes, except possibly the pursuit type, should have two complete and independent ignition systems. Motors larger than 140 hp. should have a booster system for starting on battery spark, if a starter is not provided. It is believed that our magnetos would have a much longer life if a more suitable shock-absorbing device was provided between the driving gear and the magneto shaft. A magneto mounting should be so machined that the magneto shaft will be exactly in line with its driving shaft, and dowel pins should be used to preserve this alignment. No shims should be used here.

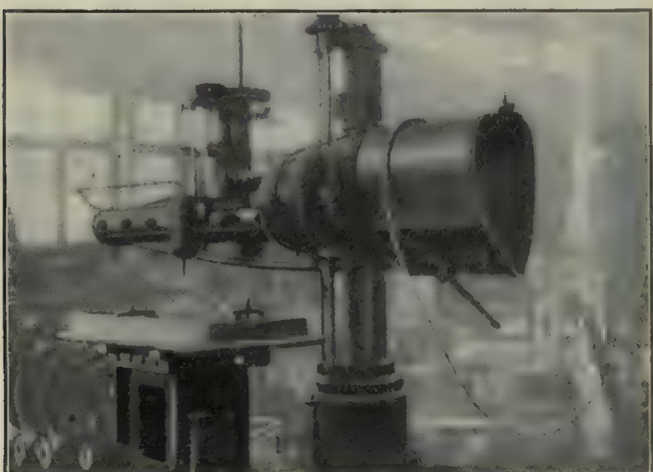


FIG. 1. REAR OF DIRECT-CONNECTED RADIAL DRILLING MACHINE

Considerable trouble has been experienced because of nonuniform and warped carbon brushes.

Carburetors should be located in such a way that oil, water and impurities cannot enter. They should be supported from the engine and not from the framework of the airplane and should be independent of the intake manifold, if feasible.

Gaskets for connection in the intake manifold should be as thin as practicable. Manifolds built of brazed copper or of welded steel are preferable to castings. Steel manifolds are considered best, but should of course be heat-treated after welding. It is also urged that more study and care should be put into the design of manifolds, relating to the shape and finish of the interior of intake passages. It is believed in this connection that much greater efficiency can be obtained by attention to fluid flow.

Radiators should preferably be placed at the leading edge of the upper wing, the header being shaped so as to form part of this leading edge. If it is necessary to place the radiator between the engine and the propeller, the radiator should be circular. The radiator should be provided with a sufficient number of points of support to prevent the deformation of the shell owing to shock on landing.

Care should be taken with the alignment of tubes at the connections in the water-circulating system. A ring reinforcement might be welded to a flange end of the thin tubing and the base machined so as to make a good fit into the cylinder jacket. It is considered bad practice to expand thin tubing.

Direct-Connecting a Belt-Driven Radial Drilling Machine

By J. W. Swaren

A belt-drive radial drilling machine has recently been rebuilt in the shops of the Pelton Water Wheel Co. in a manner increasing its usefulness as well as its capacity.

A gear box, housing a gear combination permitting five speed changes, is mounted opposite the radial arm (see Fig. 1). A 7½-hp. variable-speed motor, with its pinion meshing on the geared countershaft, is mounted on the back of the gear box and frame. A band brake, similar to a crane brake, is set between the pinion and the

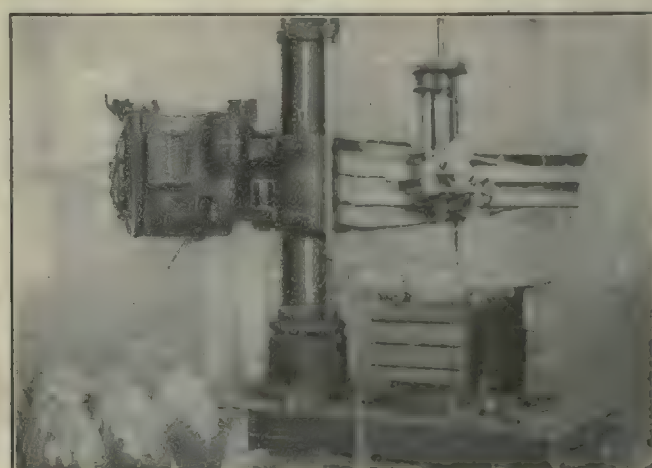


FIG. 2. FRONT VIEW OF GEAR BOX OF RADIAL DRILLING MACHINE

motor frame. This brake is solenoid operated. It is connected to the controller, which is mounted on the front of the gear box, in a place convenient to the operator.

The gear combinations are operated by a lever working in slots cut in the front wall of the gear box (see Fig. 2). A second lever controls the gear dowel pin, which must be released before the gears can be changed. The electric controller has 12 speed points, which combine with the five speed combinations of the gear box. Current for the motor is carried in a cable armored with flexible conduit.

Imports of the United States from Liege

The articles invoiced at the American consulate at Liege, Belgium, for the United States decreased in value from $685,029 for 1915 to $221,350 for 1916. The principal items entering into this trade were cream separators and parts, the shipments of which were valued at $114,647 for 1916, against $199,046 for 1915, and woolen goods amounting to $98,149, against $465,405 worth for 1915.

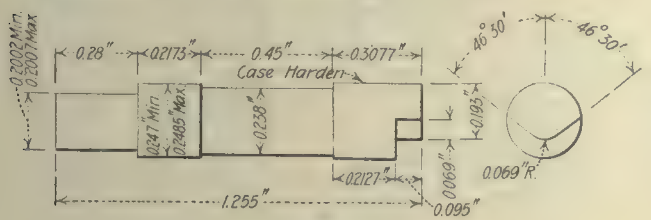
United States Munitions

The Springfield Model 1903 Service Rifle

Safety-Lock Spindle and Plunger

SYNOPSIS—These are small details but require several interesting operations. The spindle is largely an automatic screw machine job, the plunger entirely so. The thumb-piece is a drop forging and is finished all over, mostly by milling operations; some of the fixtures and gages are of special interest.

One of the difficulties of these small parts is to hold them while being machined. Special-jawed fixtures are used so as to insure their being held firmly and in proper position. The irregular outline of the thumb-piece makes it a bit troublesome but it is held easily in the various fixtures which have been designed with all the difficulties in view.



STEEL

FIG. 1100

OPERATIONS ON SAFETY-LOCK SPINDLE

Operation
1 Automatic
2 Profiling
3 Burring

OPERATION 1. AUTOMATIC

Transformation—Fig. 1101; sequence of operations, Fig. 1102. Machine Used—Gridley automatic, 1-in. stock. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Tool-Holding Devices—Regular tool holder. Cutting Tools—See Fig. 1102. Number of Cuts—Four. Cut Data—300 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 1103; A, lengths and one diameter; B, diameters and shoulders. Production—112 per hr.

OPERATION 2. PROFILING

Transformation—Fig. 1104. Machine Used—Pratt & Whitney No. 1 propeller, Fig. 1105; work at A, form at B; machining diagram, Fig. 1106. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws. Tool-Holding Devices—Taper shank. Cutting Tools—End mill. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1107, profile. Production—125 per hr.

OPERATION 3. BURRING

Number of Operators—One. Description of Operation—Removing burrs thrown up by profile cutter. Apparatus and Equipment Used—File and speed lathe. Production—1,000 per hr.

FIG. 1101

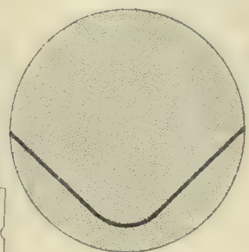


FIG. 1104

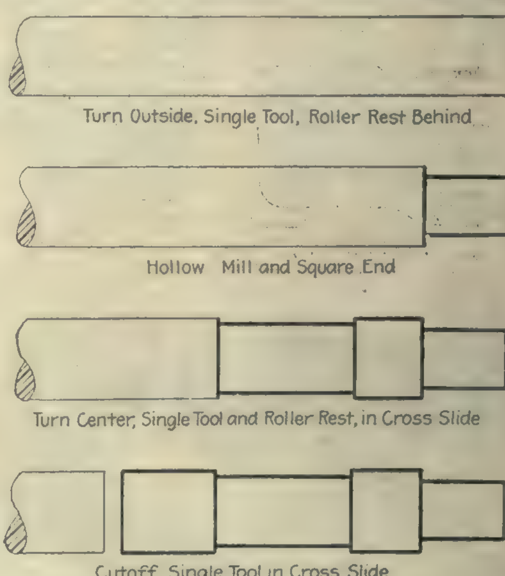


FIG. 1102

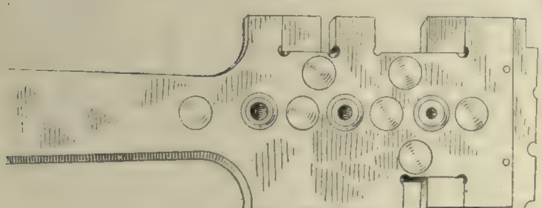


FIG. 1103A

FIG. 1103 B

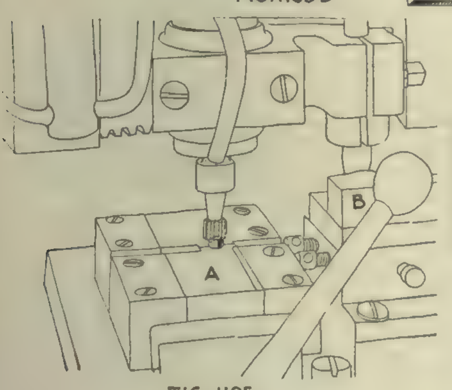


FIG. 1105

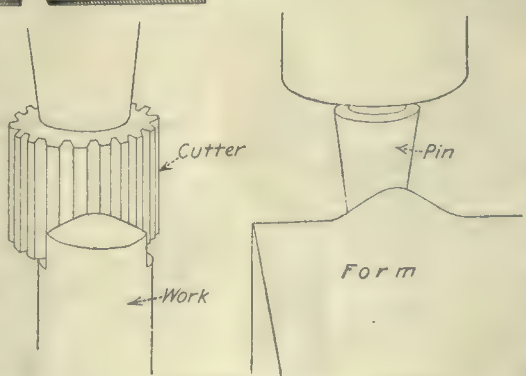


FIG. 1106

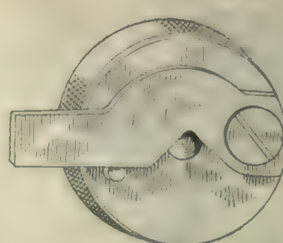


FIG. 1107

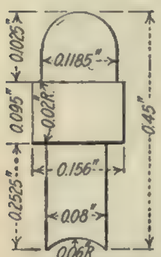
FIG. 1101, 1102, 1103, OP. 1 - FIG. 1104, 1105, 1106, 1107 OP. 2

OPERATIONS ON SAFETY-LOCK PLUNGER

Operation
1 Automatic
2 Burring

OPERATION 1. AUTOMATIC

Transformation—See tool layout, Fig. 1108-A. Machine Used—Hartford automatic, ½-in. hole in spindle. Number of Operators per Machine—One. Work-Holding Devices—Draw-back chuck. Cutting Tools—Box tools and cutoff. Number of Cuts—Three. Cut Data—900 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tools Between Grindings—800 pieces. Gages—Ring and length. Production—60 per hr.



STEEL.(Harden)
FIG.1108

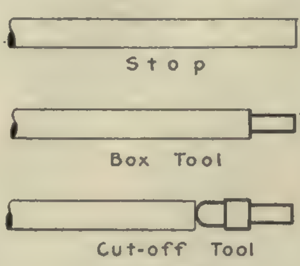
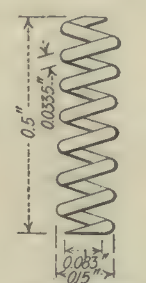


FIG. 1108A

OPERATION 2



14 Coils per inch
STEEL WIRE
FIG.1109

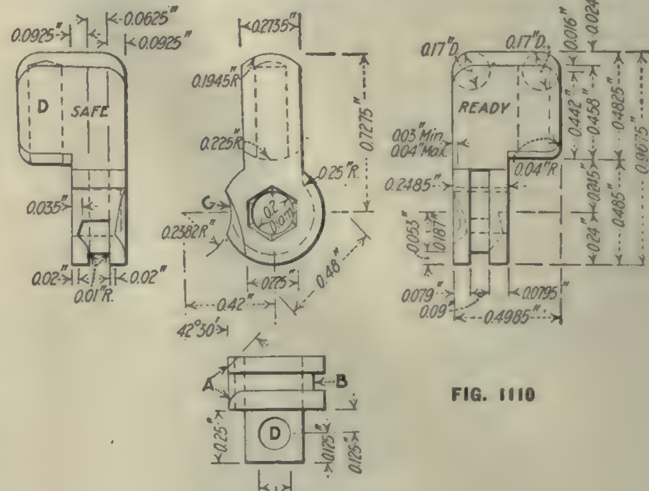
Safety Lock and Component Parts

The safety lock controls the firing mechanism and locks the bolt either in a safe position or so it can be fired at will. It consists of a thumb-piece, spring, spindle and plunger for holding it in either position. It has the cam *A*, Fig. 1110, locking groove *B*, the cocking-piece clearance groove *C* and the plunger hole *D*. The spring and plunger are at right angles to the spindle and hold it in either "safe" or "ready" position, as may be desired.

The thumb-piece is riveted to the end of the spindle, Fig. 1100. Safety lock, plunger and spring are shown in Figs. 1108 and 1109.

This riveting is done in a special fixture shown in Fig. 1157, the end of the spindle being headed over into the recess cut in the outer end of the thumb-piece and shown in Fig. 1110. This recess is cut in a special fixture, Fig. 1129, with a double angular cutter, Fig. 1130, instead of being punched or swaged as in the case of the cocking piece.

Several rotating or oscillating fixtures are used for rounding corners and there is likewise a side counter-boring operation for clearing the bolt cocking piece on the



STEEL (Case Harden)
FIG. 1110

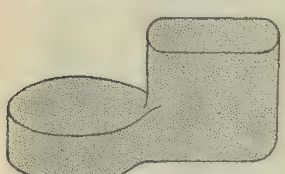
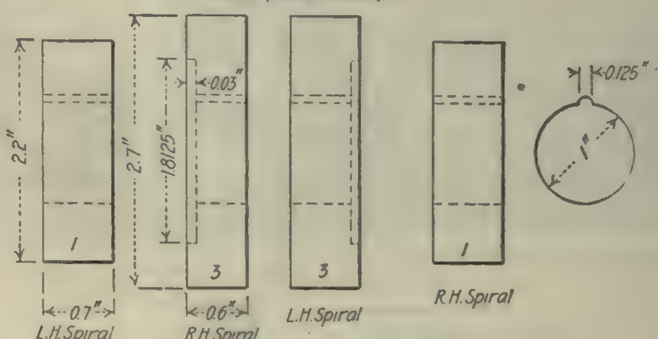


FIG.1111,OP.A


FIG.1112



24 Teeth, L.H.-Spiral 1 Turn in 68.57"
Mill Nº1-Teeth on Face Only. Nº3-Face and Side
FIG.1116

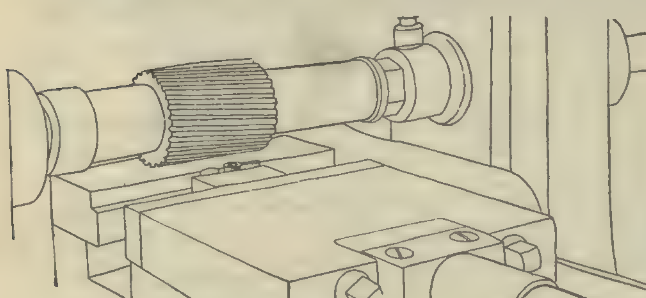


FIG.1113


FIG.1117

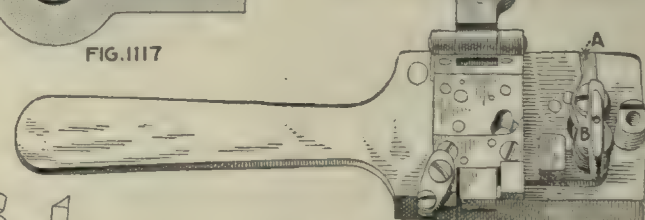


FIG.1118

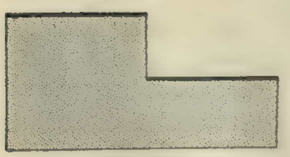


FIG.1114

FIG.1112,1113,OP.1
FIG.1114,1115,1116,OP.5
FIG.1117,1118,1119,OP.2

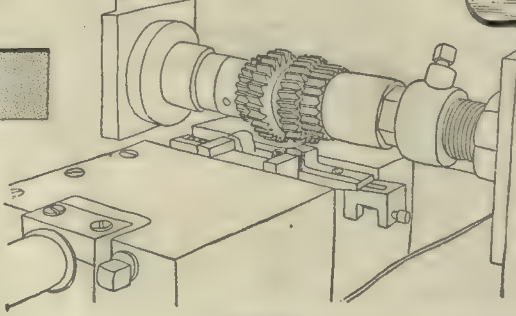


FIG.1115

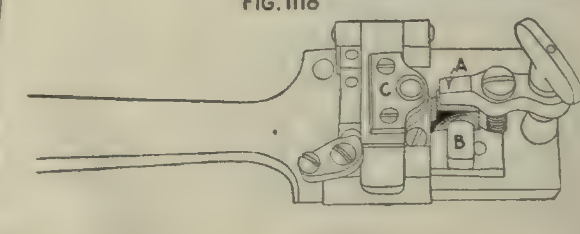


FIG.1119

bolt. This is easily done in the fixture shown in Fig. 1141.

Leaf jigs are used for drilling and have several advantages for work of this kind on small pieces. Leaf gages are also used to gage test the cams and other important corners of the thumb-piece.

The stamping of both sides at once is also of interest. A special holder carries one punch while the ram carries the other. By laying the thumb-piece in position on the lower punch and tripping the press, both names "Ready" and "Safe" are stamped at the one operation.

The nesting or interlocking of cutters is practiced quite extensively in nearly all milling operations on rifle work. The milling-cutter illustrations, such as Fig. 1123, show exactly how this is done and give all dimensions

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1111. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—250 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal; heated to 850 deg. C. (1,562 deg. F.); left overnight to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnaces; oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then left in the pickling solution (1 part sulphuric acid and 9 parts water) for 10 or 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

OPERATION C. TRIMMING

Machine Used—Perkins press, 2½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Punched down through die. Production—600 per hr.

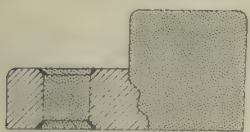


FIG. 1120, OP. 2A

FIG. 1121

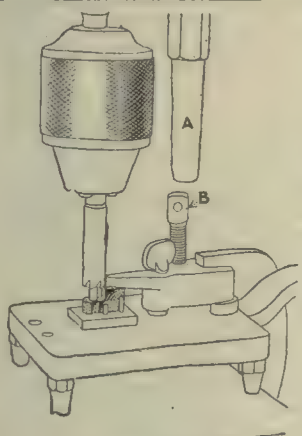


FIG. 1126

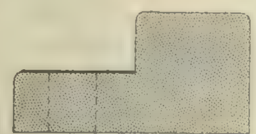
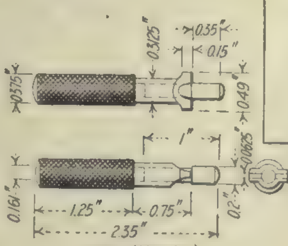


FIG. 1125



STEEL (Harden)
FIG. 1127

OPERATION 10

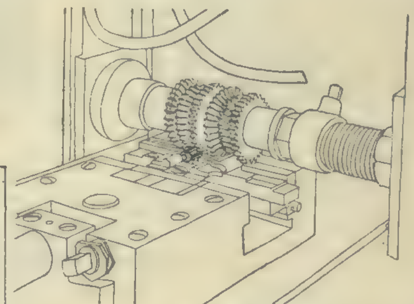
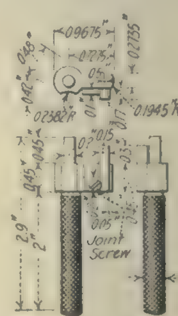
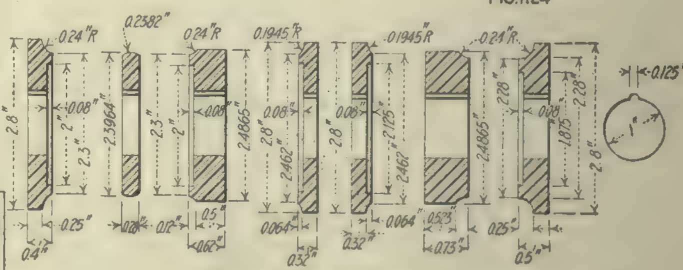


FIG. 1122



Harden
FIG. 1124



28 Teeth, L.H. for New Fixtures
" " R.H " Old

FIG 1123
OPERATION 3 & 4

necessary for making cutters. Where cutters are regular, with no special features, it is only necessary to mention them by diameter and width in the text.

OPERATIONS ON SAFETY-LOCK THUMB-PIECE

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
1	Milling rear end
5	Milling front edge
2	Drilling and reaming spindle hole
2-A	Countersinking hole for operations 3 and 4
AA	Removing burrs from spindle
3	Milling top
4	Milling bottom
CC	Removing burrs left by operation 4
10	Counterboring front of hub
7	Hand-milling for riveting spindle
11	Drilling and reaming spring-spindle hole
12	Hand-milling front and rear corners
EE	Removing burrs left by operation 12
14	Hand-milling circle over spring-spindle hole
9	Jig-milling clearance for cocking piece (operations 9 and FF grouped)
FF	Removing burrs left by operation 9
15	Profiling slot
13	Hand-milling rear cam
16	Milling front cam (on drilling machine)
6	Stamping "Ready" and "Safe" (operations 6, 8 and GG grouped)
8	Hand-milling rear end to finish
GG	Removing burrs from spring-spindle hole
17	Countersinking spring-spindle hole
18	Polishing sides, lower end and over circle
19	Filing, general cornering, matching milling cuts front of joint
20	Casehardening
21	Assembling with spindle, spring and spring spindle
22	Polishing rear end
23	Etching rear end

OPERATION 1. MILLING REAR END

Transformation—Fig. 1112. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 1113. Number of Operators per Machine—One. Work-Holding Devices—In formed vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Spiral milling cutter. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—125 per hr.

OPERATION 5. MILLING FRONT EDGE

Transformation—Fig. 1114. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 1115. Number of Operators per Machine—One. Work-Holding Devices—Special vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Two spiral milling cutters, Fig. 1116. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—For thickness of round end. Production—125 per hr.

OPERATION 2. DRILLING AND REAMING SPINDLE HOLE

Transformation—Fig. 1117. Machine Used—Run on any two-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Figs. 1118 and 1119. Tool-Holding Devices—In drill chuck. Cutting Tools—Drill and reamer. Number of Cuts—Two. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Plug, 0.02 in. in diameter. Production—125 per hr.

OPERATION 2-A. COUNTERSINKING HOLE FOR OPERATIONS 3 AND 4

Transformation—Fig. 1120. Machine Used—Bench lathe. Number of Operators per Machine—One. Work-Holding Devices—In hand. Tool-Holding Devices—Drill chuck. Cutting Tools—Countersink. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,500 pieces. Gages—None. Production—Grouped with operation 2.

OPERATION AA. REMOVING BURRS FROM SPINDLE HOLE

Number of Operators—One. Description of Operation—Removing burrs from spindle hole. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operation 2.

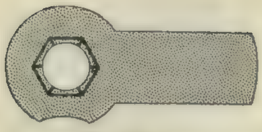


FIG. 1128

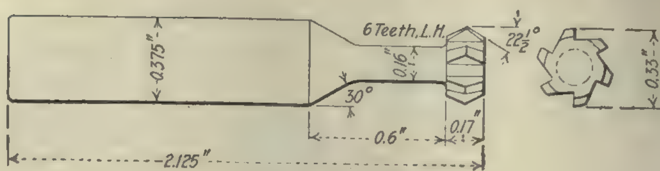


FIG. 1130

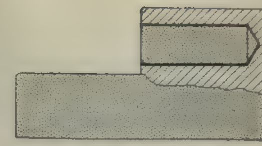


FIG. 1131

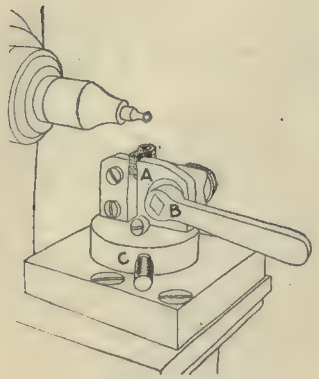


FIG. 1129

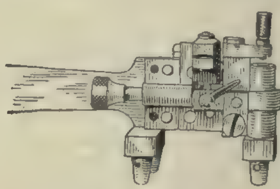


FIG. 1132

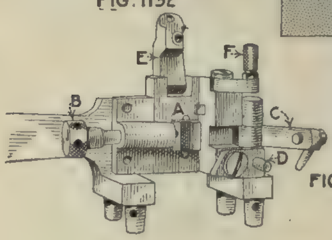


FIG. 1132A, OP. 11

FIG. 1133

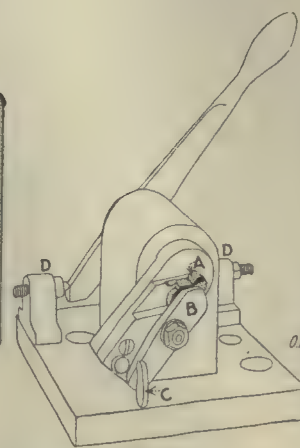


FIG. 1134

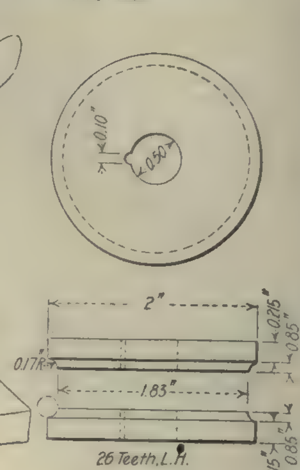


FIG. 1135

FIG. 1128, 1129, 1130, -OP. 7. FIG. 1131, 1132, 1132A, OP. 11
FIG. 1133, 1134, 1135, OP. 12

OPERATION 3. MILLING TOP

Transformation—Fig. 1121. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 1122. Number of Machines per Operator—Two. Work-Holding Devices—On stud clamped with vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1123. Number of Cuts—One. Cut Data—80 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—See Fig. 1124; thickness and location of side with center hole. Production—125 per hr.

OPERATION 4. MILLING BOTTOM

Transformation—See Fig. 1121. Machine Used—Pratt & Whitney No. 2 Lincoln type. Number of Machines per Operator—Two. Work-Holding Devices—On stud clamped with vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, see Fig. 1123. Number of Cuts—One. Cut Data—30 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1124. Production—125 per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 4.

OPERATION 10. COUNTERBORING FRONT OF HUB

Transformation—Fig. 1125. Machine Used—Ames three-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1126. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore, Fig. 1126. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grinding—3,500 pieces. Gages—Fig. 1127; thickness and diameter of counterbore. Production—300 per hr.

OPERATION 7. HAND-MILLING FOR RIVETING SPINDLE

Transformation—Fig. 1128. Machine Used—Garvin No. 3 hand miller, Fig. 1129. Number of Operators per Machine—One. Work-Holding Devices—On stud in indexing fixture; jaw A is operated by cam B; index at C; see Fig. 1129. Tool-

FIG. 1136

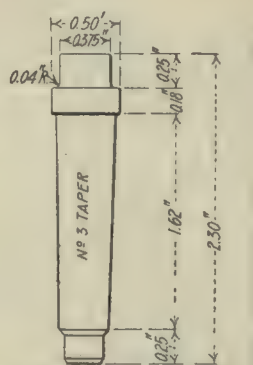


FIG. 1138 8 Teeth, L.H.

FIG. 1140

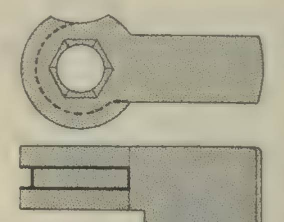


FIG. 1142

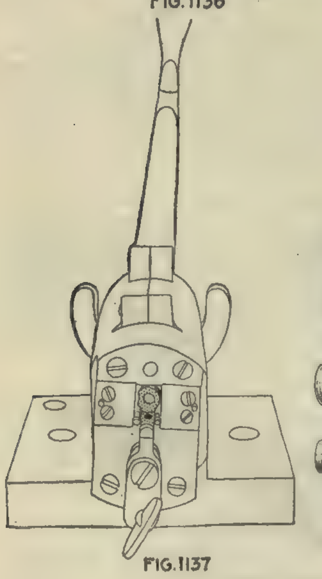


FIG. 1137

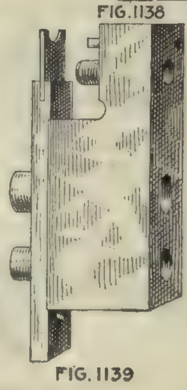


FIG. 1139

OPERATION 14

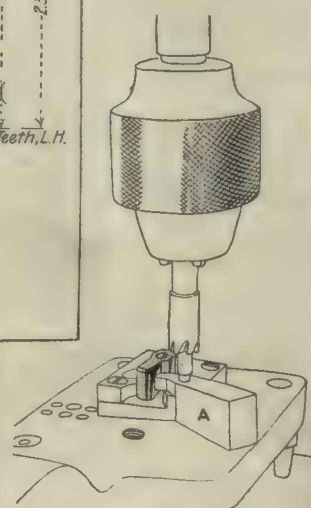


FIG. 1141-OP. 9

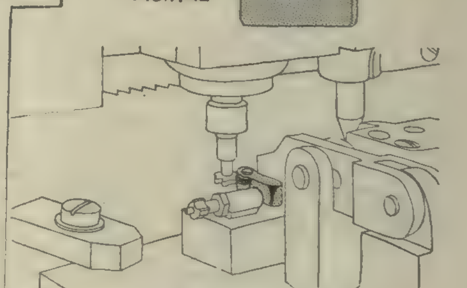


FIG. 1143

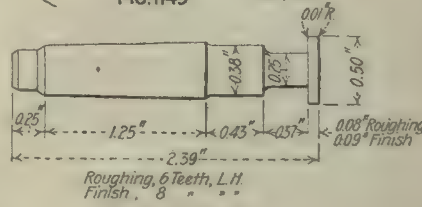


FIG. 1144-OP. 15

Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1130. Number of Cuts—Three. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—325 per hr.

OPERATION 11. DRILLING AND REAMING SPRING-SPINDLE HOLE

Transformation—Fig. 1131. Machine Used—Ames two-spindle 14-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Figs. 1132 and 1132-A. Tool-Holding Devices—Drill chuck. Cutting Tools—Bottoming reamer. Number of Cuts—Two. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Diameter and depth. Production—75 per hr.

OPERATION 12. HAND-MILLING FRONT AND REAR CORNERS

Transformation—Fig. 1133. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 1134; work held at A by finger clamp B and screw C; rotated by handle D. Tool-Holding Devices—Taper shank. Cutting Tools—Fig. 1135 Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,500 pieces. Gages—Form. Production—350 per hr.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 12

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 12. Apparatus and Equipment Used—File. Production—Grouped with operation 12.

OPERATION 15. PROFILING SLOT

Transformation—Fig. 1142. Machine Used—Pratt & Whitney No. 1 profiler, Fig. 1143. Work-Holding Devices—Stud and finger clamps. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1144. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Width and depth of groove. Production—75 per hr.

OPERATION 13. HAND-MILLING REAR CAM

Transformation—Fig. 1145. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—On stud by screw clamp, Fig 1146. Tool-Holding Devices—Taper shank. Cutting Tools—Small milling cutter. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—See Fig. 1150. Production—350 per hr.

OPERATION 16. MILLING FRONT CAM (ON DRILLING MACHINE)

Transformation—Fig. 1147. Machine Used—Ames 16-in. single-spindle upright drilling machine, Fig. 1148. Number of Operators per Machine—One. Work-Holding Devices—Rotating jig. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1149. Number of Cuts—Three. Cut Data—1,800 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1150; A, gaging rear cam; B, gaging front cam. Production—75 per hr.

OPERATION 6. STAMPING "READY" AND "SAFE"

Machine Used—Snow-Brooks press, 1-in. stroke, Fig. 1151. Number of Operators per Machine—One. Punches and Punch Holders—Square shank; stamps "Ready" and "Safe," Fig. 1152. Dies and Die Holders—Centered on pin. Average Life of Punches—Indefinite; been used three years already. Production—400 per hr.

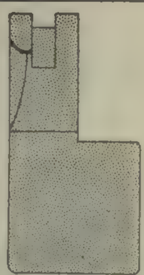


FIG. 1145

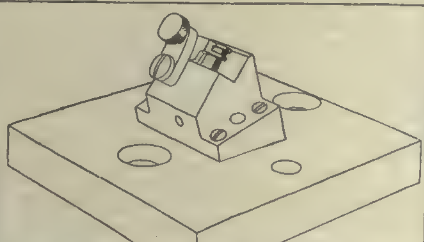


FIG. 1146

OPERATION 13

FIG. 1147

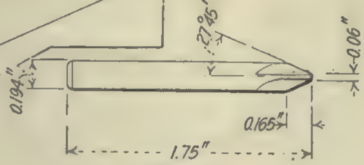


FIG. 1149

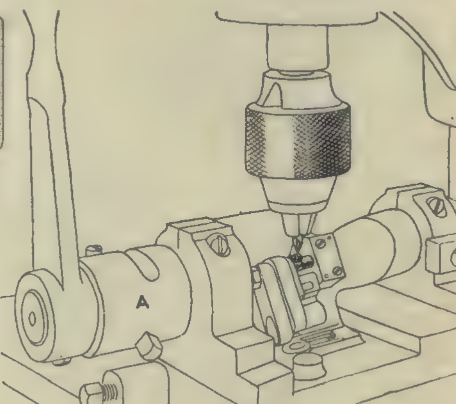


FIG. 1148

FIG. 1150A

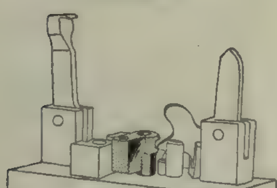


FIG. 1150B

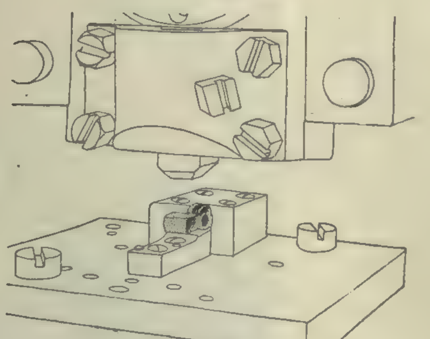


FIG. 1151

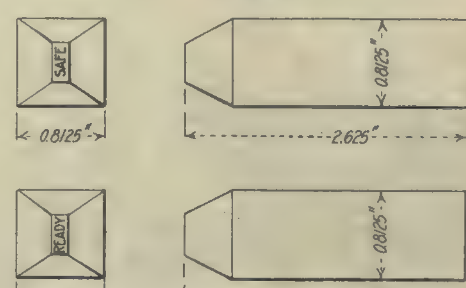


FIG. 1152

OPERATION 16

OPERATION 14. HAND-MILLING CIRCLE OVER SPRING-SPINDLE HOLE

Transformation—Fig. 1136. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—On stud in rotating fixture, Fig. 1137. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1138. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,500 pieces. Gages—Fig. 1139. Production—350 per hr.

OPERATION 9. JIG-MILLING CLEARANCE FOR COCKING PIECE

Transformation—Fig. 1140. Machine Used—Ames three-spindle 16-in. drill. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1141; pilot of counterbore fits a hardened bushing in the jig. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore with pilot. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—None. Production—250 per hr.

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 9

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 9. Apparatus and Equipment Used—File. Production—Grouped with operation 9.

OPERATION 8. HAND-MILLING REAR END TO FINISH

Transformation—Fig. 1153. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 1154. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, 1.25 in. in diameter, 0.5 in. wide. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Length, Fig. 1155; work goes over a stud. Production—250 per hr.

OPERATION GG. REMOVING BURRS FROM SPRING-SPINDLE HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around spring hole. Apparatus and Equipment Used—Scraper. Production—Grouped with operation 8.

OPERATION 17. COUNTERSINKING SPRING-SPINDLE HOLE

Number of Operators—One. Description of Operation—Removing sharp corners. Apparatus and Equipment Used—Speed lathe and countersink. Production—425 per hr.

OPERATION 18. POLISHING SIDES, LOWER END AND OVER CIRCLE

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Polishing jack and wheel. Production—50 per hr.

OPERATION 19. FILING, GENERAL CORNERING, MATCHING MILLING CUTS FRONT OF JOINT

Number of Operators—One. Description of Operation—General filing and cornering. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATION 20. CASEHARDEN

Number of Operators—One. Description of Operation—Packed in ¾ bone and ¼ leather; heated in oil furnace to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quenched in water. Apparatus and Equipment Used—Rockwell furnaces.

OPERATION 21. ASSEMBLING WITH SPINDLE, SPRING AND SPRING SPINDLE

Transformation—Fig. 1156. Number of Operators—One. Description of Operation—Assembling spindle and spring. Apparatus and Equipment Used—Special press, Fig. 1157. Production—50 per hr.

OPERATION 22. POLISHING REAR END

Number of Operators—One. Description of Operation—Polishing rear end. Apparatus and Equipment Used—Polishing jack and wheel. Production—1,200 per hr.

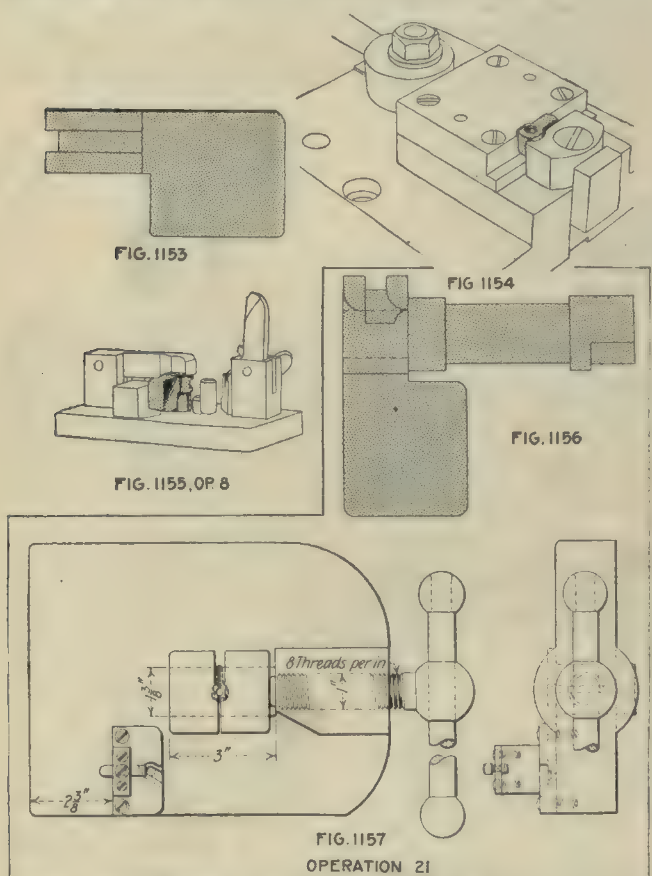


FIG. 1153 FIG. 1154 FIG. 1155, OP. 8 FIG. 1156 FIG. 1157 OPERATION 21

OPERATION 23. ETCHING REAR END

Number of Operators—One. Description of Operation—Same as cocking piece. Production—700 per hr.

Does It Pay To Put One Over on the Boss?

By A. H. Willey

Does it pay to fool the boss? Not everybody does—but there are some who try to, and occasionally do. We all make mistakes, sometimes become careless and nearly spoil or do spoil some work, then try to cover it up without letting the boss get wise. Maybe it is a driving fit on a shaft or a key, and it has been made too small. Then it is roughed up with prick-punch marks all around and driven that way.

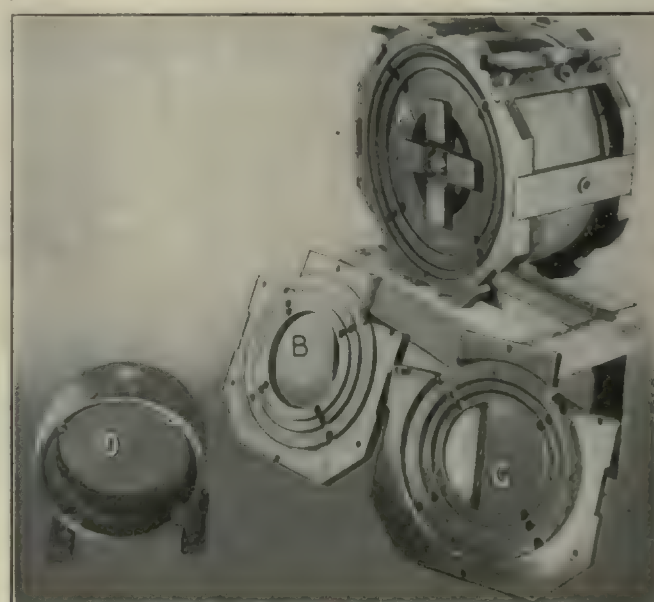
I know of a near accident caused by a key working out of a big gear in an overhead traveling crane that was carrying a small casting about 10 ft. from the floor. Down came the casting. I thought of what might have happened if the crane had been traveling through the shop over the heads of some of the men. The key, when examined, showed that it had been roughed up by a careless mechanic and driven in that way, evidently for the purpose of making it hold.

Many a loose wristpin has caused engine troubles because of improper shrink fit that the foreman did not know about. Poor work covered up so that you get by, hurts your employer's reputation when it is discovered after leaving the shop. If you slip up on a piece of work, tell your foreman about it. Do not be afraid of getting fired. Take a chance that he is fair and will help you.

Simple Method for Drilling Electric-Motor Frames

The jigs here shown for drilling electric-motor frames are as simple and have as wide a range as almost any that could be devised, and at the same time they are comparatively inexpensive. They are used by the Reno-Kaetker Electric Co., Cincinnati, Ohio. This firm makes a wide range of electric motors of various types for all purposes.

At *A* is shown a complete jig, consisting of two bushing plates and crosspieces, clamped to a motor frame.



DRILLING ELECTRIC-MOTOR FRAMES

By using this type of jig, all the holes in a frame may be drilled before removing from the jig. At *B* and *C* are opposite sides of two jig plates. Their construction is plainly illustrated. Each jig plate is made male and female, so that not only may it be used for the frame holes, but also for the corresponding side-bracket holes, which are bound to be true with those in the frame, since the same jig serves for both. Each jig plate is adapted for several sizes of work, the two shown being used for three sizes, as can be seen from the stepped rings on them. Slip bushings of hardened steel are placed in the various holes in the jig plates to guide the drills. A completely drilled moter frame is shown at *D*.

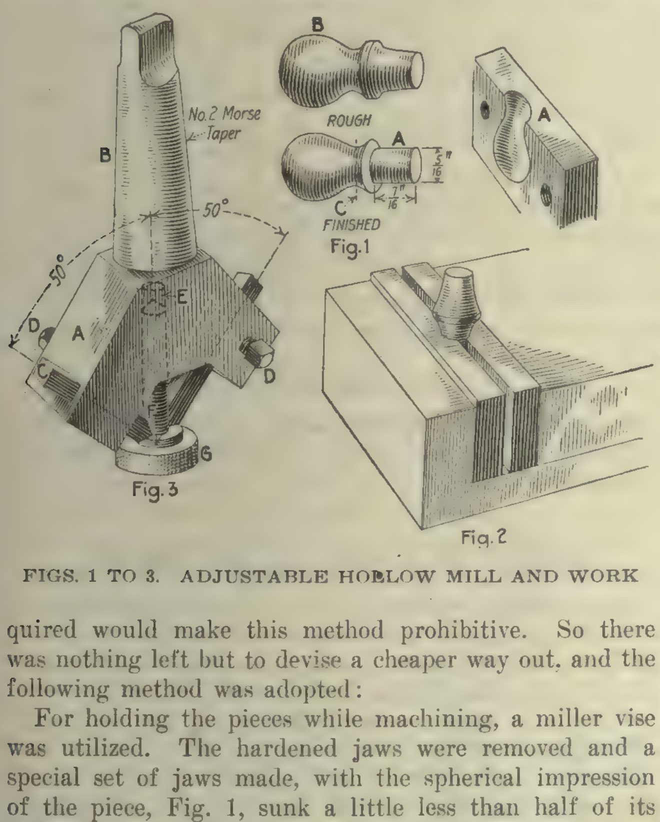
Letters from Practical Men

Home-Made Adjustable Hollow Milling Tool

Several months ago, when most contracting drop-forge shops were filling rush orders, the owner of a small drop-forge and machine shop took a large order to manufacture the pieces shown in Fig. 1. As the total number of pieces required was somewhere around 100,000 and the only machine available in the shop at the time for finishing the boss *A* was a drilling machine, the proposition to design and make the necessary tools for the job was put up to the tool maker.

The forging of the pieces was done with a pair of upsetting dies in an Acme forging machine. After the scale was removed by tumbling, and the fin left in the forging operation was trimmed off, the pieces appeared as at *B*, Fig. 1. The boss *A* serves as a rivet, and therefore the $\frac{5}{16}$-in. diameter and also the $\frac{7}{16}$-in. length were not required to very close limits.

The job could of course be machined with a commercial hollow mill, but it was thought that the price of high-speed steel and the large number of hollow mills required would make this method prohibitive. So there was nothing left but to devise a cheaper way out, and the following method was adopted:



FIGS. 1 TO 3. ADJUSTABLE HOLLOW MILL AND WORK

For holding the pieces while machining, a miller vise was utilized. The hardened jaws were removed and a special set of jaws made, with the spherical impression of the piece, Fig. 1, sunk a little less than half of its diameter into each half of the jaws, the boss *A* and a portion of the curved shoulder up to the dotted line *C* extending above the top of the vise jaws. In Fig. 2 is shown the miller vise equipped with special jaws, and the work in position for machining. At *A* is shown one of the jaws, which are made of machine steel, casehardened, to prevent undue wear.

In Fig. 3 is shown the adjustable hollow mill with which the pieces were machined. The body *A* is made of machine steel with a No. 2 Morse taper shank *B* to fit the tapered hole in the drilling-machine spindle. Two square holes were machined 50 deg. to the axis of the hollow mill to receive the ¼-in. square high-speed-steel tool bits *C*, which were secured by $\frac{3}{16}$-in. setscrews *D*. The $\frac{5}{16}$-in. hole *E* serves to locate centrally the tool-setting plug *F*, which is made of tool steel, hardened and ground. The plug *F* is also shown in the proper position at *G*.

The vise with the special jaws was clamped on the drilling-machine table and the impression trued up with the spindle, which was easily accomplished by clamping a trial piece in the vise and using an indicator (held in the drill chuck) on the boss *A*, Fig. 1. This trial piece was made by truing up one of the stock pieces in a lathe chuck and finish-turning the rivet end, both as to diameter and length. This piece was then casehardened and kept for future reference. The drill chuck was removed, and the adjustable hollow mill was inserted in its place. The tool bits *C*, Fig. 3, were adjusted to cut the correct diameter by the plug *F*, as it is plainly shown at *G*, and the setscrews *D* tightened down. Removing the plug *F* and bringing the drilling-machine spindle down till the cutting edges of tools *C* touched the shoulder on the finished trial piece and then locking the stop on the spindle completed the setting up of the drilling machine for the job.

This method worked well; and although the forge shop had a good week's start on the boy who was running the drilling machine, the boy soon caught up, and had to work on other jobs until enough stock accumulated to make it worth while to start in on the drilling machine again.

Once the drilling machine was set up, the operation was simplicity itself—gripping a forging in the vise and bringing down the spindle of the drilling machine till the stop interfered, then lifting the spindle so the hollow mill was clear at the vise to permit the removal of the finished piece. On an average the tool bits were changed about four times a day, and in order to keep the job going without interruption a few extra sets of tool bits were kept sharp, ready to be placed in the hollow mill whenever a set began to show signs of wear. The changing of the tool bits required only a few moments and the operation was practically continuous.

To make this kind of adjustable hollow mill work successfully, care should be taken to grind the various cutting and clearance angles the same and also to have the cutting edges a little in advance of the center. This will obviate cutting troubles. HUGO F. PUSEP.

Dayton, Ohio.

[It seems to us that the spindle of the drilling machine must be absolutely without shake and that three blades set 120 deg. apart would be better than two.—Editor.]

Machining a Large Sectional Cast-Steel Flywheel

Machining this large sectional cast-steel water-wheel flywheel resulted in an interesting series of operations, two of which are shown in the accompanying illustrations.

The first set of operations, not shown, consisted in drilling, on a pit-type radial drill, the holes for the binding bolts in the split arms and the machining on a floor mill of the contact faces on the split arms and the hub. The next operation was milling the flywheel faces, shown in Fig. 1. Two quarter-sections were bolted together and the assembled half was set vertically on a floor-mill table. Large angle braces provided sufficient stiffening.

The following operation was boring and facing the hub. The entire flywheel was assembled and set vertically on a floor-mill table, being held rigid by numerous braces. The photograph of this operation is not good enough to reproduce.

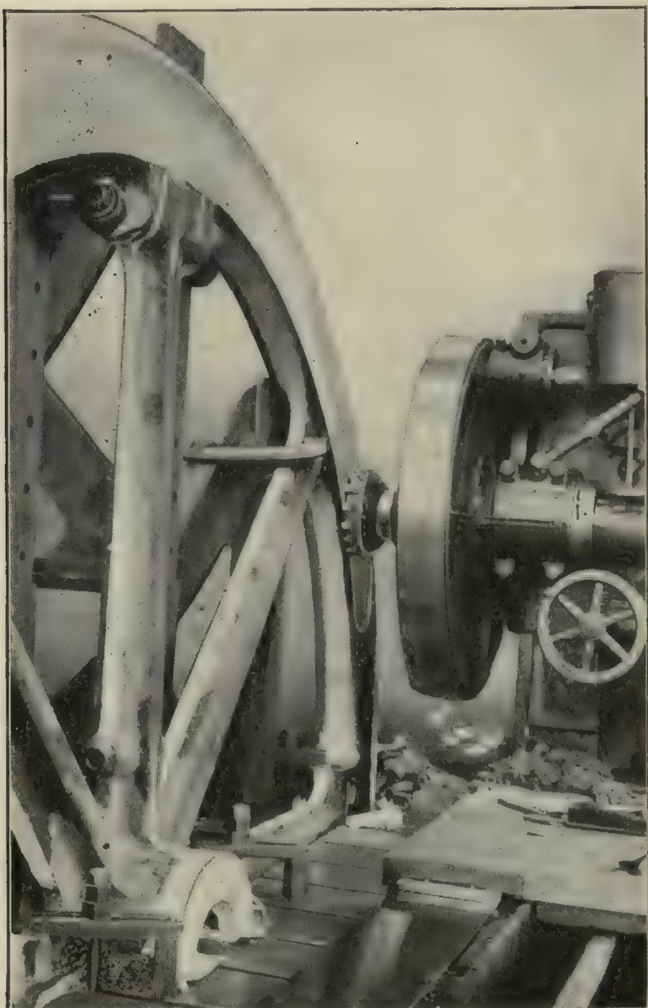


FIG. 1. MILLING THE RIM

The next operation was machining the bucket chamfer on the rim. There was no tool available that was large enough to swing the flywheel. As a substitute, a 60-in. vertical boring mill was dismantled, leaving the turntable clear. The flywheel hub was clamped to a spindle mounted on the turntable. A convenient post served for mounting a cantilever tool arm. As the boring mill has individual motor drive, no difficulty was experienced in driving the wheel. Special arms were bolted to the boring-mill faceplate to insure the necessary rigidity of the flywheel rim.

The final operation, shown in Fig. 2, was drilling the bucket-pin holes. The flywheel and spindle were lifted bodily from the vertical mill and set on the floor plate of a radial drill. By rotating the flywheel on the spindle the bucket-pin spottings were successively brought under the drill and finished by drilling and reaming. Jackscrews were used to maintain proper alignment of the flywheel faces. J. W. Swaren.

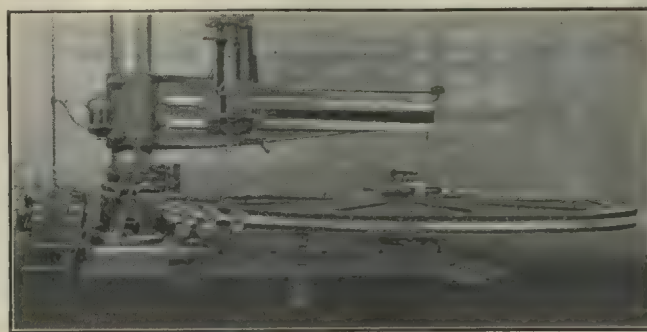


FIG. 2. DRILLING THE BUCKET-PIN HOLES

Hayward, Calif.

Press Connecting-Rod Nuts

It is often impossible for a toolsetter, especially a new man, to know which way the check nut on the connection must be turned in order to loosen it. Some punch-press manufacturers make the connection check nut with a left-hand thread, while others use a right-hand thread. This same confusion is also evident when it becomes necessary to turn the connection screw that raises or lowers the gate of the press.

Where the connection nuts are round and have pinholes drilled in them so that they can be turned by a pin instead of by a wrench, confusion can be avoided by stamping a few arrows on the outside of the nuts before hardening them, together with the word "loosen" for the check nut, and either the word "raise" or "lower" on the connection.

A plate on the front of each press, with proper directions for adjusting the connection nuts, would save much time and bother. Charles Doescher.

Waterbury, Conn.

Surface Grinding on the Shaper

Some time ago we had several large dies to be ground on both sides. The regular surface grinder was tied up, so we had to resort to some other means to get the work out on specified time.

We put the electric center grinder in the tool post of the shaper and put a jack behind the shank of the grinder to prevent lifting on the back stroke. Then we carefully screened all bearing surfaces with canvas, to prevent "gritting," and set the feed to work on the front end of the stroke (instead of the back, which is customary), thereby allowing the wheel to grind back in the same path as that made on the forward stroke. This has proved to be a very efficient surface grinder, producing work of superior quality.

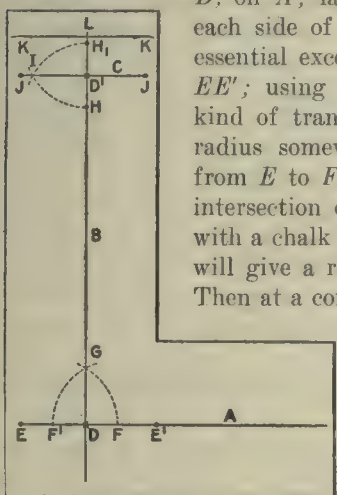
Janesville, Wis. J. A. Raught.

Discussion of Previous Question

Lining Up Widely Separated Line and Counter Shafts

On page 967, Vol. 45, G. B. Fairman describes how he lined a countershaft at a distance from the main line. I think a simpler way is as follows:

First find line *A* with a plumb bob from the mainshaft, and then at the most convenient point mark off point *D*, on *A*; lay off at equal distances on each side of *D* (the distance not being essential except to be equal), the points *EE'*; using these as centers, with any kind of tram describe arcs *G*, taking a radius somewhat longer than *ED*, say from *E* to *F* and *E'* to *F'*; through the intersection of the arcs *G* and point *D*, with a chalk line strike the line *B*, which will give a right angle with the line *A*. Then at a convenient point, as *D'*, lay off HH_1 and tram the arcs *I*, striking the line *C* through *D'* and the intersection of *I*. Then if the countershaft must go nearer the end wall than *C*, tram from two points *J*, striking the arcs *K*; and tangent to these arcs strike the line *L*, which will be the line of the countershaft. My reason for placing the line *B* through the middle of the floor is to have space to work in.



FLOOR LAYOUT FOR THE PARALLEL SHAFTS

Stoughton, Mass. DANIEL W. ROGERS.

Shrinking Small Gears

On page 31 H. J. Rueping contributes an article regarding the shrinking of small gears, and states that this method is applicable to small work only. Now it might be interesting to some of your readers to learn that I have known articles as large as locomotive driving-wheel tires to be reduced in size in this same way.

Middletown, Ohio. CHARLES W. SHARTLE.

Writing for the "American Machinist"

This is intended by way of encouragement to those practical men of the industry who have not as yet contributed to the columns of the *American Machinist*. In addition to the pleasure of seeing one's work in print, there is great educational value attached to writing. It broadens the mind and sharpens one's powers of observation.

I derive much pleasure from this fascinating work, and the financial returns have been satisfactory. With money earned in this way I have paid for a course in draftsmanship and other good things, and it is really like getting something for nothing, owing to the pleasure the work gives.

Again one's work is frequently noticed by one's employers, with its consequent advantages. Of course, all my articles are not accepted, but nevertheless I do not get discouraged.

To me the reading of the *American Machinist* is like a weekly excursion to other shops.

I heartily agree with F. P. Terry that one must read much to be successful and also that this is a most fascinating hobby. GEORGE F. KUHNE.

East Rutherford, N. J.

To Prevent Wheel Loading When Grinding Aluminum

The discussion of this subject on pages 646 and 917, Vol. 45, is very interesting to me, as it brings to my mind methods similar to those described. These methods were introduced in our grinding department a few years ago. It will perhaps be of interest to describe briefly how it occurred to me to use oil as a grinding kink when grinding aluminum. It is well known that certain mechanics and machinists in engineering establishments, especially those employed in the automobile industry, are frequently required to work in aluminum. Being employed in this industry, I have been called upon many times to perform various jobs on this light metal, particularly in the operations of turning, milling, planing, tapping, drilling, etc. Invariably I have found it advantageous, in these operations, to use lubricants. In fact, in my opinion, not one of the operations mentioned should be attempted without using a lubricant such as kerosene, lard oil, soap water, "aquiline," or a mixture of kerosene and gasoline, or lard oil and gasoline. Even in the operation of filing aluminum I have oftentimes found it beneficial to keep the file lubricated with oil. However, it was the fact I had obtained such good results in finishing aluminum castings in the various operations mentioned that caused me to use oil when grinding the metal.

GRAIN, GRADE, ABRASIVES AND BONDING PROCESSES OF GRINDING WHEELS FOR CAST ALUMINUM

Grinding-Wheel Makers	Abrasives Used in the Manufacture of Grinding Wheels	Bonding Processes Used in the Manufacture of Grinding Wheels	Grain of Grinding Wheels	Grade of Grinding Wheels
Abrasive Material Co.	Carbide of Silicon	Elastic	30 to 60	Medium soft
American Emery Wheel Works	Carbolite	Elastic	36 to 60	Soft
Carborundum Co.	Carborundum	Elastic	16 to 50	Medium soft to medium hard
Norton Co.....	Crystolon	Elastic	24 to 46	Soft to medium
Safety Emery Wheel Co.	Corex	Vitrified	30 to 60	Medium soft to medium
Sterling Grinding Wheel Co.	Corundum	Vitrified	30 to 36	Medium to medium hard
Vitrified Wheel Co.	Carbolon	Elastic	20 to 46	Medium

I agree most heartily with F. B. Jacobs' statement that "any old wheel picked up at random will not successfully grind aluminum," because aluminum is a metal

with characteristics vastly different from other metals. Its extreme lightness, its low tensile strength and its low resistance to abrasion are very marked. Hence the importance of employing special grinding methods on aluminum, to obtain increased production of accurate work.

Regarding the selection of wheels of suitable grain and grade for various forms of grinding, such as internal, surface and plain cylindrical work on cast aluminum, the information given in the table may be of interest.

In conclusion, I believe that there is no standard system of grading grinding wheels. E. ANDREWS.

Manchester, England.

Cutting a Perfect Gear with a Broken Cutter

I would like to add to E. A. Clark's article on cutting perfect gears with a broken cutter, on page 68, that I have never had any success in cutting gears with a broken-toothed cutter on a Fellows gear shaper.

It seems to be that Mr. Clark is cutting gears with only one cut. I cut 96-tooth 24-26 pitch cast-steel gears with two cuts—a roughing and a finishing cut—in order to get a gear within 0.004 and 0.006 in. of concentricity. The other day I tried to cut gears with a broken-toothed cutter, but found that another tooth of the cutter burned, as the finishing cut was too heavy.

I would like to learn what is the best lubricant for cutting cast-steel gears and small tool-steel gears on the Fellows gear shaper.

How can gears be repaired with one burned tooth without taking a chance of burning another?

St. Louis, Mo. EMIL DAIBER.

Is America Going To Lose a Good Market?

Not quite a year ago the *American Machinist* contained a few articles concerning opportunities for American machine tools in Holland. At the same time remarks were made as to the local manufacture of machine tools and attention was mainly drawn to the tremendous increase of machine tool imports. The sudden leap of the imports was due to the war, but statistics make out that the imports had steadily and rapidly been increasing since 1900. This was due to the success of the manufacture of Diesel, gas and combustion engines, lamps, the building of ships and marine engines, and the increasing production of sugar-mill machinery. The results obtained are remarkable, because Holland does not boast any natural (steel or mining) resources to speak of. But they are not more surprising than a statement that small maritime-agricultural nation intends to build "American" engine lathes in line with the best types on the market and improved to suit local requirements.

I do not think that Dutch manufacture of machine tools in itself ever will be a noticeable rival to the American, but when a small nation, accustomed to quiet and thorough reflection, starts to think it is able to improve upon a product which they regard as by far the best on the market, it is time for the producer to take notice; and he might ponder if his tool really is the acme of perfection. The English manufacturers of, for instance, cutlery for sheep shearing, weaving, dyeing and allied machinery for a long time thought their output invincible. Suggestions of customers for small improvements were laid aside, giving the German competitors a free hand in claiming a great part of their foreign and even colonial markets.

The above does not imply that Hollanders look down upon American machines, all of a sudden, because they are going to build machines on American principles. Machine-tool building was inaugurated in Holland by the Army Department of Engineering, dividing up an order for 400 plain millers and some special machinery among Dutch manufacturers. The speedy results in all cases were highly satisfactory in every respect. A Rotterdam firm is engaged in the manufacture of a small lathe and of two engine lathes with an 18-in. swing over the bed and respectively 3 ft. 8 in. and 5 ft. 8 in. between centers. The design reminds one from beginning to end of the American quick-change gear, screw-cutting engine lathe, but for the legs, which have been made box-shaped as on larger lathes. They are being made up in lots of fifty—all parts interchangeable, by means of a complete system of gages, jigs and fixtures. The greatest thought is given even to small details like weathering the beds after rough planing to take out internal stresses. Before taking apart for painting, the lathes are subjected to severe tests and inspected for accuracy with micrometer dial indicators. Each lathe is provided with a spare, square revolving tool holder to do different operations at the same time on a lot of similar pieces.

Though Holland is a metric country through and through, it might be of interest to many readers of the *American Machinist* to know that the tables of screw cutting, etc., on these lathes are in the English system.

Brooklyn, N. Y. JAN SPAANDER.

Another Simple Sine Bar

On page 1032, Vol. 45, Fred Henke describes a simple method of making a sine bar. I know another method which I think is equally good.

The bar is made of machine steel, and the center distance for the studs is laid out with dividers and drilled and tapped for the locating button screws. Small bolts are put through these holes with washers under their nuts and heads somewhat larger in diameter than the holes to be bored for the stud shanks. The bar is now ready to be carbonized and hardened, after which the bolts and washers are removed, leaving soft metal around the holes. The bar may be ground to size all over, the buttons accurately located and the holes bored to receive the stud shanks. R. K. ROWELL.

Bridgeport, Conn.

The Use of Snap and Ring Gages

On page 12, F. H. Bogart writes an interesting article on snap and ring gages. I do not propose to make any criticism of Mr. Bogart's article, yet he has not pointed out all the advantages of ring gages.

In using them on work turned between centers the ring is slipped over the tail spindle and allowed to stay there during the process of turning. If the work is slightly

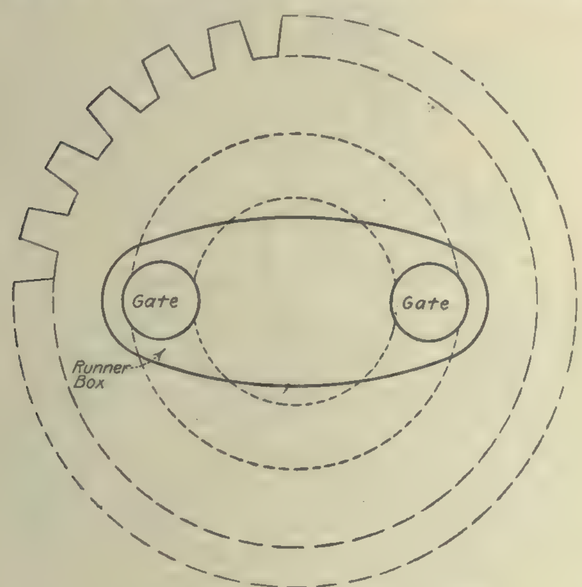
oval, which often happens (especially with a lathe that has a worn spindle), the ring gage will detect it at once. If the operator is not aware that his lathe is turning oval, he is not apt to discover it with a snap gage. In filing or polishing a bearing down to finished size, the operator slips his ring on and slides it along. If there is a slight swell in the work, he draws the ring back and files or polishes off the swell. By slipping the gage back and forth a few times the high spots are made visible. This could not be accomplished with a snap gage.

As for measuring diameters between shoulders, etc., I believe a suitable split-ring gage will eventually be devised for that purpose. J. A. RAUGHT.

Janesville, Wis.

How Would You Gate These Patterns?

In reply to the query on page 557, Vol. 45, I would make two pouring gates as indicated in the illustration. It is difficult to tell whether one would be sufficient or not, as dimensions are not given; but if the hub and web are sufficiently heavy, as shown, one would be enough and the other one could be enlarged and used as a riser. Gears up to 15 in. are gated this way satisfactorily, and in the case of heavy gears the runners are not cut on the



THE WAY TO MAKE THE GATE

teeth, but at the points below them; or if the gear has arms, they are used as runners, the gate being midway between them.

In dropping iron any distance on large work, as recommended on these 4-in. gears, it is good practice to nail a piece of tin or sheet steel 1/8 in. or even heavier right under the gate, to prevent the bottom of the mold from being cut.

To make these teeth free from fins is an easy matter, because the parting line can be made at the top of the teeth, leaving only the boss of gears in the cope. A fine grade of sand should be used and the pattern drawn, so that no patching will have to be done. The iron should be poured hot, particularly if one gate is used. A good mixture for this grade of work is silicon, 2.25; manganese, 0.80; sulphur, 0.08; phosphorus, 0.60.

Montreal, Quebec. C. R. WHITE.

The "Coincider" Who Always Agrees with You

The man described in J. P. Brophy's article, on page 88, and termed a "coincider," is not solitary; he exists in legions and predominates in certain quarters because he is the type of man wanted.

He never does anything wrong, only doing what he is told to do. As Mr. Brophy says, "if he pretends to understand and does not, then when mistakes are made he will escape the blame," etc.

This type of man is always ready to do anything that is required of him; he never kicks, and never contradicts; in fact, he is nothing but a coward, and he is as slippery as an eel.

I have said that men like this are wanted. They are not only wanted, but they are promoted to responsible positions. Some executives do not care for any other kind, because the other kind wastes time in arguments based on contradictions of the boss.

If Mr. Brophy is a man that appreciates "the brave warrior" with the courage to contradict the big chief, when he knows that the big chief's statement or idea is wrong, then Mr. Brophy is surrounded by honest men only and he must possess a powerful business organization.

The coincider goes to the limit in playing his hypocritical game. He is a good fellow, as Brophy says. Yes, not only good fellow, but a very good fellow. Always with a little smile, he does not say much; and the little he does say is chiefly in the form of a bouquet directed at the boss. If cornered, he calls his game playing politics. He well knows that in his game he does not do that which is right, but he also knows that he is working for his personal interests.

As Brophy says, the coincider is of two kinds, the most dangerous being the "wise proposition and silent schemer." These men consider their interests above their employer's interests, and any smooth scheme to get there is good enough for them. FRANCIS J. G. REUTER.

New Haven, Conn.

I wish I knew Mr. Brophy. I am sure we could be good friends. You see, he thinks just the way I do, and we always get on well with such people. I do detest the "coincider," told about on page 88. That word "coincider" will stick.

Some years ago, I was in charge of a branch of engineering work for one of the largest corporations in the world, in a line in which there were very few available data of a reliable kind. The work was of an important and remunerative kind, and the time for preparation was very short. It was necessary to get together a group of men who were individually competent to take a unit of the proposed whole, perfect the details of that unit and merge the units, via the chief draftsman and myself, into an efficient mechanism. It could not be made a simple mechanism, as a whole, but the units, as always, were desired to be of simple details.

I have wished many times since that I could get that bunch together again. It may have been old-fashioned luck or it may have been predestination or some such animal, but there was not a coincider among them. They were bright men, every one of them, and they would stand

up and fight for their ideas. They could not, any of them, have taken the entire job and have proposed all the essentials of the successful whole. It remains to be said that they are beyond my reach now. They are scattered in positions of responsibility and trust, wherever they work. I consider myself fortunate that I am about to get again the services of the one who was in charge of the bunch.

Like Mr. Brophy, I am afraid of the coincider. He is a delusion and a snare, and he is as costly as the man who takes hold of a job that is too big for him and makes mistakes. No man in general charge of a work can oversee it and beforehand provide for the ultimate design of each detail. He needs and must have men who feel that they know, as well as the boss, how to make a piece. The manner in which they handle their belief in their own ability is the true index of either wisdom or conceit.

Illustrative of this last was an incident in the engineering proposition before mentioned. A certain control group had been made to sketches of my own, conceived hurriedly and put through as the best construction known at the time. Just before its assembly into the whole, however, the chief draftsman, who was fully informed as to the desirability of losing no time, came to me with a simple sketch that made my ideas look foolish. Suppose he had been a coincider at that time? A very little study showed me that he had "made rings around me," and my first order was to throw out my own construction and substitute his.

The coincider is poison. Beware of him. Do not hire him. I would far rather have a man tell me to my face that my ideas were no good, and make my pride get to work, than to agree with me and allow a poor job to go through and fail. The coincider in such a case usually tells everyone who will give him a hearing that he told the boss about it, but the boss would not listen. The man who is worth the most to the boss is the one who, when the boss will not listen, gives him a jar that makes him listen, using discretion, of course, in applying the jar. ROBERT G. PILKINGTON.

Chicago, Ill.

Soft Steadyrest Jaws

Reading the article on universal steadyrest jaws in the *American Machinist* on page 32 put me in mind of a kink I used some months ago, which may be of value to some of the readers.

Having a large number of cold-rolled steel shafts to be highly polished, squared up on the ends and a small hole drilled in one end, we used the ordinary steadyrest, with the result that some of the shafts were scored. I then made up three jaws of babbitt similar to the ones furnished with the steadyrest. After doing half a dozen shafts the jaws were worn to a good bearing and gave no more trouble, needing very little adjustment to keep them in proper order. FRED L. HARBAND.

Winsted, Conn.

Measuring Odd-Toothed Gears

On page 67 Robin Duff asks how to go about measuring the outside diameter of odd-toothed gears accurately and rapidly.

I suggest that one tooth space of each gear be filled with soft solder. It is evident that, when grinding, a cylindrical surface will be given the solder to correspond with the gear. This will enable the operator to measure over it and the opposite gear tooth with a micrometer, to determine the correct outside diameter. This kink is often used when grinding odd-spaced reamers, drills, etc., and is applicable to the grinding of odd-toothed gears.

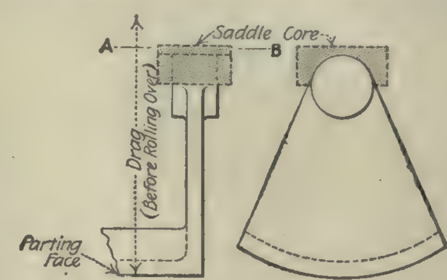
Providence, R. I. ROBERT R. CONNELL.

[Solder is apt to fill the wheel.—Editor.]

What Method Would You Use in Producing This Casting?

I contributed an illustration, which appeared on page 318, Vol. 45, and asked for suggestions for molding the piece shown. In the illustration herewith is given a method that is simple, inexpensive and practical for both the patternmaker and the molder. It is the way I should do this job.

The pattern is placed in the drag flask with the parting face resting on the bottom board. Saddle cores (not core prints), made to fit over the circumference and



METHOD OF MAKING THE CASTING

down to the center line of the bosses, are laid loosely on the pattern, as shown (one side only). Sand is filled in up to the line *AB*. The saddle cores are lifted, and the loose bosses are withdrawn from the mold. The saddle cores are placed back in the mold, filling in the sand is continued and the mold finished. The drag is then ready to be rolled over and placed in the proper position to receive the cope. M. E. DUGGAN.

Kenosha, Wis.

Employment Bureaus for Classifying Workmen

The reasons set forth by Frank C. Hudson, on page 167, are all pertinent, but there is still another reason—the lack of classification of the employers as well as of the employees. The grades of men suggested by C. W. Johnson, on page 64, may fit his particular case admirably, but how differently this would appeal to some other shop superintendents.

The grade A man in the average shop would probably not rank above C on fine watchwork or in optical work. On the other hand, the grade C men in Mr. Johnson's shop would probably go up into the A class in many shops.

Until we can classify employers and employees as well as employment, it is almost useless to attempt to classify employees in the manner outlined. I. B. RICH.

New York City.

Editorials

The Duty of Americanization

Some two hundred American engineers were entertained recently in one of the magnificent homes of New York City. The purpose of the gathering was to discuss the topic "The Engineer in Americanization." A number of addresses were given, all in the spirit of emphasizing the need of Americanizing the immigrant as soon as possible after he lands in this country, and pointing out the place that the engineer should fill in this nation-wide work.

In spite of the interest shown the result of the meeting was inconclusive. There was a failure to organize the engineers and their forces behind this movement for helping the immigrants; there was a failure to present the experience of those who have been doing this identical work for many years; there was a failure to emphasize the need of character building as a part of the plan.

It is perhaps wise to have a clear idea of what is meant by Americanization of the immigrants, and what the minimum requirements must be. As presented at the gathering referred to, Americanization was stated as "the realization of the ideals of America: Free education; representative government; freedom of contract; freedom of speech; equality before the law; political freedom; equal opportunity; abolition of class lines." The minimum requirement for the Americanization of the immigrant was declared to be: "American citizenship and undivided allegiance; a common language; one American standard of living; one American industrial standard; a homestake in America; reasonable stability of population; industrial justice—the same standard for employer and employed."

Going a step farther with the outline, it was stated that the agents of this industrial Americanization are the engineers of America, in whose hands are the human as well as the mechanical destinies of our industries. Engineers and shop executives will have no disposition to shirk their duties and responsibilities in regard to foreign workmen, but they will ask to know what has been done already along these lines, and what are the effective means of reaching their object. Two great agencies have worked toward the Americanization of the foreigner for many years; these are the public schools of the United States and the Young Men's Christian Association.

Everyone is more or less familiar with night schools and the work that they do in teaching English and elementary subjects to foreigners. Detroit has had an especially brilliant record in this respect. One reason for it has been the active coöperation of the businessmen of the shops with the city. In that particular place the engineers and the shop executives have seen their way clear to aid in solving this problem and have actively helped.

The spirit of the work done by the Young Men's Christian Association of this country and its results are not at all well known. Two general lines are being followed. One is the "Industrial Service Movement," carried on by the students in our engineering schools and universities; the other is the industrial work done by state secretaries in a few cases and through the regular associations in many cities.

At the present time the three great industrial states of Pennsylvania, Massachusetts and New Jersey have each a paid state industrial secretary. Over forty city associations have full-time industrial and immigration secretaries. About 500 associations have at least one secretary who gives a large proportion of his time to this particular work.

At this season about 40,000 men are studying the English language in association classes. Over 300,000 are being reached in lectures on government and American citizenship, including a study of our American institutions, personal health, right living and the like. Last year in Chicago alone 139,000 foreigners attended 129 different lectures in the public parks, held under the auspices of the Young Men's Christian Association. As a grand total, over 1,000,000 men each year are attending noon educational and religious shop meetings.

The industrial work has been going on since 1902, and in the brief space of fourteen years has grown to the extent indicated by the figures above. During the last ten years the association has been coöperating with manufacturing firms all over the United States. This is particularly true of the cotton-mill districts of the South, and the coal, copper and mining sections.

A most important contribution is the Roberts system of teaching English, worked out in Young Men's Christian Association classes.

Where the subject of Americanization of the immigrant is discussed, the experience of the men who have initiated and fostered this tremendous work in the Young Men's Christian Association should be sought and heeded.

The other side of the work, that known as the "Industrial Service Movement," was inaugurated at Yale in 1907. It has since spread so that today 250 colleges and engineering schools have enlisted 4500 men—mostly cadet engineers—engaged in forty varieties of volunteer service among working men and boys. The greater part of these men are serving foreigners. They are reaching about 100,000 men and boys each week. Listen to the testimony from two engineering graduates who did work of this kind while in college:

> . . . Those two evenings a week unknowingly became a part of me. I had a chance to project Christian and American ideals among foreigners hungry for our native tongue. I learned far more than I taught. It would be impossible to urge too strongly that college men get into this game. Among my most-prized possessions are three books given to me "As a token of appreciation from your thankful pupils!"
>
> We are planning a comprehensive system of teaching English and American citizenship for foreign employees and giving these and all our other men splendid opportunities for improving their education and recreation. We are really building character in our plants. The man can thank, not me—but the Industrial Service Movement.

Again, whenever the topic of Americanizing the immigrant is discussed, engineering graduates who have

done their bit in this industrial service movement should be given an opportunity to tell of their experiences.

Before the war the Young Men's Christian Association had fourteen secretaries in as many European ports of embarkation who gave immigrants cards of introduction to use in this country. Secretaries are also maintained at several ports of entry. Work is done in the steerage of steamers and on immigrant trains.

To be sure, to teach the immigrants our language, our ways and our ideas, is a duty placed upon all who are native born or have become Americanized. As a group, engineers and shop executives appreciate the need of this work perhaps more keenly than any others. They are ready to do their part. Without doubt they have done much in the past as individuals. It is not at all surprising that an effort is made to knit them together in some organization which shall have for its purpose the furthering of this great national work.

But the engineer is a practical fellow and must see the means and the machinery that he is to use before he will put his shoulder behind the wheels of progress. Let us have a comprehensive plan and let us also draw from the experience of those who have given years of generous service to this very work.

The High Cost of Shells

The great discrepancy between the bids of American makers and that of Hadfield's, Ltd., of England, for the large naval shells causes much speculation. That a firm engaged in supplying its own country with munitions for the greatest war of history can underbid us in delivery as well as price is neither pleasing nor encouraging.

While both raw material and labor may be a trifle lower in England, these cannot account for the difference of $200 per shell in cost, although it will probably be used as an argument for higher tariffs. It is possible that the naval department of Hadfield's is not very busy, this branch of the service having used but a small amount of shells. Or knowing its own country is well supplied, it may desire to get an initial order, even at small profit, with a view to future business.

It will be recalled that a somewhat similar situation occurred a few years ago when the American bidders cut their prices on learning that this same company would submit a bid. But with Hadfield's presumably busy with British work, the prices went up again this time, and the immense volume of business makes them independent, for the time at least.

If Hadfield's can supply shells that will pass the tests which the Bethlehem Co. says are too severe, it is high time that Bethlehem and others learned how to do it. And if they have spent over half a million dollars without being able to make a shell which was acceptable, there is something decidedly wrong with either the requirements or with their own engineering force.

Whether the British government allows the shells to be supplied by Hadfield's or not and entirely aside from the matter of profits, there is something radically wrong when there is a difference of 30 per cent., or $200 a shell, between bids, especially where conditions are as nearly alike as in this case.

No one wants those who supply articles for defense to lose money, but as national defense means more to them than to individuals, owing to their having more to lose, they should be in a position to furnish ammunition as cheaply and as promptly as anyone else. If they cannot, there must be something radically wrong in methods or in organization.

The main thing to do is to get shells and get them quickly. And any shop with a capacity for this work should be glad of an opportunity to show what it can do.

What About American Airplane Motors?

There are so many conflicting reports about the airplane motors built in this country that it is difficult to form an intelligent opinion in regard to them. From some quarters comes the information that the motors and airplanes we send abroad are used almost entirely for instruction purposes, and rarely in actual service, on account of their defects and general unreliability. Other reports, which are much more pleasant to believe, deny this and tell us that the machines and motors are giving good service in every particular. Much as this would tickle our vanity, the truth probably lies somewhere between the two statements.

The development of airplanes and motors has unfortunately been sadly retarded by the long drawn out patent litigation of the past ten years. As a result there are few large builders in this country, and the state of the industry plainly shows the effect of this delayed development. Motor trouble was given as the cause for the large percentage of failures in the recent flight of twelve machines from New York to Philadelphia, a comparatively easy trip in these days.

It is up to us to find out exactly where the present motor develops trouble and remedy the defects. These include valves leaking after a few hours' run; unequal distribution of gas to cylinders; magneto contacts becoming dirty and failing to deliver hot sparks with certainty; and faulty mounting of magnetos.

The Government is wisely buying various makes of motors, for encouragement and to test out different ideas, but their development and standardization should be pushed as rapidly as possible. It is safer to assume that they are far from what they should be than to rest content with their development for, knowing they are not perfect, we can improve them to the highest standard. No country or race has a monopoly on brains or mechanical genius, but self-satisfaction is an opiate that we should studiously avoid.

One feature of airplane maintenance in the army seems to be sadly in need of revision—the attempt to care for motors and planes without highly skilled men. So far as we have been able to learn there are no regular airplane mechanics attached to the flying corps. The best mechanics to be found among the enlisted men are detailed to care for and repair planes and motors, which seems to be a dangerous and costly economy.

This is why Captain Clark, of the flying corps, condemned the use of shims in airplane motor bearings. These bearings are taken up by men untrained in motor work and who sometimes get all the shims on one side of the shaft. This is sufficient reason for a metal-to-metal bearing cap, but the conditions should be changed from every point of view. The airplane motor has plenty of legitimate difficulties without adding those that are unnecessary and expensive.

Foreign Trade Convention—An Attempt To Forecast the Future

SYNOPSIS—Prospects for foreign trade after the war and the practical applications of principles already demonstrated as bringing success in export business were the two major topics considered at the largest foreign-trade convention ever held in the United States. Speakers declared for a merchant marine, the Webb Bill, adequate foreign banking facilities and investment in foreign loans.

Over 1300 delegates were in attendance at the fourth National Trade Convention, held in Pittsburgh, Penn., Jan. 25 to 27. The spirit shown was one of inquiry. What will be the foreign-trade situation at the close of the war? What will Europe need? Can she pay for what she wants? How will South American markets be affected by the stopping of hostilities in Europe?

Questions of this kind were freely asked, and several papers and addresses attempted to give answers. The general opinion seemed to be that Europe must buy from us during the rehabilitation period, but to what extent or for how long no one can predict.

The opening topic was "World Trade After the War." The first paper was a committee report prepared by the National Foreign-Trade Council. Excerpts from it relating to productive machinery are printed elsewhere in this issue. The figures presented are stupendous.

The second address, by W. W. Nichols, chairman of the United States Industrial Commission to France, dealt with "Industrial Reconstruction in Europe." With direct reference to conditions in France, Mr. Nichols said: "The business is there; our commission can tell you what that business is, and a reading of its report will suggest to your mind some elements you need to consider in accepting it."

And again: "France looks to us as a superior exploiter of labor-saving machinery to help her to deal with what she expects to be the most difficult phase of her reconstruction—namely, to find adequate means to offset a great deficiency in her manual labor. She estimates that this deficiency will actually be 1,500,000 men, and to this must be added serious impairment of effective personal service by the loss of limb, sight or other sense. In fact, France is so impressed with the gravity of this situation that at the outset this constituted the principal reason given for our commission visit."

Mr. Nichols also emphasized that we must seek this foreign business in friendly coöperation, not with a spirit to exploit through destructive competition.

Suggested Methods of Coöperation

Many manufacturers have asked, "If the Webb Bill becomes law, how can I coöperate in seeking foreign trade?" A committee report answered this question by outlining five plans:

1. By forming a group of large manufacturers, closely identified, making kindred but generally noncompeting products.
2. By forming a group of manufacturers controlled by one company making kindred and noncompeting goods.
3. By forming a large group of small manufacturers, each entirely independent, whose products are allied and which may be both competing and noncompeting.
4. By forming a group of manufacturers making similar and generally competing products, who coöperate with one selling organization on a commission basis.
5. By forming a group of producers of raw materials, who unite in one general selling agency for the disposition of their export products.

The report explains the plans in considerable detail. Anyone contemplating joining such an export organization will do well to study the suggestions made.

Problems of the Smaller Manufacturer

A helpful topical discussion was devoted to the export problems of the smaller manufacturer. A series of 31 questions had been prepared, and from two to eight answers were offered for each. These concerned ways to study a foreign market, select salesmen and agents, prepare catalogs, advertise and the like. These topics brought out more discussion than any others, apart from the major subject of world-wide conditions.

Friday morning's session was devoted to our "National Shipping Policy," and the final session on Saturday was given over to reports from the various groups that had held topical discussions. Anyone interested in any phase of foreign trade will be repaid by procuring for his own reading copies of all the papers and discussions given.

Final Declaration of the Convention

No resolutions were adopted by the convention. The final declaration drawn by a general committee follows:

World conditions, because of the European War, offer to the United States both opportunities and responsibilities. These responsibilities must be recognized if the United States is to realize the opportunities. The share of the world's commerce to which the United States aspires is that to which its resources, productive capacity, enterprise and skill entitle it. No thoughtful, patriotic American citizen desires more, or will be content with less.

Our trade must depend for its future development primarily upon the efficiency of our agricultural and industrial production, upon the enterprise of American manufacturers, merchants and bankers and upon the training of youth in our schools, colleges and universities. The wider distribution of the benefits of foreign trade is dependent upon the participation of a steadily increasing number of industries and enterprises of moderate size. Governmental agencies, the Department of State, with the diplomatic and consular services, the Department of Commerce, the Federal Reserve Board and the Federal Trade Commission can assist American enterprise by the negotiation of advantageous commercial treaties, by collecting and disseminating information regarding foreign markets and suggesting improved financing, selling and purchasing methods. These governmental agencies have already rendered and can render still greater assistance to merchants or manufacturers desirous of extending their foreign trade, but in the last analysis success is to be attained only by the courage, intelligence and efficiency of

the merchants, the manufacturers and the bankers themselves, the coördination of their efforts and their ability to coöperate with each other and with the Government departments created to serve them.

To meet world competition, however, American business, using the term in its broadest implication, must be relieved of disadvantages imposed by legislation and protected by governmental action from possible discrimination in foreign markets.

Important Questions Emphasized

The discussion in this convention has emphasized the vital importance, as bearing upon the future of our foreign trade, of certain questions which are being, or should be, considered:

1. Doubt as to the application of the anti-trust laws to export commerce should be removed. Congress should promptly enact in principle the Webb bill, now pending in the Senate, with the modifications hitherto recommended by the Federal Trade Commission, to the end that American exporters generally, while marketing abroad the products of American agriculture and industry, may have the advantages of coöperative action in their efforts to meet foreign combinations.

2. The chief duty of the United States Shipping Board should be to develop a sound national shipping policy, calculated to attain the following objects:

a. The increase of national income and of domestic prosperity by affording greater facilities for the sale abroad of products of the soil and industry of the United States, and for the importation of foreign materials and products necessary to American life and industry.

b. The development, under the American flag, of transportation service with foreign countries and with the possessions of the United States.

c. Aid to national defense and maintenance of foreign commerce, whether the United States be belligerent or neutral.

To render our foreign commerce reasonably independent of foreign carriers there will be required a merchant tonnage so great that it can only be sustained on the basis of ability to compete for the world's carrying trade with the vessels of other nations. Such disadvantages in cost of operation as are imposed by economic conditions should be offset by greater efficiency, but it is the duty of the Government to offset those imposed by legislation.

3. While it is impossible to anticipate the future relations of the nations now at war, with one another and with neutrals, it is certain that antebellum conditions will be radically altered. Commercial treaties under which the world's trade was conducted prior to August, 1914, have been ruptured by the war. The negotiation of new agreements between the members of both belligerent groups, between these groupings and neutrals, and the relations between the groups themselves, will necessitate a complete readjustment of the arrangements formerly in force. The United States will inevitably be obliged to negotiate new commercial treaties to conform to the bases fixed by other nations to govern their relations with each other. The possible effects of European economic alliances and preferential or discriminatory tariffs that may be imposed thereunder upon American treaty relations and American trade should be given careful consideration by the Congress and by the proper departments of the Government, including the Tariff Commission.

The State Department has already created a Bureau which is studying these problems. This Bureau should be enlarged and enabled to secure the services of experts. This work of the Department of State should be coördinated with the activities of the Department of Commerce, and both these departments should coöperate closely with the Federal Reserve Board, the Federal Trade Commission, the Shipping Board and the Tariff Commission, when organized. The Department of State, through this Treaty Bureau, should consult with commercial organizations and business men individually in order that their needs may be taken into consideration.

Whatever be its underlying principle the United States tariff system should possess adequate resources for the encouragement and protection of the foreign trade of the United States. To assure to the United States the continuance of the favorable treatment which our commerce enjoyed before the war and to protect American exports against discrimination in foreign markets, Congress should adopt the principle of a flexible or bargaining tariff.

In submitting the foregoing considerations to this convention your committee desires to express its appreciation of the spirit of coöperation which has already been evidenced by the Departments of State and Commerce, and by the Federal Reserve Board and the Federal Trade Commission, and of their readiness to assist business men throughout the country. We believe it to be the sense of this convention that the National Foreign Trade Council and the delegates here assembled individually will consider it a privilege and a duty to coöperate with these governmental agencies in their efforts to encourage the development of American foreign trade.

Chandler & Farquhar Co. Divides Its Business

Because of the great growth of the small-tool and machine-tool business of the Chandler & Farquhar Co., Boston, Mass., the stockholders decided on Feb. 1 to divide the two departments of the firm and conduct each through a separate corporation. The same general management will be retained. The machinists' tool and supply department will hereafter be carried on under the original name of the Chandler & Farquhar Co. It will be located at the premises now devoted to handling small tools, 34 to 38 Federal St.

To carry forward the machine-tool business a new corporation has been formed—the Lynd-Farquhar Co. It will be located at 419 to 425 Atlantic Ave., the same premises where the machine-tool business has previously been conducted.

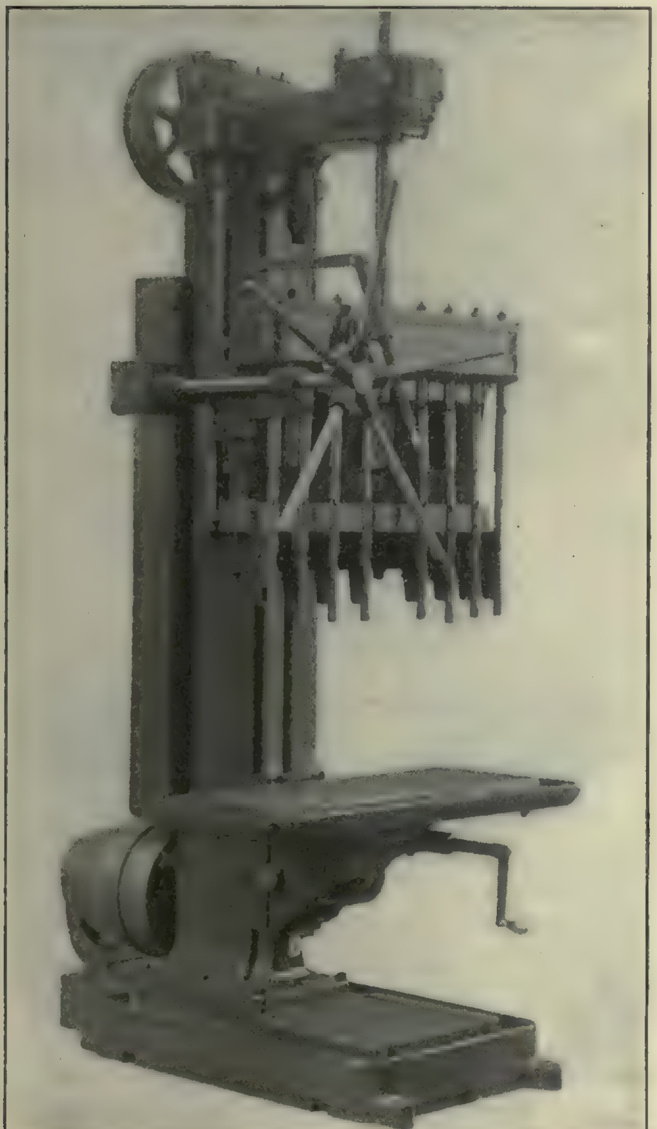
Charles S. Farquhar will retain his interest and official position in the machinists' tool and supply end of the business, with Alexander Chandler as general manager. Mr. Farquhar will also take up the duties of the position of treasurer and financial manager of the Lynd-Farquhar Co. The management of the machine-tool business will continue under the direction of Robert J. Lynd, who becomes president of the new corporation.

By this division of the two independent lines of business of the Chandler & Farquhar Co., thus permitting a concentration on each line by the corporation that will conduct it in the future, it is believed that better service will be given to the customers of the firm.

Shop Equipment News

Multiple-Spindle Drilling Machine

This machine, known as Model 39, is made by the National Automatic Tool Co., of Richmond, Ind. In its main features it closely follows the lines of the company's Models 40 and 41, and like them it also has the



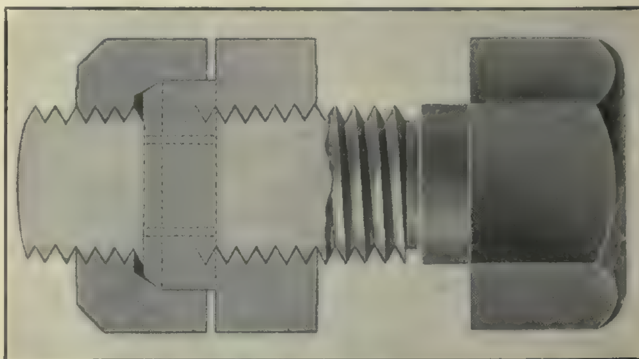
EIGHT-, TWELVE- OR SIXTEEN-SPINDLE DRILLING MACHINE

Rail, 24 and 36 in.; the 24-in. bored for 8 or 12 spindles, and the 36-in. for 8, 12 or 16 spindles, as ordered; spindles bored for Nos. 1 or 2 Morse taper, they have 2-in. vertical adjustment and are also adjustable 3 in. in or out; independent changes of speed, 2 to 1 ratio; three feeds from box; six speeds, ranging from 330 to 2500 r.p.m.; feed per revolution, 0.002 to 0.012; capacity, sixteeen $\frac{5}{16}$-in. holes or twelve $\frac{3}{8}$-in. holes; size of table, 14x40 in.; floor space, 35x58 in.; maximum distance from table to bottom of spindles, 25 in.; weight, 4200 lb. net.

independent spindle speeds, so important in a multiple-spindle machine where different sizes of drills are likely to be used. The sizes and specifications, however, of the Model 39 differ considerably from the other models mentioned.

Improved Locknut

The locknut illustrated is one of the latest forms that have been placed on the market. The nut consists of two parts. The lower half is provided with a cylindrical-shaped projection the extreme end of which is machined

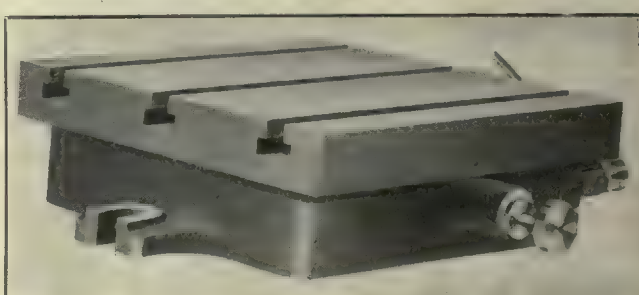


AN IMPROVED FORM OF LOCKNUT

to the shape of a truncated cone. The whole projection is divided into six fingers by means of three cross-slots in a manner somewhat similar to that used in making castellated nuts. The under side of the upper half, or locking part, of the nut is machined to fit over these six fingers as shown. On screwing the nut down the fingers are squeezed inward, firmly locking the lower half of the nut to the bolt. The Drake Locknut is manufactured by the Western Screw and Locknut Co., San Francisco, Calif.

Revolving Turret Table

The mechanism shown has recently been placed on the market by the Milliken Machine Works, West Newton, Mass., and is known as the Universal Production Turret Table. The tool is designed for use on millers, shapers,



UNIVERSAL PRODUCTION TURRET TABLE

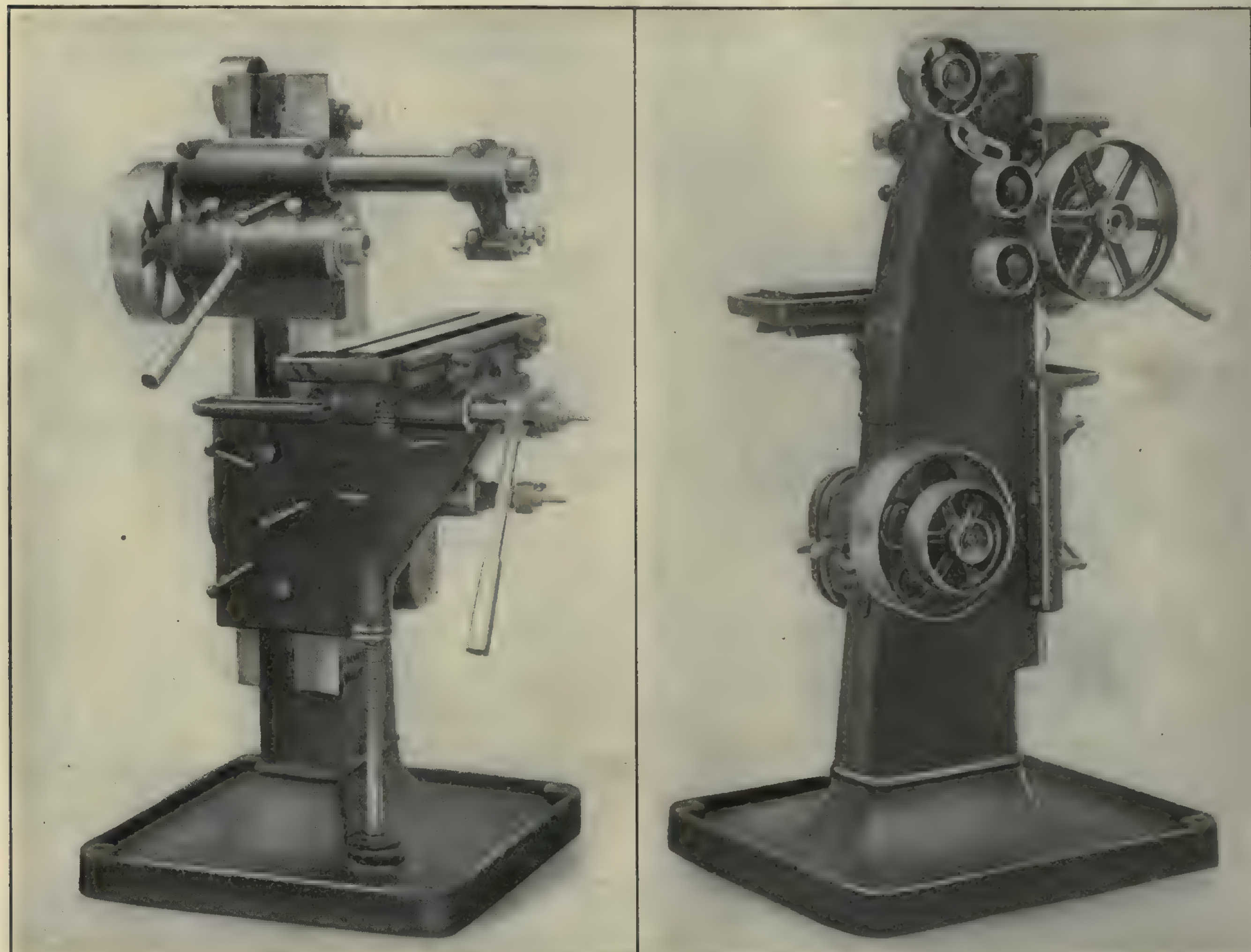
surface grinders, drilling machines, etc., and consists of a base designed to be bolted to the machine table and a top that revolves or swivels on the base. The base is provided with a tongue to fit into the T-slots of the machine table, and with a clamp screw and indicating pin for the turret action. The top, or revolving, plate has three T-slots for securing parts to be machined and a hole in the center for locating the work central.

Hand Millers for Fine Work

The hand miller shown in Figs. 1 and 2, which are front and rear views respectively, is manufactured by the Superior Machine and Engineering Co., Detroit, Mich. It is so made that very little of it extends beyond the base, so that batteries of the millers can be placed in a comparatively small space. It is designed to handle fine work, with speeds high enough for very small mills and also with sufficient power for the largest mills used on this class of machine, the range being from ⅛- to 5-in. mills.

Both the head and knee slide are on the same column at right angles to the usual position. The guiding surfaces are of the long narrow type, and adjusting gibs are provided to take up wear. The sliding members are so made as to be easily locked without disturbing the gib adjustment. The spindle head is counterbalanced and may be operated by means of a hand lever, which is convenient in cutting Woodruff keyways and the like. The knee-elevating screw is of the stationary type, and the nut on the knee is ball bearing. The hand lever on the carriage may be set at any radial angle to suit the operator or position of the work. A screw feed may be had for the table in place of the hand lever, when so ordered. Graduated dials are provided for the elevating and crossfeed screws. An adjustable stop on the column is furnished to gage vertical head movement, and a swinging stop also may be used.

In the back of the column is a two-speed gear box, and outside the column in a box are two transposing gears, doubling these speeds. The three side pulleys are also interchangeable, giving a still wider range of speeds. Other gear or pulley ratios are made as ordered. Small idler pulleys, carried on an adjustable bracket, provide means for keeping the spindle belt tight at all times. The speed gears run in an oil bath. A slotting attachment or vertical milling head may be applied in place of the regular head.



FIGS. 1 AND 2. FRONT AND REAR VIEWS OF NO. 1 HAND MILLER

Column ways, 6¾ in. wide by 37 in. long; angle of front way, 60 deg.; width of flat on column, 2⅞ in., with angle of 1⅞ in.; from edge of column to end of kneeways, 13⅝ in.; length of knee, 14 in.; width of crossways on knee, 6 in.; length of crossways on knee, 12½ in.; width of saddle, 8 in.; working surface of table, 4¼x22 in.; total surface, 7¼x26 in.; T-slot, ⅝ in. wide; overarm, 2¼ in. in diameter; distance from nose of spindle to end of overarm-bracket center, 6½ in.; hole in spindle, No. 10 Brown & Sharpe taper; vertical lever movement of spindle head, 4½ in.; length of table feed, with hand lever, 6 in.; crossfeed of table, 6 in.; vertical adjustment of table under spindle, 12 in.; spindle speeds, eight regular from 150 to 750 r.p.m.; tight and loose countershaft pulleys, 3 in. face by 10 in. in diameter, to run 350 r.p.m.; base of machine, 26x34 in.; height over all, 48½ in.; weight, about 750 lb.

Hydraulic Wheel-Rim Shrinker

The machine shown in Fig. 1 was made by the Metalwood Manufacturing Co., Detroit, Mich., for shrinking automobile-wheel steel rims to exact size. The press is of hydro-mechanical construction, operating the dies by means of a hydraulic cylinder and piston through a series of toggle levers. A front view is given in Fig. 2.

The closure of the dies is regulated by means of a handwheel screw and nut, as shown, the nut carrying a bolt that butts against the stop plate or main casting of the frame. Variation in size is taken care of by bringing this screw bolt farther forward, which decreases the movement of the ram; or by receding the bolt, the cylinder ram is allowed a longer movement and more closure of the dies. Any lost motion in the toggles is taken up by springs. The toggles are adjusted for angularity by outside adjusting screws, as shown. All toggle parts are of carbon steel, carefully machined.

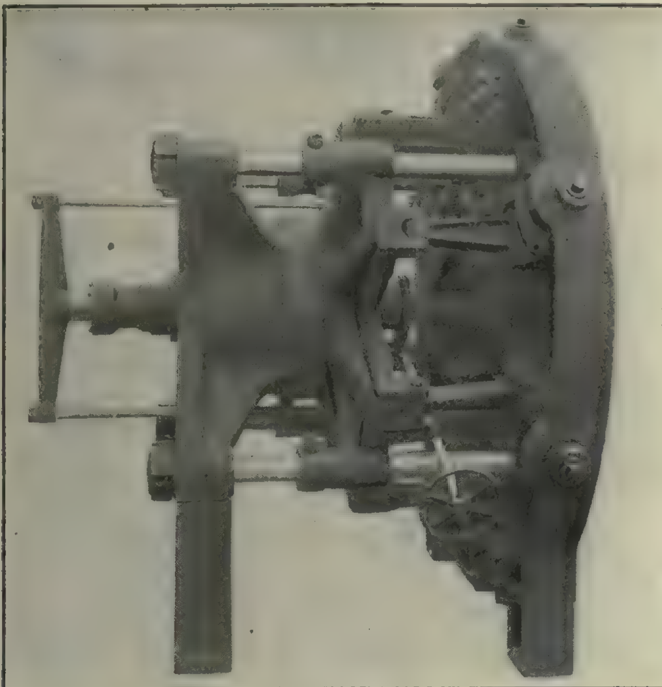


FIG. 1. HYDRAULIC WHEEL-RIM SHRINKER

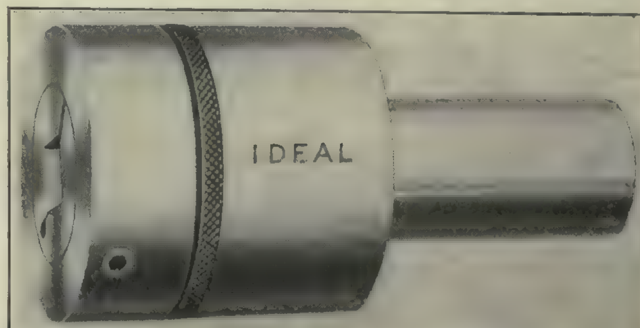
FIG. 2. FRONT VIEW, SHOWING DIES

The press is made entirely of steel, except the legs. There is a hydraulic pull-back, carried on a constant pressure from the accumulator line. The ram spider, to which the toggles are connected, has babbitted bearings sliding on heavy bars. The ram is of hard semisteel, finished and polished, and is so designed that the packing may be renewed with little trouble. The U-type chrome-leather packing is used in both the main and pull-back cylinders.

The machine is designed to operate under from 1000 to 2000 lb. per sq.in. hydraulic pressure. At 1000 lb. about 675 tons' pressure is exerted on the tires to be pressed. The dies are of carbon steel, fitted with tongue and groove, and are held in place by screws. The machine, under test, made from eight to nine strokes per minute. It weighs about 26,000 lb.

Releasing Tap and Die Holder for Turret Work

The releasing tap and die holder illustrated herewith is one that has recently made its appearance on the market. In use the action of the tool is as follows: The tap or die is brought up to the work, being driven by two pins, and when the turret stops the tool continues its work until it has moved forward far enough to release these driving pins. The tool then spins with the work until reversed. An adjusting screw is provided for changing the amount of tool travel after the turret stops, thus making it possible to work up close to a shoulder. The reverse is accomplished by means of a roller placed in a taper groove. The instant the holder starts to reverse the roller runs up the taper groove, grips the shank and backs up the tool. Left-hand threads may be handled by removing the roller and placing it in a second taper groove provided for the purpose. By placing rollers in both grooves a non-releasing holder is secured. The entire mechanism is inclosed to protect it from chips and dirt. The tool is being marketed by the Ideal Brass Co., of Indianapolis, Ind.



RELEASING TAP AND DIE HOLDER

How Are Steel Beads Manufactured?

An inquirer asks how the small, bright, steel beads used for decorative purposes are made. The beads referred to are very hard and shiny, the hole through them being quite small. Any contributions on this subject will be welcome.

Metric Conversion Tables—Erratum

On page 703, Vol. 45, the equivalent of 15.2 mm. should be 0.59842 in. instead of 0.40157 in., as published.

New Publications

Modern Machine-Shop Practice—Six volumes; 2324 pp.; profusely illustrated; each volume indexed; flexibly bound. Published by American Technical Society, Chicago, Ill. Price, $17.80.

This is the seventh edition of this set of books dealing with machine-shop practice. It is a series of treatises, each written by a specialist or, in some cases, by two or more men in coöperation. As an example of the printer's art the work is excellent. The illustrations are numerous, and many are of an unusual and interesting character.

To indicate the scope of this work, the contents of each volume is given: Vol. 1—Machine-Shop Work (Hand and Power Tools); Machine-Shop Work (Gear Cutting, Turret Lathes and Screw Machines); Machine-Shop Work (Modern Manufactures). Vol. 2—Machine-Shop Management; Metallurgy; Welding; Die Making and Metal Stamping. Vol. 3—Tool Making; Tool Design. Vol. 4—Foundry Work; Forging. Vol. 5—Pattern Making; Mechanical Drawing. Vol. 6—Machine Drawing (General Principles); Machine Drawing (Design of Duplex Pump); Machine Drawing (Design of Direct-Current Generator); Automobile-Shop Work.

Elementary Cams—By Franklin DeRonde Furman. Ninety 5¾x9-in. pages; 69 illustrations; indexed; cloth bound. Published by John Wiley & Sons, Inc., New York City. Price, $1.25.

The author in his preface points out very properly that there is a sharp contrast between the development of the gear and the cam. Articles in technical journals and numerous books have dealt with the former, but little has been written about the latter. Shop practice in regard to gears has been carried to a high degree of perfection. On the other hand, cams are too often designed "by eye" instead of being based upon an intelligent theory of their action. Thus, this book on elementary cams has been prepared with a view to gathering together in permanent form information on the various types in common use and how to design a representative cam in each class. Most of the base curves generally followed in cam design are described, and their application is pointed out.

There are five chapters or sections, with these headings: Definitions and Classification; Method of Construction of Base Curves in Common Use; Cam Problems and Exercise Problems; Timing and Interference of Cams; Cams for Reproducing Given Curves or Figures.

This book will be of service to anyone having to deal with the design of cams.

Steam Power—By C. F. Hirshfeld and T. C. Ulbricht. First edition; four hundred and twenty 7½x5-in. pages; cloth; indexed; illustrated by 228 charts, diagrams and cuts. Published by John Wiley & Sons, New York City and London. Price, $2.

The purpose of this book, as stated by the authors, is to present such information to engineers whose work does not require knowledge of the more complicated thermodynamic principles as will give them a correct viewpoint with regard to the use of heat in the power plant, even though it does not enter deeply into the theoretical considerations leading up to that viewpoint; to supply the tools required for the solution of power-plant problems of the common sort. Mathematical treatment has largely been eliminated, and anyone familiar with elementary algebra should be able to understand readily such equations as are found in this book. Brief explanations of physical and chemical concepts are given in every case in which the text requires their use, so that those who have not studied these subjects should have little difficulty in reading this part of the text understandingly.

The first natural division of the table of contents comprises (1) Physical Conceptions and Units, (2) The Heat-Power Plant, (3) Steam, (4) The Ideal Steam Engine, (5) and (6) Entropy Diagrams and Temperature Entropy Diagrams of Steam Cycles. Then come (7) The Real Steam Engine, (8) The Indicator Diagrams and Derived Values, (9) Compounding, (10) The D-Slide Valve, (11) Corliss and Other High-Efficiency Engines, (12) Regulation, (13) The Steam Turbine, (14) Condensers and Related Apparatus. Combustion and Fuels (Chapters 15 and 16) deal with the theoretical aspect of these subjects, giving definitions and the heat values and composition of various combustibles, followed by Steam Boilers (17), Recovery of Waste Heat (18), and Auxiliaries (19), closing with a few pages of steam tables.

This is one of the "Wiley Technical Series" for vocational and industrial schools and is well adapted to the purpose intended.

A Bibliography on "English for Engineers"—By Wilbur Owen Sypherd. Sixty-three 4¾x7¼-in. pages. Published by Scott, Foresman & Co., New York City. Price 25c.

This little bibliography is intended to offer to those who are interested a reasonably ample list of references to books and articles published prior to January, 1916, dealing with the art and practice of technical writing. Forty-five pages of the book are devoted to this general list. The references come from many sources, cover a large part of the field of technical journalism, and should be of considerable help to anyone who is studying this subject or preparing himself for editorial or journalistic work. The latter part of the book, from page 47 on, is entitled "The Engineer's Library." This part of the book does not seem as well planned or worked out as the matter that precedes it. For illustration, the wide field of mechanical engineering is covered with only twenty-six titles. Of these, fifteen—that is, more than one-half—deal with steam- or power-plant engineering. In future editions either this latter part of the book should be suppressed or else it should be much extended in order to live up to its name with a reasonable degree of comprehensiveness.

Obituary

Ellis J. Hannum, secretary of the Newton Machine Tool Works, Inc., Philadelphia, Penn., died on Jan. 7.

William W. Smalley, president and treasurer of the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., died on Dec. 27, 1916.

Col. Herbert Hughes, director of William Jessop & Sons, Inc., Sheffield, England, died recently. Colonel Hughes represented the British government at the International Conference on Trade Marks held at Washington, D. C., a few years ago and was quite well known in American commercial circles.

Catalogs Wanted

The Duntley Products Co., Erie, Penn., manufacturing pneumatic cleaners, is desirous of compiling a catalog file and would be glad to receive from manufacturers copies of their catalogs.

The Mont Color and Chemical Co., Monticello, N. Y., which has recently been formed to produce chemicals, intermediates, and dyes from coal tar, desires to receive catalogs of machinery for use in its factory.

Business Items

The Toledo Machine and Tool Co., Toledo, Ohio, is moving into the new two-story shop addition it has just completed.

The Parker Rust-Proof Co., Detroit, Mich., has recently completed negotiations for the T. W. Coslett (Coslettizing) patents.

The Light Manufacturing Foundry Co. has established a new office in the Penobscot Building in Detroit. C. F. McRae will be in charge.

The Chicago Pneumatic Tool Co. held the annual convention of its sales factory organizations at the Great Northern Hotel, Chicago, on Jan. 11, 12 and 13.

The Union Forging Co., Union, N. Y., has recently completed a 75x100-ft. addition to its factory. Another addition to be used for heat treating and sand blasting will be erected in the near future.

The Van Norman Machine Tool Co., Springfield, Mass., has increased its capital stock from $400,000 to $1,000,000. The business of the company since its reorganization in 1912 has grown very rapidly, the plant and equipment being doubled in 1915. Additions will be made in the near future.

The Spranger Rim and Wheel Co., Detroit, has changed its name to the Spranger Wheel Co. and has purchased 4½ acres at Market Place and Clayton Ave., Detroit. Plans are being drawn for a 175x300-ft., two-story factory. The necessary machinery has already been contracted for. The capital of the company has also been increased from $100,000 to $300,000. John A. Lancaster, formerly of Louisville, Ky., is the new treasurer and general manager. Howard E. Adams and J. Robert Wilkin are to handle the sales. Frank Spranger remains as superintendent.

The Quickwork Co., of Ohio, has been organized for the purpose of taking over and operating the machinery business of H. Collier Smith, of Detroit. The company is capitalized at $400,000. The management of the business remains unchanged, H. Collier Smith being president and general manager, H. E. Groves, vice-president, A. F. Smith, secretary and treasurer, K. J. O'Leary, production manager, R. H. Sims, sales manager, and Harry G. Smith head of the engineering department. Quickwork machines will be manufactured at St. Marys, Ohio, where the company has purchased a modern, well-equipped plant on 21 acres within the city limits. General offices and salesrooms will be in Detroit as heretofore.

Personals

J. M. Schenk has been made president of the Lebanon Chain Works, Lebanon, Penn.

Arthur M. Watkins has been made treasurer of the Inter-Continental Machinery Corporation.

O. R. Adams, Rochester, N. Y., has just opened a new salesroom for metal-working machinery.

W. L. Batt has been appointed sales manager of the Hess-Bright Manufacturing Co., Philadelphia, Penn.

H. A. Daniels will be field representative of the gear department of the Bausch Machine Tool Co., Springfield, Mass.

J. G. Blunt has recently been appointed mechanical engineer of the American Locomotive Co. at Schenectady, N. Y.

The Richardson Phenix Co., Milwaukee Wis., has opened a sales office in Cleveland which will be in charge of W. J. Oettinger.

J. R. Greenwood has become associated with the office of Charles H. Higgins, who is now located at 165 Broadway, New York City.

H. D. Gumpper, recently associated with the Emerson Co., has joined the electric truck sales department of the Buda Co., Chicago, Ill.

Joseph Froehlich, for the past 10 years superintendent and factory manager of the F. L. Schmidt shops, New York City, has resigned his position.

L. E. Thomas, formerly general manager of the Birdsboro Steam Foundry and Machine Co., Birdsboro, Penn., has been made vice-president of the same concern.

The Bengol Trading Co., Inc., 92 William St., New York City, has been organized for the purpose of trading in American-made products throughout the Russian Empire.

G. W. Wagstaff, who formerly represented the Bethlehem Steel Co. in northern Ohio, has become associated with the Onondaga Steel Co., Syracuse, N. Y., and will represent them in northern Ohio, Pennsylvania, Buffalo and Detroit.

F. E. Traphagen, general foreman of factory No. 2 of the Vallorber Jewel Co., Lancaster, Penn., has resigned his position to become general foreman of the machine shop of the American Machine Tool Co., Hackettstown, N. J.

The Bosch Magneto Co., Springfield, Mass., and Plainfield, N. J., has reorganized its purchasing department and hereafter all purchases will be handled from the Springfield office. The buying of materials for the product will be in charge of S. T. Plimpton and John Pauly. The purchase of equipment and supplies will be in charge of P. G. Puffer and C. E. Spalding.

The Union Switch and Signal Co. merged into the Westinghouse Air Brake Co. on Jan. 12. The officers of the company are as follows: Chairman of the board, W. D. Uptegraff; president, A. L. Humphrey; vice-president, John F. Miller; vice-president and treasurer, T. W. Siemon; vice-president in charge of sales, G. A. Blackmore, acting vice-president and secretary, T. S. Grubbs; controller, C. A. Rowan; auditor, F. V. Shannon; assistant treasurer, M. K. Garrett.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month. Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings first Wednesday of each month, Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Electric-Driven Herringbone-Gear Planer

SYNOPSIS—The R. D. Nuttall Co. has had in operation for a little over a year a large electric-driven gear planer which is used principally for herringbone gears. The tool slide is advanced and returned and the gear blank is oscillated to give the required helix angle to the teeth under the control of a reversing motor. The cutting speed is varied by changing the motor speed. The indexing mechanism is driven by a small independent motor.

The increasing demand for large cut herringbone gears caused the R. D. Nuttall Co., of Pittsburgh, Penn., something over a year ago to install a large gear planer of special design. Though used principally for herringbone gears, an occasional spur gear is cut on this machine. It was built at the Gleason Works and embodies some features of the machines regularly built by that firm. However, the engineers of the Nuttall Co. assisted in its design and it can properly be looked upon as a joint product of both firms. It is electrically controlled and operated and presents an interesting application of the variable-speed reversing motor to a special machine tool.

The maximum capacity of the machine in herringbone gears is a diameter of 16 ft. and a face width of 110 in. —that is, 55 in. for each half of the herringbone. The maximum diameter for spur gears is likewise 16 ft., and the maximum face width 55 in. The minimum pinion diameter that can be cut for both herringbones and spurs is 18 in.

A front view of the machine is given in Fig. 1, which, however, does not show a small portion of the left-hand end of the bed, or rail. This bed is stationary, being firmly attached to a heavy concrete foundation, which is independent of the shop building and shop floor. At the right is the headstock, carrying the work spindle of the machine and the indexing wheel with its mechanism. This headstock is adjustable along a cast-iron bedplate to permit setting up for gears of various diameters. The left-hand end of the work arbor, or pinion shaft, is carried in a supporting bearing, as shown in Fig. 2.

Upon the bed, or rail, is a sliding saddle carrying the toolhead. At the left-hand end of the machine is a variable-speed reversing motor, shown in Fig. 3, and beside it the electrical controlling mechanism, shown in Fig. 4. The indexing wheel and the mechanism carried upon it are best seen in the final illustration, Fig. 5.

The 20-hp., 220-volt, direct-current variable-speed, reversing motor is started and stopped by the push buttons at the right-hand end of the bed and drives through gearing on to two horizontal shafts running through the bed of the machine. The shorter of these shafts extends for only about one-half the length of the bed, where it drives a gear meshing with a rack beneath the saddle carrying the tool head. The reversing of the motor, and because of this the change in the direction of motion of the saddle to give the cutting and return strokes, is accomplished through the dogs and the electric switch shown in Fig. 4. These dogs are set in the same way as those used on planers and control the reversing switch.

The electric equipment for reversing and speed changing is shown at the left in Fig. 4. In all there are 13 different motor speeds and thus 13 cutting speeds, the maximum being 100 ft. per min.

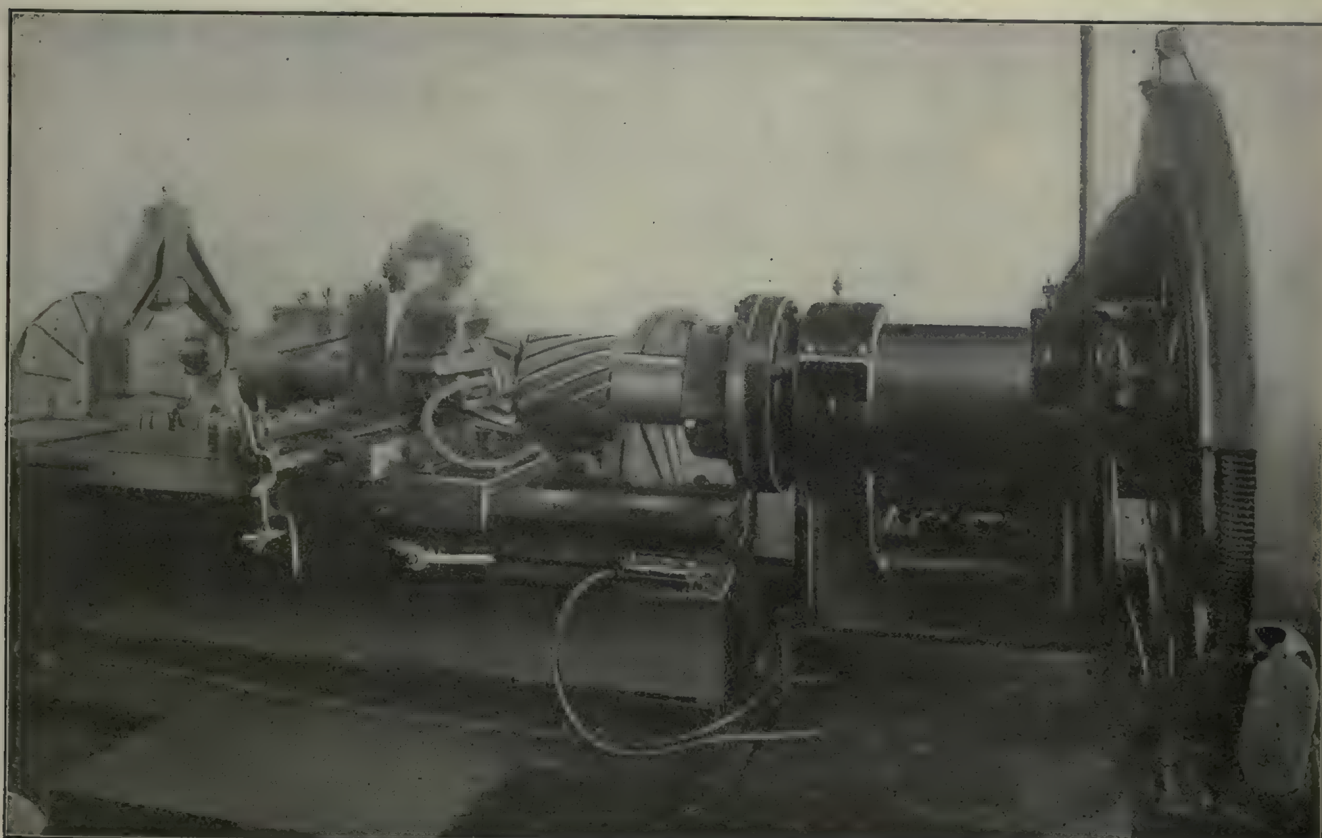


FIG. 1. FRONT VIEW OF ELECTRIC-DRIVEN HERRINGBONE-GEAR PLANER

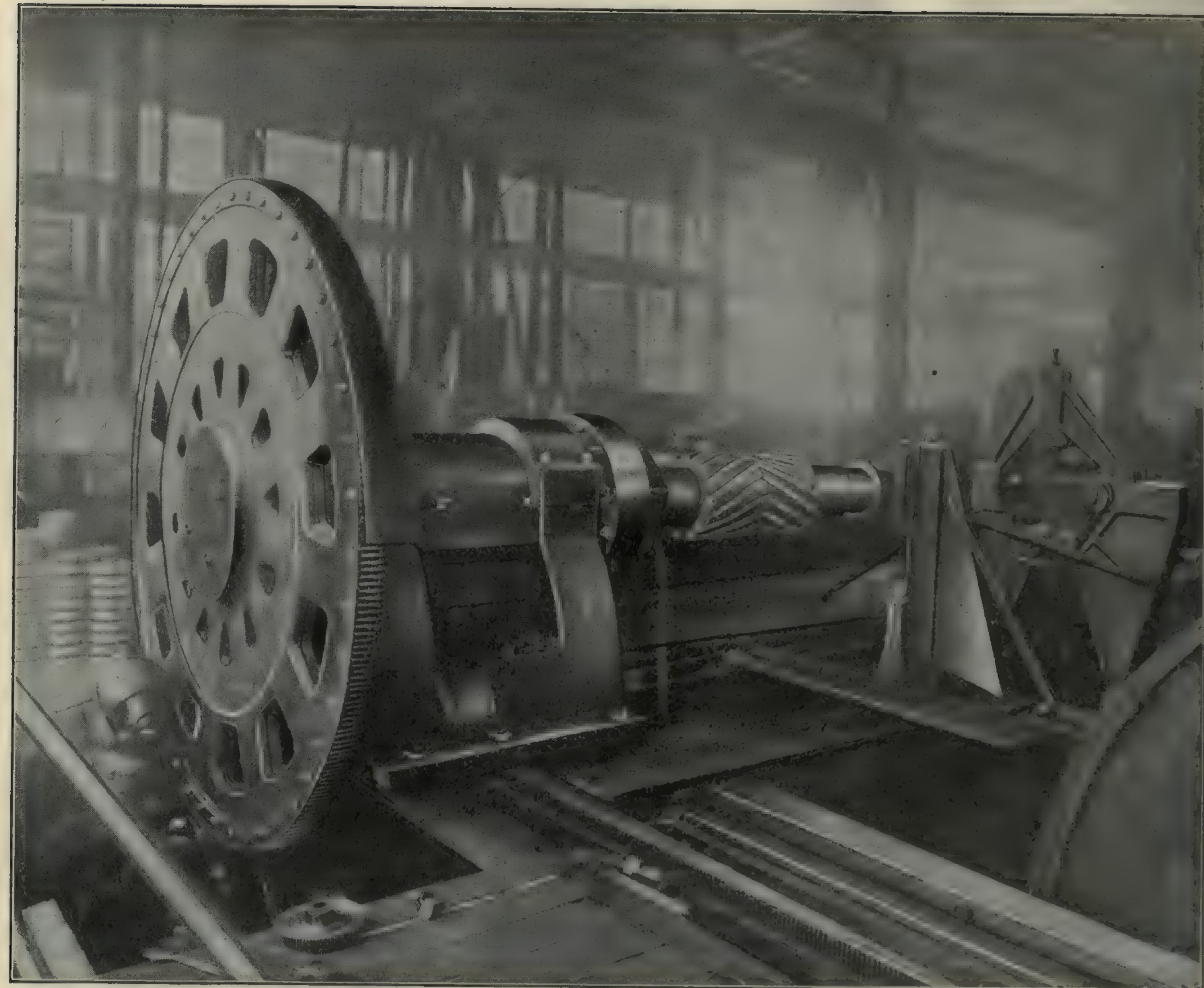


FIG. 2. REAR OF ELECTRIC-DRIVEN HERRINGBONE-GEAR PLANER

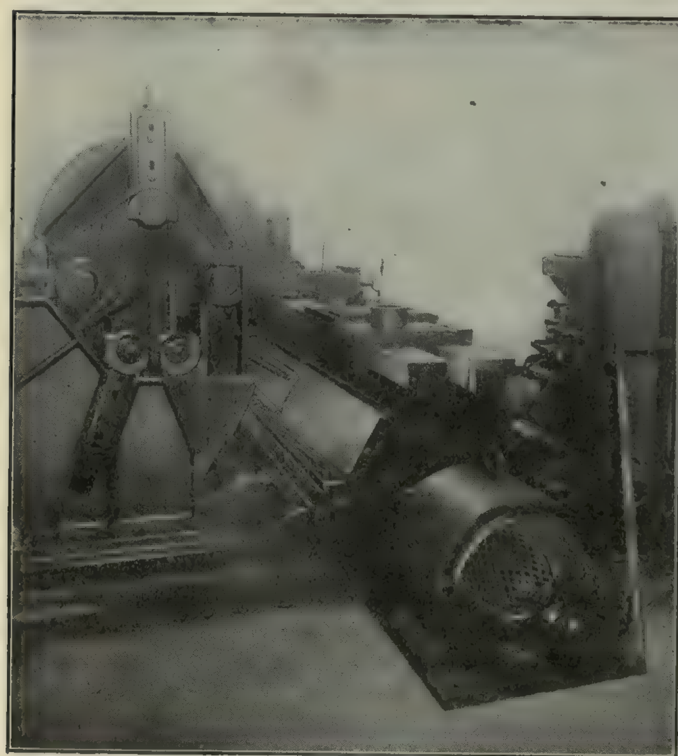


FIG. 3. THE DRIVING MOTOR

FIG. 4. THE ELECTRICAL CONTROL

The second and longer shaft driven from the motor passes through to the pit containing the indexing wheel. There it drives a short vertical shaft through bevel gears, and this, in turn, through compound gearing and a long secondary shaft, drives a short wormshaft known as the "fantail." The worm on this shaft meshes with the index wheel and supplies the drive for oscillating the gear

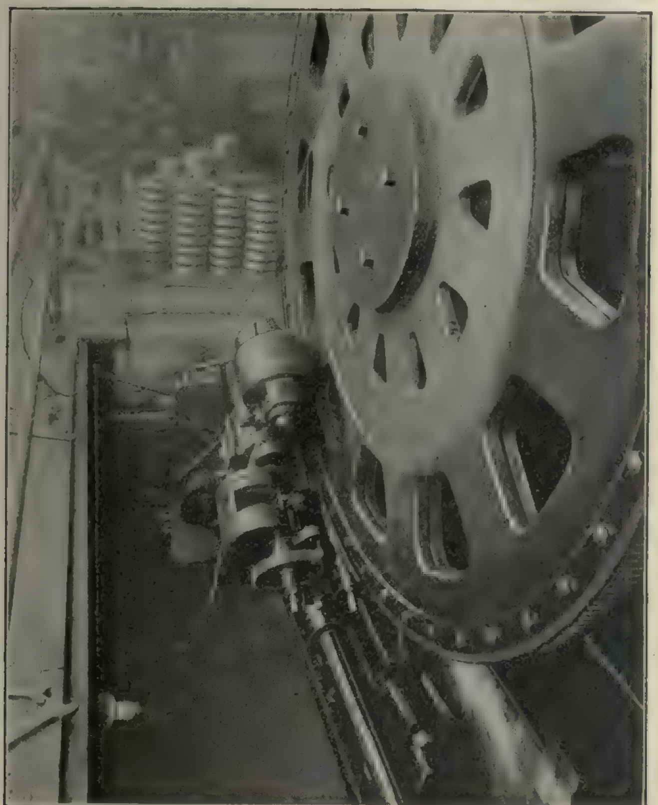


FIG. 5. INDEX WHEEL AND INDEXING MECHANISM

blank to produce the required helix angle, which has been standardized at 23 deg. for herringbone and helical gears.

The cutting tool is carried in a clapper box in a head, as shown in Fig. 1. The former, to give the tooth shape, is located on the back of the head and does not show in any of the illustrations. It does not differ in principle from that used on spur-gear planers.

The clapper box, carrying the tool, is set in a circular slide, shown in Fig. 1, so that the angle of the tool can be changed to cut both sides of a herringbone pinion without changing tool heads. On pinions and small herringbone gears each half of the gear is cut in the same direction; that is, one side is cut from the outside to the center and the other from the center to the outside. Large herringbone gears, however, are always cut from the outside in. For this work two tool heads are needed, and are provided, one being left-hand and the other right-hand.

Method of Feeding

The tool is fed in by a ratchet feed operated by dogs on the front of the bed. A wrench is shown on the nut of one of these dogs in Fig. 1. The return of the tool after the proper depth has been reached is by hand. A positive adjustable stop determines the depth of cut, and when this stop is reached a friction in the head of the ratchet-feed lever slips and prevents damage to the feeding mechanism.

The method of holding pinions in the machine is shown in Fig. 1, the chuck having been made by the Nuttall Co. A flange is integral on the end of the headstock spindle. Against this is bolted another flange, carrying a chuck, one-half of which has been cut away and is held in place by clamping bolts. A series of split bushings are provided to go inside this chuck and grip the ends of straight shafts. In case a pinion shaft has a tapered end the clamping bushing is made with a taper to correspond to that of the shaft.

In addition to this arrangement for large gears, a series of faceplates is provided, the smallest of which is 4 ft. and the largest 12 ft. in diameter. These are so arranged that one faceplate fits the one next smaller, thus providing a maximum range of capacity with a minimum number of pieces. A part of the rim of the largest faceplate is shown at the extreme right in Fig. 2. For use on very large gears, a roller support is provided which is brought in contact with the rim of the gear blank opposite to the position of the cutting tool. This device is not shown in any of the illustrations. On very long shafts the roller rest shown at the left in Fig. 3 is used. The position of this rest is adjustable in both directions with reference to the bed of the machine, to adapt it for various sizes of gears. The indexing mechanism is the same in principle as that which is used on regular Gleason gear planers. It is shown attached to the lower side of the indexing wheel in Fig. 5. The small operating motor is controlled from a switchboard on the wall. When it becomes necessary to index, this motor is started and the indexing mechanism is tripped by means of the cord shown running over the top of the index-wheel guard in Fig. 1. A pull on this cord permits the completion of one indexing cycle, which may index for one tooth or for a fraction of a tooth, as one-half or one-quarter, depending upon the way in which the indexing mechanism is geared.

Sammy's Shop—Who Wants the All-Around Man?

By W. Osborne

"Sammy, if things go on in the way they have been going lately in the shops of this country we'll soon find out that we're in a bad way. There is a need everywhere for trained men." Mr. Brown was very much in earnest. He was holding a magazine in his hand, and Sammy judged that he had been reading it. "The shops of the country are being called upon to do the work that keeps the wheels of civilization going."

Mr. Brown owned the shop and Sammy listened respectfully, although he did not see any close connection between Mr. Brown's remarks and the work of building cornshellers. So he answered with a noncommittal "Well!"

"If you kept yourself in touch with all that's going on in the world by reading such articles as this one," he touched the magazine in his hand, "you'd soon see that the situation is serious if not alarming. The old apprenticeship system has been allowed to die and we have nothing to take its place. Some of the big companies have schools, but they are for the few; and even at that they don't begin to furnish all-around workmen for even the companies that have them. Now, what are we going to do about it? Just tell me, what are we going to do about it?"

This query was aimed so directly at Sammy that he had to say something in reply. Not having felt this crying need himself, he did not know very much about it. So he took off in a direction that he hoped would lead somewhere else.

"We had an all-around man working here once. He could run any machine in the shop, and could do blacksmithing and floorwork. He could run a machine better than a green man who had never run it before, but he could not run it as well as the regular fellow that usually ran it.

"He was handy to have around whenever any of the other men were sick, but our men are a healthy lot and don't often get sick; and he was a hard man to keep going when everybody else was here. He did so much less work than an ordinary man that he set a bad example in that way. He quit one day because he said he was not being paid for what he knew. But he was being paid for what he did."

"Do you think the state should establish schools for teaching children how to make a living?" asked Mr. Brown.

"Yes, I do. If the schools would leave off some of the frills that most of the children never have any practical use for, and teach in their stead some of the things that most of the children will have use for, I think it would be better. But about the way the country is going without the apprenticeship system, did you ever think that some of the writers are away off? I came up under that system. I am good enough to keep my job as foreman of your shop. I served full time before I was called a machinist. If a foreman ever explained a principle to me I fail to recall it. Nature put a big bump of inquisitiveness into me so that I liked to find out why things were so, and I just naturally got the repair jobs and outside jobs. It saved the foreman trouble on such work to have someone do some of the thinking about the proper combination of details. The work that we did in those days was not, on an average, as well done as the work we are now doing.

How Sammy First Made and Now Makes Mr. Brown's Cornshellers

"Just wait a minute, now, Mr. Brown. The first cornshellers that we made were built under the jobbing system, where the man that turned the shaft also drilled and slotted it, planed the squared end and cut the keyways in it. The man that turned a wheel drilled it for an oil hole, if it needed one. If it needed a setscrew, he drilled the hole and tapped it too. Some fellows that stayed with us long enough could build a complete cornsheller good enough to be sold. It took them some time to do it, and those cornshellers cost so much that it was hard work for you to find a man with money enough to be able to buy one.

"Now the man that turns the main shaft turns all the shafts we use. I believe he cannot grind a twist drill properly, but he is not running a drill press, he is doing turning on a lathe, and he is turning more shafts in a day than the all-around man could turn in a week; and he is turning them lots better. It is just so with the other parts of the machine. Each man can do his part, and he can do it well.

"Some men have been on several of the machines. There's Bob. He comes nearer being an all-around man than any one in the place. He does the repair work and the odd jobs and gets mighty restless if he is kept at any work on one machine too long."

Mr. Brown looked at the article in his hand, rubbed his other hand over his head, looked Sammy over carefully and, after glancing around at the men in the shop, said, "We have a nice, steady lot of men, Sammy, but don't you think that we would do a lot better if we had the shop full of men who were ambitious enough to be working to improve themselves and become all-around men?"

The Lot of the Specialist Is Not So Bad After All, All Things Being Considered

Sammy wrinkled up his forehead. He knew what he wanted to say, but he did not know how to say it so that Mr. Brown would understand him. "It takes a boy three years to get a good start at being an all-around workman. It takes a smart boy about three to six months to be a one-machine man who is getting about as much wages as the apprentice is getting when he has just finished his time. The average specialist continues to get at least as much as the average machinist, and he has as steady a job and under as good conditions. When it comes to looking for another job such as he likes to work at, there are many more shops that want men of his kind than there are that really want and have work for all-around men. Tool makers, designers and foremen are as apt to develop from the fellow that just got a job in the shop at the best wages going, as they are to develop from the boy who has served his time. All roads lead up for the chap that is mechanically interested, industrious, wide awake and a thinker. None of them do for the fellow who is the opposite. Now to try to answer your question: If we had really all-around men on these machines building our cornshellers, we couldn't keep them there for love or money; and, anyhow, how long would a man continue to be an all-around man if he was kept working on one machine doing one thing? And how often could I change him if I always need all of that one thing that the machine can get out?

"Why don't we use machines each one of which will turn, drill, grind, plane, cut pipe, mill, and generate gears? When we find that is a good plan we will need the all-around men to run the machines."

Mr. Brown returned to the office with the air of a man who felt that he was sowing seed on barren ground, and Sammy drifted over to where the last lot of cornshellers was being put together.

Opportunity for Manufacturers

The Purchasing Agents Association of Rochester, N. Y., whose membership is made up of purchasing agents, superintendents and production managers, has recently decided to allow representatives of manufacturers the privilege of addressing its members at the regular meetings. The only conditions imposed is that no orders shall be solicited at the meeting. It is believed that the members would derive great benefit from a program of this character and that many manufacturers would seize this opportunity to obtain a hearing. Communications should be addressed to E. A. Scheibe, care of the Bausch & Lomb Optical Co., Rochester, N. Y.

Production Time Studies To Check Rates and Operations*

By Dwight V. Merrick†

SYNOPSIS—If a task is continually performed in longer than the set time, it is essential to find out the reason. This is done by making a production time study. It shows whether operator, machine or rate is at fault. The method of making and analyzing such studies is shown.

After a time study has been completed, an instruction card prepared, and a rate set, there is sometimes complaint made that the operator is unable to reach the standard called for by the instruction card. This may be due to one or more of several causes: Lack of skill on the part of the operator; trouble with the machine; improper equipment; unnoticed or unnecessary delays or wastes of time; or an incorrect time study.

If an operator consistently fails to perform his task in the allotted time, it is essential that his work be studied to ascertain which of the above enumerated items is the cause of the failure. If the fault lies with the operator, he may be corrected or put under instruction. If the machine is out of order, the necessity of repairs or adjustment becomes at once apparent. If the time study has been carelessly or incorrectly made, that fact will be revealed and the rate called for by the instruction card can be canceled pending the correction of the study and the establishment of a new rate. It should be said here that when the original time study is made and computed according to the methods previously described, the rate will seldom be found to be incorrect, but that the trouble will lie with the machine or the operator. The study that is made to determine the cause of failure of an operator to reach the standard set is known as a "production study."

A production study consists in an observation of a job during its entire course, the time of the various elements or cycles of elements being taken, together with the time of all interruptions or delays of any kind whatever. The production study should begin preferably when the operator starts work in the morning and should continue throughout the day, or possibly for several days, provided the job lasts that long, and the nature of the work requires it. It is especially desirable that the study continue for an entire day if the work is of such a nature as to require considerable exertion on the part of the operator, in order that the effects of fatigue may be determined. It often happens that a time study which is apparently correct for jobs whose duration is but an hour

OBSERVATION SHEET Fleming Bros. Auto. Polisher 1445-2M 9-15

OBSERVER'S NAME Monroe MACHINE NO. 18788 DATE 4-26 1916

WORKMAN'S NAME AND QUALIFICATIONS J. Grofrowski, Good

PIECE Model 1895 Musket Barrel

OPERATION #1 Finish Polish

LINE	COLUMN	START	FINISH	DIFFERENCE	NOTE
1	7	11.61	12.29	.68	Getting Work Tray
1	13	23.89	24.22	.33	"
1	20	7.78	8.21	.43	"
					1.25

	DETAILED OPERATIONS	1	2	3	4	5	6	7	8	9	10
1	Pick up Barrel & Chain Fix	09 09	10 2.01	09 3.93	13 5.88	13 7.83	10 9.77	* 08 12.37	09 14.28	10 16.21	10 18.18
2	Tighten Fixture & Clutch In	05 14	06 2.07	06 3.99	06 5.94	06 7.89	05 9.82	05 12.42	05 14.33	04 16.25	05 18.23
3	POLISH 282 R.P.M.	1.33 1.47	1.32 3.39	1.32 5.31	1.32 7.26	1.31 9.20	1.32 11.14	1.33 13.75	1.33 15.66	1.33 17.58	1.34 19.57
4	RETURN CARRIAGE	.37 1.84	37 3.76	36 5.67	36 7.62	35 9.55	36 11.50	36 14.11	37 16.03	36 17.94	37 19.94
5	Loosen Fix. & Remove Barrel	07 1.91	08 3.84	08 5.75	08 7.70	~~12~~ 9.67	11 11.61	08 14.19	08 16.11	~~14~~ 18.08	09 20.03

	DETAILED OPERATIONS	11	12	13	14	15	16	17	18	19	20	AVERAGE	MINIMUM TIME
1	Pick up Barrel & Chain Fix	09 20.12	09 22.04	* 13 24.35	11 26.32	10 28.25	10 0.18	10 2.11	10 4.04	10 5.97	* 08 8.29	200 .10	08 .08
2	Tighten Fixture & Clutch In	05 20.17	05 22.09	09 24.44	05 26.37	05 28.30	05 0.23	05 2.16	05 4.09	05 6.02	05 8.34	98 .0516	04 .041E
3	POLISH 282 R.P.M.	1.33 21.50	1.35 23.42	1.34 25.78	1.32 27.72	1.33 29.63	1.33 1.55	1.32 3.48	1.32 5.41	1.32 7.34	1.32 9.66		
4	RETURN CARRIAGE	36 21.86	36 23.78	36 26.14	35 28.07	37 0.00	37 1.92	37 3.85	37 5.78	36 7.70	36 10.02		
5	Loosen Fix. & Remove Barrel	09 21.95	11 23.89	07 26.21	08 28.15	08 0.08	10 2.02	09 3.94	09 5.87	08 7.78	08 10.12	154 .0855	07 .0684

INDIVIDUAL DEVIATIONS

1 — 1.25
2 — 1.29
3 —
4 —
5 — 1.22
3 | 3.76
AVE. DEVIATION → 1.25

13 #90 Emery used
14 19½" " wheel
15 Barrel revolves 282 R.P.M.
16 24 Barrels in Tray
17 Wheel changed every 150 pcs.
18 R.P.M. of wheel 1525
19 Length of run 25½"
20 Feed .066

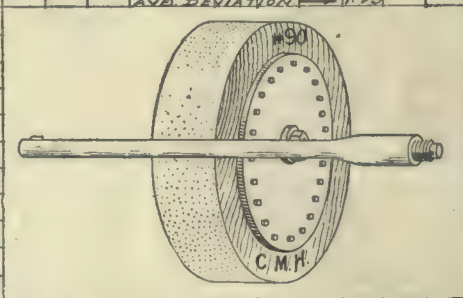


FIG. 1. ORIGINAL TIME STUDY OF THE POLISHING OF A RIFLE BARREL

†Consulting engineer, New York City.

Note—This article is one of several by the same author dealing with the general subject of "Time Study for Machine Tools." Other articles of this series appeared on pages 177 and 221.

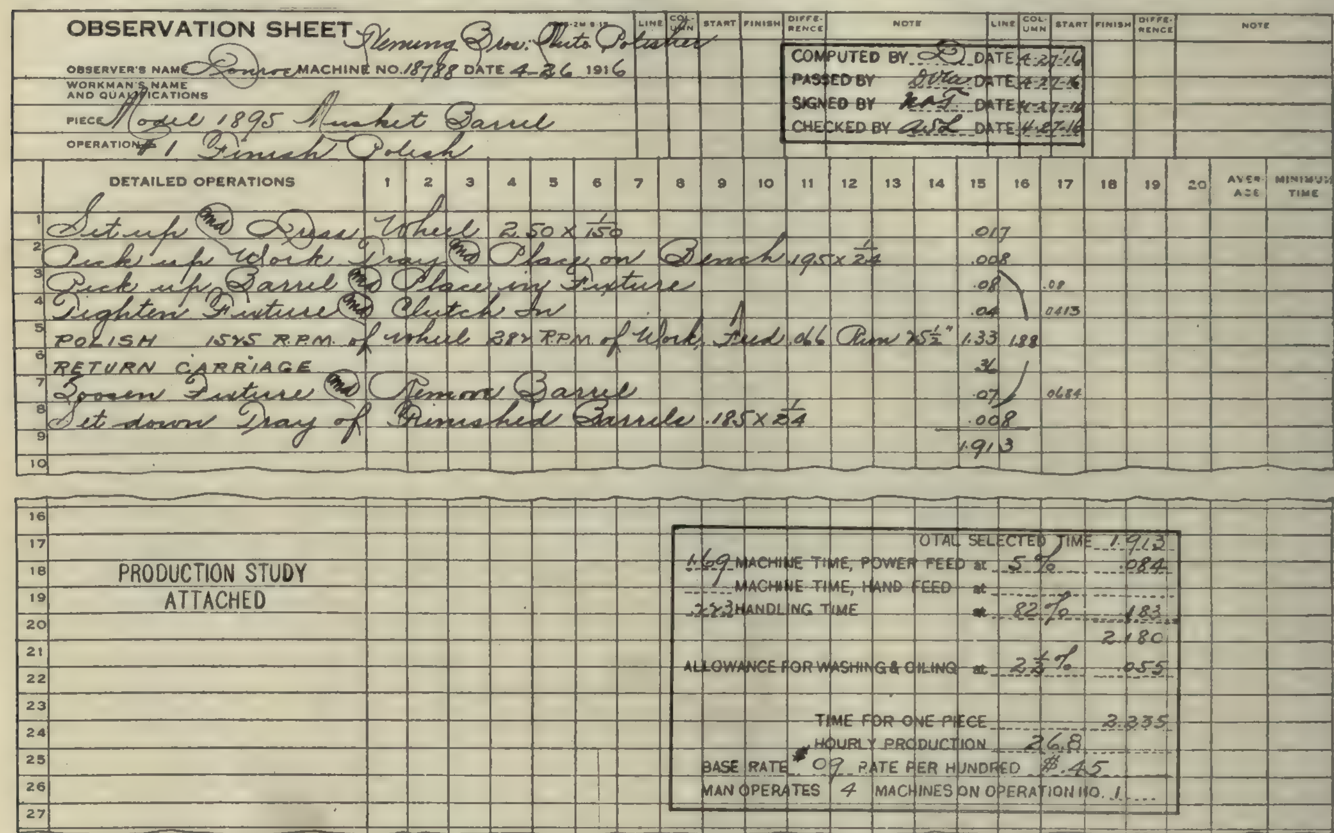
or two will set a rate which is far too severe if the job is to be continued for eight or ten hours, due to the cumulative effect of fatigue in the longer job.

In making the production study, the watch should be started at the commencement of work and allowed to run continuously until the study is completed. The observer notes the elapsed time at the completion of each element or cycle and at the beginning and end of each interruption, noting the class of work or the nature of the interruption or delay in each case. The observer takes differences, thus obtaining the individual times of the several elements, as the study proceeds, provided that there is a sufficiently long interval between the readings to permit him to do this. The taking of differences on the spot and the frequent comparison of the several individual times enable the observer to detect discrepancies in the operator's work and to determine and apply the remedy at once. This is clearly set forth in the study which is illustrated.

At the conclusion of the observations, the total time consumed in the several operations and by the various delays is summarized and totaled. It is then easy to determine whether the operator wasted time, was subjected to unnecessary delays, such as waiting for material, whether the machine was out of order or was run at an improper speed.

The accompanying illustrations show a time-study sheet and its summary, together with the instruction card written from them, and also a production study made to ascertain the reason for the failure of the operator to complete his task in the time allowed. The operation is polishing the barrel of a military rifle in a Heming Bros. automatic polishing machine. It is unnecessary to comment on the taking of the study or on the setting of the rates therefrom. These features of time-study work were fully set forth in the first article of this series. The original study is presented in order that the relation which exists between the original study, the task as laid down by the instruction card, and the performance of the task as shown by the production study can be traced through the various steps.

One feature of the time-study summary, however, can be noted here. This is the use of the allowance curves, shown in the first article on page 225, where there is both machine and handling time involved. The study in the first article in which the use of these curves was introduced involved no machine time. Referring to Fig. 2, it will be noted that of the 1.91 min. required for the completion of the cycle, 1.69 min., or 90 per cent., is consumed by the machine, while but 10 per cent., or 0.19 min., is devoted to handling the work into and out of the machine. For machine time, a flat allowance of 5 per cent. is made, while the allowance for handling time depends on the percentage that the handling time is of the total time of the cycle, and also on the actual amount of the handling time. The curve for 10 per cent. handling time is used in the present case, and the point at which the ordinate for a handling time of 2.23 min.—the sum of the handling time of the cycle proper and the prorated handling time of the group of pieces moved at one time (items 1, 2 and 8, Fig. 2)—intersects this curve gives the percentage allowance that must be made for handling the work. The value in the case under consideration is 82 per cent., and the actual handling time as shown by the summary, Fig. 2, and by the instruction card, Fig. 3, is multiplied by this value and the product added to the total cycle time. (See the instruction card Fig. 3) Values intermediate to those shown can be interpolated, if the percentage of handling time is not an even multiple of 10 per cent.


OBSERVATION SHEET Heming Bros. Auto Polisher
OBSERVER'S NAME Monroe MACHINE NO. 18788 DATE 4-26 1916
WORKMAN'S NAME AND QUALIFICATIONS
PIECE Model 1895 Musket Barrel
OPERATION #1 Finish Polish

COMPUTED BY D DATE 4-27-16
PASSED BY DVa DATE 4-27-16
SIGNED BY KAT DATE 4-27-16
CHECKED BY ASL DATE 4-27-16

	DETAILED OPERATIONS	15	16	17
1	Set up and Dress Wheel 2.50 x 1/150	.017		
2	Pick up Work Tray and Place on Bench .195 x 1/24	.008		
3	Pick up Barrel and Place in Fixture	.08		.08
4	Tighten Fixture and Clutch In	.04		.0413
5	POLISH 1545 R.P.M. of wheel 387 R.P.M. of Work, Feed .66 Run 25½"	1.33	1.88	
6	RETURN CARRIAGE	.36		
7	Loosen Fixture and Remove Barrel	.07		.0684
8	Set down Tray of Finished Barrels .185 x 1/24	.008		
9		1.913		

PRODUCTION STUDY ATTACHED

TOTAL SELECTED TIME 1.913
1.69 MACHINE TIME, POWER FEED at 5% .084
MACHINE TIME, HAND FEED at
.223 HANDLING TIME at 82% .183
2.180
ALLOWANCE FOR WASHING & OILING at 2½% .055
TIME FOR ONE PIECE 2.235
HOURLY PRODUCTION 26.8
BASE RATE .09 RATE PER HUNDRED $.45
MAN OPERATES 4 MACHINES ON OPERATION NO. 1

FIG. 2. SUMMARY OF THE TIME STUDY

TABLE A. THE PRODUCTION STUDY IN DETAIL[1]

Observation No.	Operation	Continuous Time, Min.	Individual Time, Min. Machine	Handling	Delay
1	A-D	1.95	1.95		
2	A-D	3.95	2.00		
3	A-D	6.05	2.10		
4	A-D	7.98	1.93		
5	A	8.12		0.14	
6	B-C	9.88	1.76		
7	D	9.93		0.05	
8	A	10.05		0.12	
9	B-C	11.81	1.76		
10	D	11.85		0.04	
11	A	11.99		0.14	
12	B-C	13.75	1.76		
13	D	13.80		0.05	
14	A	13.98		0.18	
15	B-C	15.75	1.77		
16	D	15.80		0.05	
17	A	15.93		0.13	
18	B-C	17.71	1.78		
19	D	17.75		0.04	
20	A	17.91		0.16	
21	B-C	19.68	1.77		
22	D	19.72		0.04	
23	A	19.88		0.16	
24	B-C	21.64	1.76		
25	D	21.69		0.05	
26	A	21.83		0.14	
27	B-C	23.60	1.77		
28	D	23.64		0.04	
29	A	23.78		0.14	
30	B-C	25.55	1.77		
31	D	25.60		0.05	
32	A	25.74		0.14	
33	B-C	27.49	1.75		
34	D	27.54		0.05	
35	A	27.69		0.15	
36	B-C	29.47	1.78		
37	D	29.53		0.06	
38	A	29.65		0.12	
39	B-C*	1.43	1.78		
40	D	1.54		0.11	
41	A	1.71		0.17	
42	B	3.10	1.39		
43	C	3.48	0.38		
44	D	3.52		0.04	
45	A	3.84		0.32	
46	B	5.23	1.39		
47	C	5.60	0.37		
48	R	5.90			0.30
49	D	5.99		0.09	
50	A	6.16		0.17	
51	B	7.58	1.42		
52	C	7.95	0.37		
53	D	8.00		0.05	
54	A	8.18		0.18	
55	B	9.59	1.41		
56	C	9.97	0.38		
57	D	10.02		0.05	
58	W	10.50			0.48
59	A	10.58		0.08	
60	B	12.06	1.48		
*	*	*	*		
101	C	2.86	0.39		
102	D	2.91		0.05	
103	A	3.05		0.14	
104	B	4.48	1.43		
105	C	4.86	0.38		
106	D	4.90		0.04	
107	M	5.80			0.90
108	C W	7.40			1.60
109	S M	7.60			0.20
110	D W	7.88			0.28
111	A	7.92		0.04	
112	B	9.32	1.40		
113	C	9.70	0.38		
114	D	9.76		0.06	
115	A	9.93		0.17	
116	B	11.35	1.42		
117	C	11.73	0.38		
118	D	11.83		0.10	
119	W	12.17			0.34
120	A	12.31		0.14	
*	*	*	*		
181	B	13.75	1.40		
182	C	14.12	0.37		
183	D	14.36		0.24	
184	W	14.78			0.42
185	A	14.95		0.17	
186	B	16.33	1.38		
187	C	16.71	0.38		
*	*	*	*		
205	A	24.88		0.13	
206	B	26.26	1.38		
207	C	26.63	0.37		
208	D†	26.69		0.06	
209	A	0.22		0.22	
210	B	1.68	1.46		
211	C	2.07	0.39		
212	D	2.23		0.16	
213	A	2.38		0.15	
214	B	3.85	1.47		
215	C	4.25	0.40		
216	D	4.35		0.10	
217	A	4.53		0.18	
218	B	6.02	1.49		
219	C	6.42	0.40		
220	D	6.55		0.13	
221	A	6.70		0.15	
222	B	8.19	1.49		
223	C	8.59	0.40		
224	D	8.67		0.08	
225	A	8.83		0.16	
226	B	10.33	1.50		
227	C	10.75	0.42		
228	D	10.84		0.09	
229	A	11.00		0.16	
230	B	12.52	1.52		
231	C	12.93	0.41		
232	D	13.02		0.09	
233	A	13.20		0.18	
234	B	14.72	1.52		
235	C	15.13	0.41		
236	D	15.23		0.10	
237	A	15.38		0.15	
238	B	16.91	1.53		
239	C	17.33	0.42		
240	D	17.42		0.09	
241	A	17.59		0.17	
242	B	19.16	1.57		
243	C	19.56	0.40		
244	D	19.65		0.09	
245	A	19.83		0.18	
246	B	21.40	1.57		
247	C	21.82	0.42		
248	D	21.89		0.07	
249	A	22.04		0.15	
250	B	23.65	1.61		
251	C	24.07	0.42		
252	D	24.18		0.11	
253	W*	30.00			5.82
254	S M	0.40			0.40
255	A	0.52		0.12	
256	B	2.17	1.65		
257	C	2.60	0.43		
258	D	2.68		0.08	
259	A	2.85		0.17	
260	B	4.53	1.68		
261	C	4.97	0.44		
262	D	5.05		0.08	
263	A	5.21		0.16	
264	B	6.92	1.71		
265	C	7.36	0.44		
266	D	7.53		0.17	
267	A	7.71		0.18	
268	B	9.43	1.72		
269	C	9.86	0.43		
270	D	9.94		0.08	
271	A	10.11		0.17	
272	B	11.82	1.71		
273	C	12.25	0.43		
274	D	12.40		0.15	
275	A	12.56		0.16	
276	B	14.23	1.67		
277	C	14.65	0.42		
278	D	14.74		0.09	
279	A	14.91		0.17	
280	B	16.64	1.73		
281	C	17.06	0.42		
282	D	17.18		0.12	
283	A	17.33		0.15	
284	B	19.08	1.75		
285	C	19.51	0.43		
286	D	19.59		0.08	
287	A	19.82		0.23	
288	B	21.57	1.75		
289	C	22.00	0.43		
290	D	22.08		0.08	
291	A	22.23		0.15	
292	B	23.99	1.76		
293	C	24.41	0.42		
294	D	24.52		0.11	
295	A	24.77		0.25	
296	B	26.56	1.79		
297	C	26.98	0.42		
298	D	27.08		0.10	
299	A	27.28		0.20	
300	B	29.06	1.78		
301	C	29.49	0.43		
302	D	29.58		0.09	
303	A	29.76		0.18	
304	B*	1.54	1.78		
305	C	1.97	0.43		
306	D	2.07		0.10	
307	A	2.21		0.14	
308	B	3.98	1.77		
309	C	4.40	0.42		
310	D	4.51		0.11	
311	A	4.66		0.15	
312	B	6.32	1.66		
313	C	6.73	0.41		
314	D	6.90		0.17	
315	A	7.08		0.18	
316	B	8.76	1.68		
317	C	9.15	0.39		
318	D	9.30		0.15	
319	A	9.45		0.15	
320	B	11.09	1.64		
321	C	11.52	0.43		
322	D	11.59		0.07	
323	A	11.73		0.14	
324	B	13.37	1.64		
325	C	13.80	0.43		
326	D	13.89		0.09	
327	A	14.05		0.16	
328	B	15.69	1.64		
329	C	16.11	0.42		
330	D	16.20		0.09	
331	A	16.35		0.15	
332	B	17.98	1.63		
333	C	18.40	0.42		
334	D	18.48		0.08	
335	A	18.62		0.14	
336	B	20.28	1.66		
337	C	20.70	0.42		
338	D	20.78		0.08	
339	A	20.93		0.15	
340	B	22.60	1.67		
341	C	23.02	0.42		
342	D	23.11		0.09	
343	A	23.29		0.18	
344	B	24.93	1.64		
345	C	25.36	0.43		
346	D	25.43		0.07	
347	A	25.63		0.20	
348	B	27.28	1.65		
349	C	27.69	0.41		
350	D	27.97		0.28	
351	A	28.14		0.17	
352	B*	29.79	1.65		
353	C	0.21	0.42		
354	D	0.29		0.08	
355	A	0.44		0.15	
356	B	2.09	1.65		
357	C	2.50	0.41		
358	D	2.60		0.10	
359	A	2.76		0.16	
360	B	4.45	1.69		
361	C	4.88	0.43		
362	D	4.96		0.08	
363	A	5.14		0.18	
364	B	6.82	1.68		
365	C	7.25	0.43		
366	D	7.35		0.10	
367	A	7.50		0.15	
368	B	9.21	1.71		
369	C	9.63	0.42		
370	D	9.73		0.10	
371	A	9.92		0.19	
372	B	11.61	1.69		
373	C	12.05	0.44		
374	D	12.15		0.10	
375	A	12.33		0.18	
376	B	14.08	1.75		
377	C	14.52	0.44		
378	D	14.59		0.07	
379	A	14.78		0.19	
380	B	16.52	1.74		
381	C	16.94	0.42		
382	D	17.15		0.21	
383	A	17.30		0.15	
384	B	18.98	1.68		
385	C	19.41	0.43		
386	D	19.47		0.06	
387	A	19.63		0.16	
388	B	21.36	1.73		
389	C	21.78	0.42		
390	D	21.85		0.07	
391	A	21.98		0.13	
392	B	23.69	1.71		
393	C	24.12	0.43		
394	D	24.24		0.12	
395	A	24.42		0.18	
396	B	26.12	1.70		
397	C	26.56	0.44		
398	D	26.63		0.07	
399	A	26.86		0.23	
400	B	28.60	1.74		
401	C	29.04	0.44		
402	D	29.13		0.09	
403	A*	29.31		0.18	
404	B	1.06	1.75		
405	C	1.48	0.42		
406	D	1.57		0.09	
407	A	1.73		0.16	
408	B	3.47	1.74		
409	C	3.90	0.43		
410	D	4.02		0.12	
411	A	4.17		0.15	
412	B	5.93	1.76		
413	C	6.36	0.43		
414	D	6.48		0.12	
415	A	6.67		0.19	
416	B	8.44	1.77		
417	C	8.88	0.44		
418	D	9.00		0.12	
419	A	9.18		0.18	
420	B	10.93	1.75		
421	C	11.37	0.44		
422	D	11.44		0.07	
423	A	11.60		0.16	
424	B	13.37	1.77		
425	C	13.81	0.44		
426	D	13.90		0.09	
427	A	14.06		0.16	
428	B	15.86	1.80		
429	C	16.29	0.43		
430	D	16.37		0.08	
431	A	16.56		0.19	
432	B	18.38	1.82		
433	C	18.81	0.43		
434	D	18.98		0.17	
435	M	19.60			0.62
436	C W	21.90			2.30
437	S M	22.45			0.55
438	D W	23.65			1.20
439	A	23.82		0.17	
440	B	25.33	1.51		
441	C	25.74	0.41		
442	D	25.79		0.05	
443	A	25.92		0.13	
444	B	27.49	1.57		
445	C	27.93	0.44		
446	D	28.11		0.18	
447	A	28.32		0.21	
448	B*	29.92	1.60		
449	C	0.34	0.42		
450	D	0.45		0.11	
451	A	0.64		0.19	
452	B	2.26	1.62		
453	C	2.68	0.42		
454	D	2.78		0.10	
455	Adjust Mach.	3.24			0.46
456	A	3.38		0.14	
457	B	5.01	1.63		
458	C	5.43	0.42		
459	D	5.54		0.11	
460	Insp. Work	5.70			0.16
461	Adjust Mach.	5.85			0.15
462	A	6.09		0.24	
463	B	7.78	1.69		
464	C	8.22	0.44		
465	D	8.31		0.09	
466	W	8.69			0.38
467	A	8.82		0.13	
468	B	10.53	1.71		
469	C	10.96	0.43		
470	D	11.07		0.11	
471	A	11.21		0.14	
472	B	12.98	1.77		
473	C	13.43	0.45		
474	D	13.50		0.07	
475	A	13.65		0.15	
476	B	15.45	1.80		
477	C	15.90	0.45		
478	D	15.97		0.07	
479	A	16.11		0.14	
480	B	17.88	1.77		
481	C	18.32	0.44		
482	D	18.42		0.10	
483	A	18.59		0.17	
484	B	20.37	1.78		
485	C	20.80	0.43		
486	D	20.87		0.07	
487	A	21.04		0.17	
488	B	22.80	1.76		
489	C	23.23	0.43		
490	D	23.31		0.08	
491	A	23.46		0.15	
492	B	25.18	1.72		
493	C	25.60	0.42		
494	D	25.67		0.07	
495	M	25.94			0.27
496	A	26.07		0.13	
497	B	27.43	1.36		
498	C	27.80	0.37		
499	D	27.90		0.10	
500	A	28.15		0.15	
501	B	29.51	1.36		
502	C	29.89	0.38		
503	D	29.97		0.08	
504	A	0.10*		0.13	
505	B	1.46	1.36		
506	C	1.83	0.37		
507	D	1.90		0.07	
508	A	2.10		0.20	
509	B	3.45	1.35		
510	C	3.82	0.37		
511	D	3.90		0.08	
512	A	4.06		0.16	
513	B	5.40	1.34		
514	C	5.78	0.38		
515	D	5.85		0.07	
516	A	5.98		0.13	
517	B	7.34	1.36		
518	C	7.69	0.35		
519	D	7.78		0.09	
520	A	7.98		0.20	
*	*	*	*		
646	C	9.90	0.36		
647	D	9.98		0.08	
648	A	10.11		0.13	
649	B	11.43	1.32		
650	C	11.79	0.36		
651	D	11.87		0.08	
652	A	12.02		0.15	
653	B	13.34	1.32		
654	C	13.69	0.35		
655	D	13.80		0.11	
656	A	13.95		0.15	
657	B	15.28	1.33		
658	C	15.64	0.36		
659	D	16.04		0.40	

[1] In order to economize space, the following observations have been omitted in the table: 61-100, 121-180, 188-204, 521-646, all inclusive. The omitted observations have the same general trend as those immediately preceding and following them, and their omission detracts nothing from the value of the production study as used for illustrative purposes.

* The stop watch is graduated only for a total reading of 30 min., and it resets itself to zero at the end of the 30-min. period. Consequently, 30 min. must be added to the actual reading of the watch at the points noted (*) before subtracting to obtain the individual time.

† The observer for some reason not now apparent reset his watch to zero at this point.

With this digression we can now return to a consideration of the production study. Referring to the time-study summary, Fig. 2, it will be observed that the machine operation divides itself naturally into four parts: The setting of the work in the machine, the polishing operation, the return of the carriage to its initial position and the removal of the work from the machine. These operations are listed in the production study, Fig. 4, as items A, B, C and D respectively. The other items listed in the time-study summary are not part of the cycle proper, but are operations performed on a group of pieces or on the machine after the completion of a certain number of pieces, and are prorated to the individual piece. The object of the production study is to ascertain how closely the operator adhered to the times allowed for the various elements of the cycle in the time-study summary and instruction card.

Fig. 4 represents the first sheet of the production study. The observer began by noting and recording the elapsed time of the complete cycle, operations A to D inclusive. He then found that it was possible to separate the machine operations from the handling operations, and after the first four pieces were made he followed this procedure, noting the handling time before the machine operations, the two machine operations, and the handling time after the machine work as three separate groups. Twelve pieces were made under these conditions, when the desirability of still further division of the elements became apparent. The machine operations were accordingly separated and observations made of items A, B, C and D.

The observer took differences as he proceeded, these being represented by the small figures 1.95, 2.00, 2.10, 1.93, etc., in the upper part of the spaces opposite the various items in Fig. 4. The handling time is separated from the machine time on the observation sheet by recording it in a different column, as shown in the illustration. While this is not absolutely necessary, it makes the analysis of the study more convenient than it would otherwise be. Moreover, it enables the observer to easily notice discrepancies in the performance of different parts of the job.

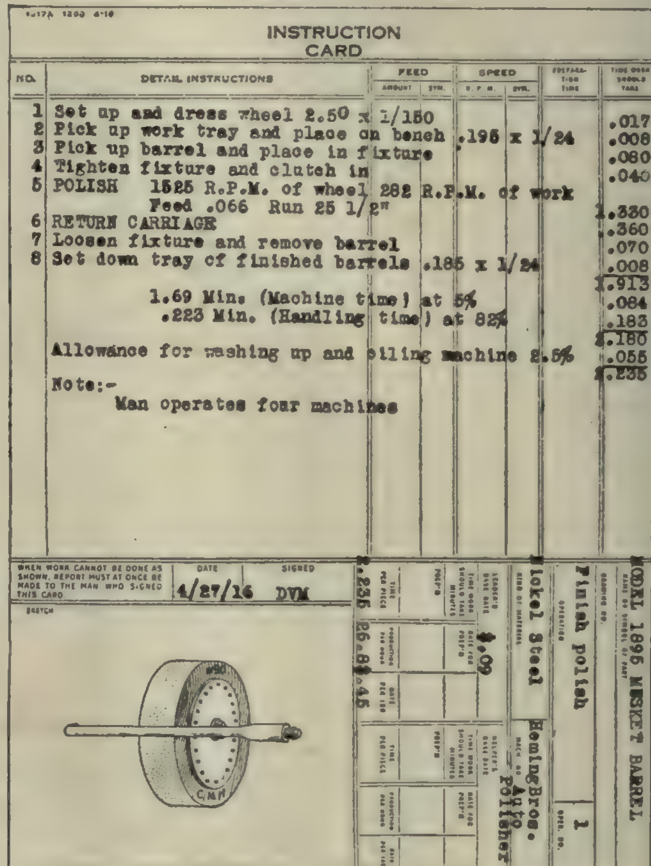
In line 18, column 4 of Fig. 4, there is noted an interruption to the smooth progress of the work, symbolized by the letter R. The significance of this is that there was an unavoidable delay, beginning at the completion of operation C (5.60 min.) and terminating 0.30 min. later (5.90 min.), after which operation D was performed in its regular order. The time of this delay should be entered in a different column than either the machine or handling time. Similarly, in column 13, Fig. 4, lines 17 to 20, will be noted other interruptions which are likewise recorded. The production study illustrated required five observation sheets similar to Fig. 4 for recording all the operations and interruptions to the work. The observations of the complete production study, together with the individual times of the various operations and interruptions, are reproduced in the accompanying Table A. The following symbols are used in designating the operations and interruptions to work while making this study:

Useful Operations—A, handling of work before polishing; B, actual polishing in the machine; C, returning the carriage to its initial position; D, handling of the work after the polishing operation.

Delays—C, cleaning chips; CW, change wheel; DW, dress wheel; L, washing; M, trouble with machine; P, personal delays (toilet, etc.); R, irregular delays (unavoidable); SM, start machine; TA, adjusting tools; TG, grinding tools; U, unnecessary delays; W, moving work.

Interpretation of the Study

A careful study of Table A will reveal how important it is to subdivide the operations as far as possible, and also to take differences as the study proceeds. Consider operation B, that of polishing. It will be noted that at the beginning of the production study, the time consumed in this operation ranged from 1.39 min. to 1.43 min.



INSTRUCTION CARD

NO.	DETAIL INSTRUCTIONS	TIME
1	Set up and dress wheel 2.50 x 1/150	.017
2	Pick up work tray and place on bench .196 x 1/24	.008
3	Pick up barrel and place in fixture	.080
4	Tighten fixture and clutch in	.040
5	POLISH 1525 R.P.M. of wheel 282 R.P.M. of work Feed .066 Run 25 1/2"	1.330
6	RETURN CARRIAGE	.360
7	Loosen fixture and remove barrel	.070
8	Set down tray of finished barrels .185 x 1/24	.008
		1.913
	1.69 Min. (Machine time) at 5%	.084
	.223 Min. (Handling time) at 82%	.183
		2.180
	Allowance for washing up and oiling machine 2.5%	.055
		2.235
	Note:- Man operates four machines	

WHEN WORK CANNOT BE DONE AS SHOWN, REPORT MUST AT ONCE BE MADE TO THE MAN WHO SIGNED THIS CARD. DATE 4/27/16 SIGNED DVM

SKETCH

2.235 26.8 .45 .09 Nickel Steel Finish polish 1 Heming Bros. Auto Polisher MODEL 1896 MUSKET BARREL

FIG. 3. INSTRUCTION CARD MADE FROM THE TIME STUDY

(See operation No. 42 and those immediately following it up to observation No. 210.) The time for operation B at this point begins to increase progressively, until it reaches a maximum of 1.82 min. at observation No. 432 and remains in the neighborhood of this time up to observation No. 494. At this point the observer called the attention of the room foreman to the progressive increase in the time required for operation B and suggested that a belt dressing be applied to correct an apparent slipping of the driving belt. This was done, the resultant delay being denoted by M (observation No. 495). Upon resuming work, the time for operation B dropped to 1.36 min. (observation No. 497) and stayed at that point or lower until the end of the study.

The production study is summarized as shown in Fig. 5. The individual times relating to the various operations are totaled and entered at the proper point on the summary sheet, and similarly, the several sums of the individual times of the different classes of the delays are entered. The various totals are divided by the number

of pieces made during the production study in order to make a comparison of the results with the original time study.

The most instructive figures in the production summary in the present case are those of the cycle times. Reference to the table will show that a total of 165 pieces were machined. Of these, the handling time was determined separately after the first four pieces were machined, or on a total of 161 pieces. The machine operations were separated after the first 16 pieces were completed, or on 149 pieces. The totals of the handling time for the 161 pieces, for operations A and D respectively, were 25.77 min. and 14.15 min., and the average handling time per piece for these two operations was as follows: A—25.77 ÷ 161 = 0.159 min.; D—14.15 ÷ 161 = 0.091 min. Likewise the machine times for 149 pieces were: Operation B—total, 226.96 min.; average per piece, 1.523 min. Operation C—total, 59.10 min.; average per piece, 0.396 min.

The significance of these figures can be grasped if they are compared with the figures of the time-study summary, Fig. 2, and with the allowances for the two kinds of work. This is done in Table B.

An inspection of columns 5 and 6 of this table immediately reveals that the trouble was due to the machine. In those operations which depended on the dexterity of the operator, the production time was well within the allowed time. In fact, it closely approached the selected minimum time. On the other hand, in the machine operations, over which the operator had little or no control, the production time exceeded the allowed time by a large margin. As already pointed out, this was due to the slipping of the belt, which fault was recognized and corrected during the progress of the production study. It is quite conceivable, however, that in a great number of cases the trouble would not be so obvious, and an analysis and comparison such as is illustrated in Table B would be necessary to determine where the difficulty lay.

TABLE B—COMPARISON OF TIME-STUDY AND PRODUCTION STUDY SUMMARIES

Time given is in minutes per piece

1	2	3	4	5	6
Operation	Time Study, Min.	Allowance, Per Cent.	Allowance, Min.	Total Time Allowed, Min.	Production Study, Min.
A..........	0.12	82	0.0984	0.218	0.159
B..........	1.33	5	0.0665	1.3965	1.523
C..........	0.36	5	0.0180	0.378	0.396
D..........	0.07	82	0.0604	0.130	0.091

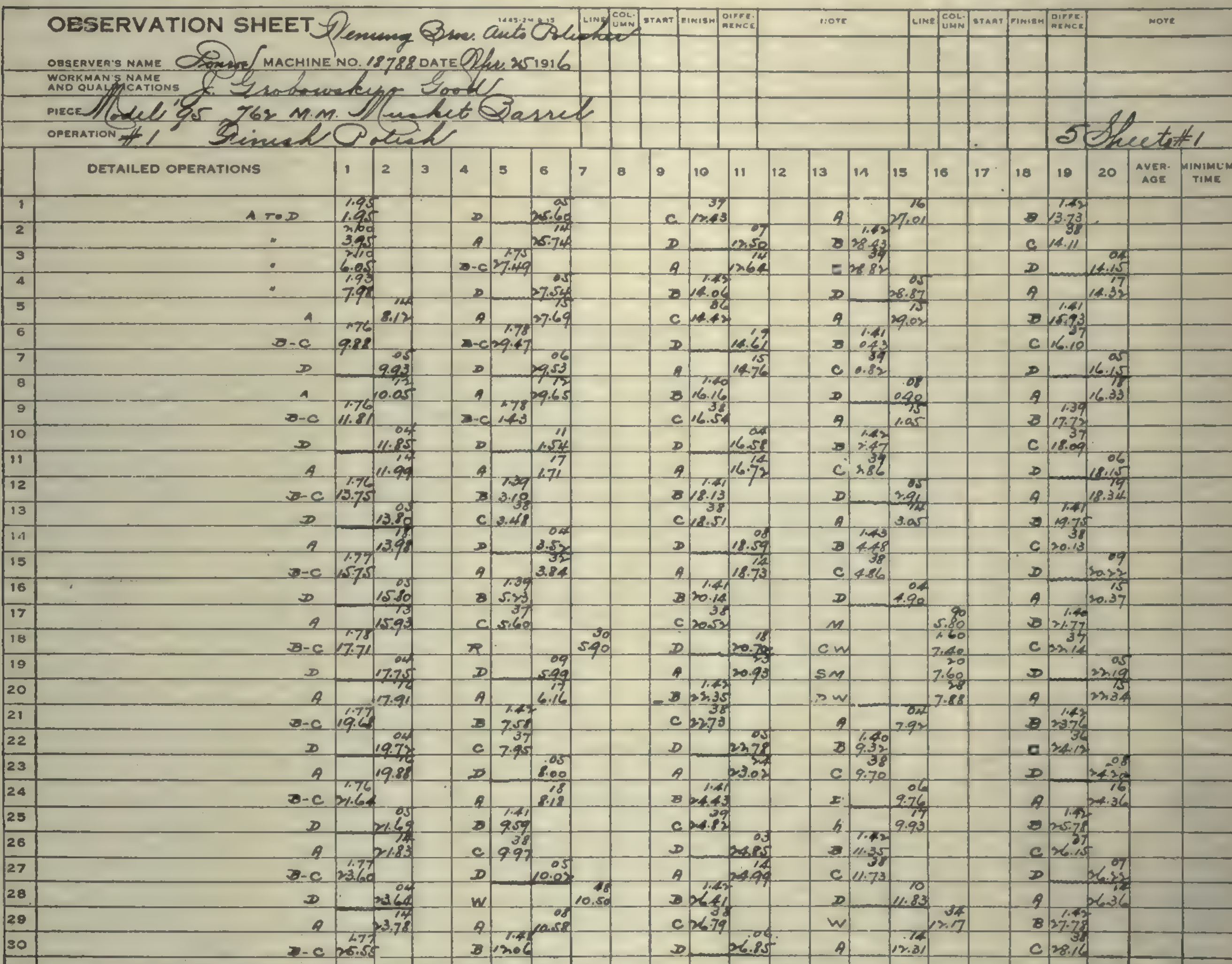


FIG. 4. OBSERVATION SHEET OF PRODUCTION STUDY MADE TO ASCERTAIN WHY OPERATOR FAILED TO COMPLETE TASK IN TIME CALLED FOR ON INSTRUCTION CARD

Analysis of Delays

The items in the production study outside of the regular cycle of work operations can be analyzed in the same manner. These are listed in the production-study summary under the head of "Delays." Take for instance the item of moving work. The instruction card calls for the rifle barrels to be moved in lots of 24 and allows

an average time per piece of 0.016 min. (see items 2 and 8, Fig. 3), plus an allowance of 82 per cent. The total time which is allowed for the 165 pieces then will be as follows:

Total selected time	165 × 0.016 = 2.64 min.
Allowance	2.64 × 0.82 = 2.16 min.
Total time allowed	4.80 min.

The production-study summary shows (item W) that the operator consumed 7.44 min. for this part of his job, or 2.64 min. more than were necessary.

The instruction card also calls for the setting up and dressing of the wheel for every 150 pieces, giving an average time per piece for this purpose of 0.017 min. plus the 82 per cent. allowance. The allowed time and the actual time consumed work out as follows:

Total selected time	165 × 0.017 = 2.805 min.
Allowance	2.805 × 0.82 = 2.300 min.
Total time allowed	5.105 min.
Time consumed (items CW, SM, DW)	6.53 min.
Excess of time consumed	1.425 min.

In addition there were the two delays of 1.79 min. due to machine trouble and 0.30 min. due to an unavoidable, but unstated, cause. The total time lost unnecessarily then is the sum of the four losses noted above, or 6.15 min., which is well within the time saved on cycle operations A and D.

These delays may be examined in a little different light. Referring to the time-study summary, Fig. 2, it will be noted that the minimum time per piece is 1.913 min. and the allowed time, excluding the time for washing, is 2.180. The gross delay allowance per piece then is (2.180 — 1.913) ÷ 1.913 = 13.9 per cent., or 0.267 min. per piece. For 165 pieces this is a total of 43.85 min. The unnecessary delays were thus 14 per cent. of the total allowance for delays, and had there been no machine trouble, they would not have affected the completion of the task in the allotted time.

It is evident that a production study as outlined above would promptly reveal whether the operator was deliberately wasting time by unnecessarily leaving his machine, by engaging in conversation, or by any other means. It would also reveal lack of skill, which would appear in the shape of excessive handling time, or frequent adjustment of his machine or tools, and would further point out delays in furnishing work to the operator. The production study illustrated confirmed the correctness of the time study, in that nearly all the operations except the machine operations were performed in close to the minimum times, and the machine operations also approached their minimums after the machine trouble had been corrected. (See observations 497 to 659 in Table A.) The value of the production study cannot be overestimated. It is an important and necessary adjunct to the time study.

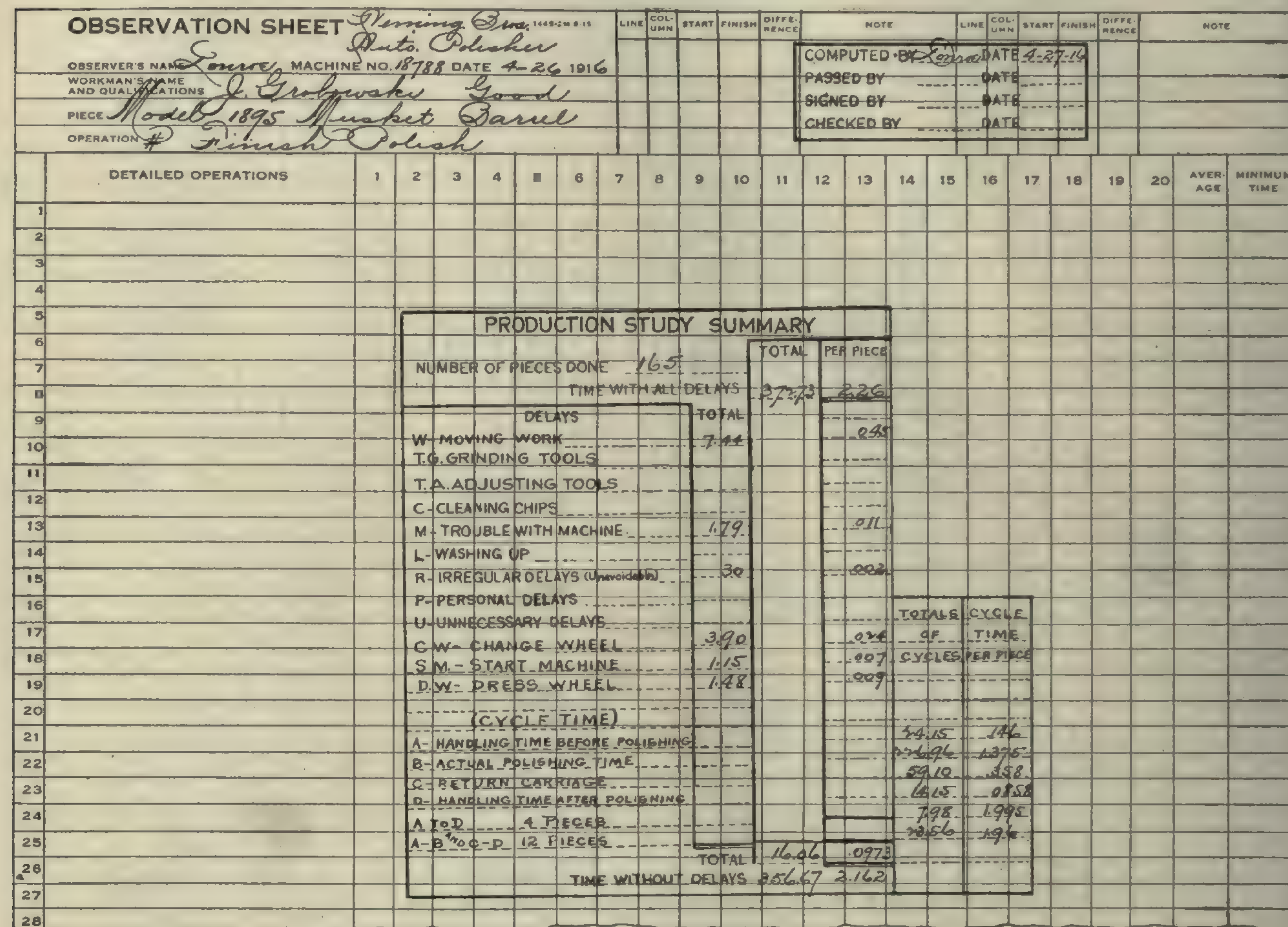


FIG. 5. THE PRODUCTION-STUDY SUMMARY

❋

A Consignment of 360 Automobiles for Buenos Aires reached that port on a steamer from Philadelphia the last week in December. This shipment, with a consignment of 70 a few weeks previously, brought the number of automobiles imported into Argentina in 1916 to the figure of 4676. It is understood that the greater part of the machines imported into Argentina are of comparatively small type, designed particularly for country use. Small cars are becoming popular among farmers, who find them of great service.

Making Dies for Typewriter Type

By Frank A. Stanley

SYNOPSIS—Correct type cannot be manufactured without perfect dies. The first considerations are the correct location and proportion of the characters, and in the practice of the company referred to in this article it is customary to establish the position and proportions of these characters from a drawing that is made 50 times the size required in the finished type. The outlines in this original drawing are transferred to a brass templet on a reduced scale, and a still greater reduction is effected in a second engraving process for the cutting of the type die itself.

The first process in the manufacture of type at the plant of the Noiseless Typewriter Co., Middletown, Conn., is the preparation of the dies. Upon the accuracy with which these dies are made and the character of the material from which they are produced depend the quality of the typewriter type themselves and the quantity of such type that may be put through in any one die before it breaks down in service

The type-making department of this plant is illustrated in Fig. 1, which gives a clear idea of the general equipment in the line of rolling machines, milling and drilling apparatus, bench microscopes for testing the product, special gaging apparatus for inspection of the work as it proceeds through the department, tote boxes and trays for handling large quantities of type and dies in the progress of the work from one end of the department to the other.

FIG. 1. TYPE-MAKING DEPARTMENT, NOISELESS TYPEWRITER CO.

It will be seen from this illustration that the department is brilliantly illuminated from natural sources on all sides, so that every operation may be carried on under the most favorable conditions, so far as lighting is concerned. For working hours after the sunlight has disappeared, satisfactory artificial illumination is provided, so that all the processes through which the work passes are conducted under the best arrangements for close observation in the machine processes as well as in the later tests and inspection operations.

The type used in the Noiseless machines are 28 in number, each carrying three characters, which are formed upon the front edge of a blank approximately 1¼ in. high by ¼ in. deep. These type are permanently secured by rivets to the end of the type bars, and exact dimensions of both type bar and type are shown in Fig. 2. The appearance of this type when secured to the bars and mounted in place on the typewriter is brought out plainly by Fig. 3.

The commencement of the series of operations in the production of the type-rolling dies consists in making a drawing of the character to be reproduced in the type. This drawing, on a scale 50 times the size of the desired character on the typewriter type, is made on a piece of Bristol board and attached to the table of a Gorton engraving machine, as in Fig. 4 at *A*. The machine is then operated to cut a templet *B* of brass, the character produced here being one-third of that on the original drawing *A*. The operation of this machine, which is built on the pantograph principle, needs no special description, and the method of driving the spindle with a high-speed round belt is also shown.

After completion the templet B is transferred to the vertical engraving machine at the right, and here the die block is engraved. It is cut with the work traversing over the tool by the action of the guide plunger, which is moved around the brass templet at B. In this machine there is a further reduction of $16\frac{2}{3}$ to 1, so that from the original drawing to the character engaged in the die block there is a total reduction of 50 to 1. This means that in the case of typewriter type $\frac{1}{10}$ in. high the original drawing is made in characters 5 in. high.

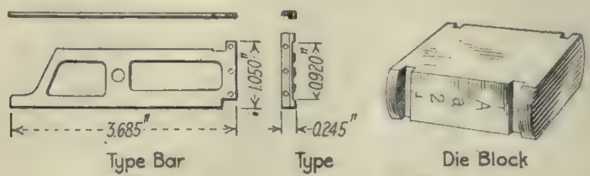


FIG. 2. TYPE BAR AND TYPE FOR NOISELESS TYPEWRITER AND DIE FOR MAKING THE TYPE

Referring to the engraving machine at the left of Fig. 4, it will be seen that a special table is carried at the rear of the supporting arm to support the large drawings, and an original of almost any size could be used if it were desired to change the ratio of reduction in the engraving process.

It should be pointed out that in connection with this templet work and the production of the type die blocks it is the practice of this shop to put a pair of locating marks upon the face of each die block in order that these marks may be transferred to the face of the die itself and used throughout the various processes of finishing the type body by locating each type from these special marks. These locating marks are in the form of an inverted T—that is, a plus sign with the lower leg eliminated. Two of the marks will be noticed on the face of the die block in Fig. 2. They are placed on a master templet cut as in Figs. 4 and 5, and their relation to the characters, letters or numerals is exactly established by the locating holes in the templet. In the process of reduction between the drawing and the die templet and from the die templet to the die block later on, the location cross is cut down to the block dimension indicated in the face of the die block, Fig. 2, the leg of the three-sided cross being not much over $^3/_{64}$ in. long.

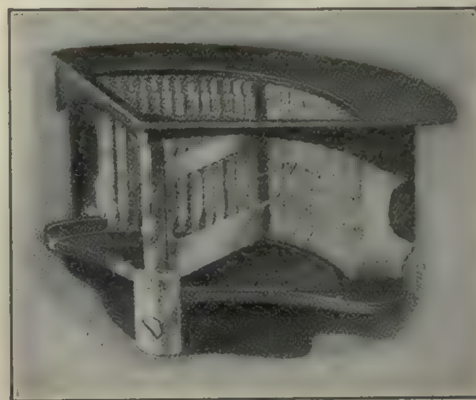


FIG. 3. TYPE FOR NOISELESS TYPEWRITER

The dies made in this manner are of Styrian Blue Label alloy steel, which is stated to be the steel used by the Government in making coining dies. This steel comes in 12-ft. bars, which are thoroughly annealed so as to machine readily. The die blocks are cut off and shaped to the form indicated in Fig. 2 and are then ready to be placed in the vertical engraving machine at the right in Figs. 4 and 5, where the three printing characters and the two locating cross-marks are cut in with a rapidly revolving engraving tool.

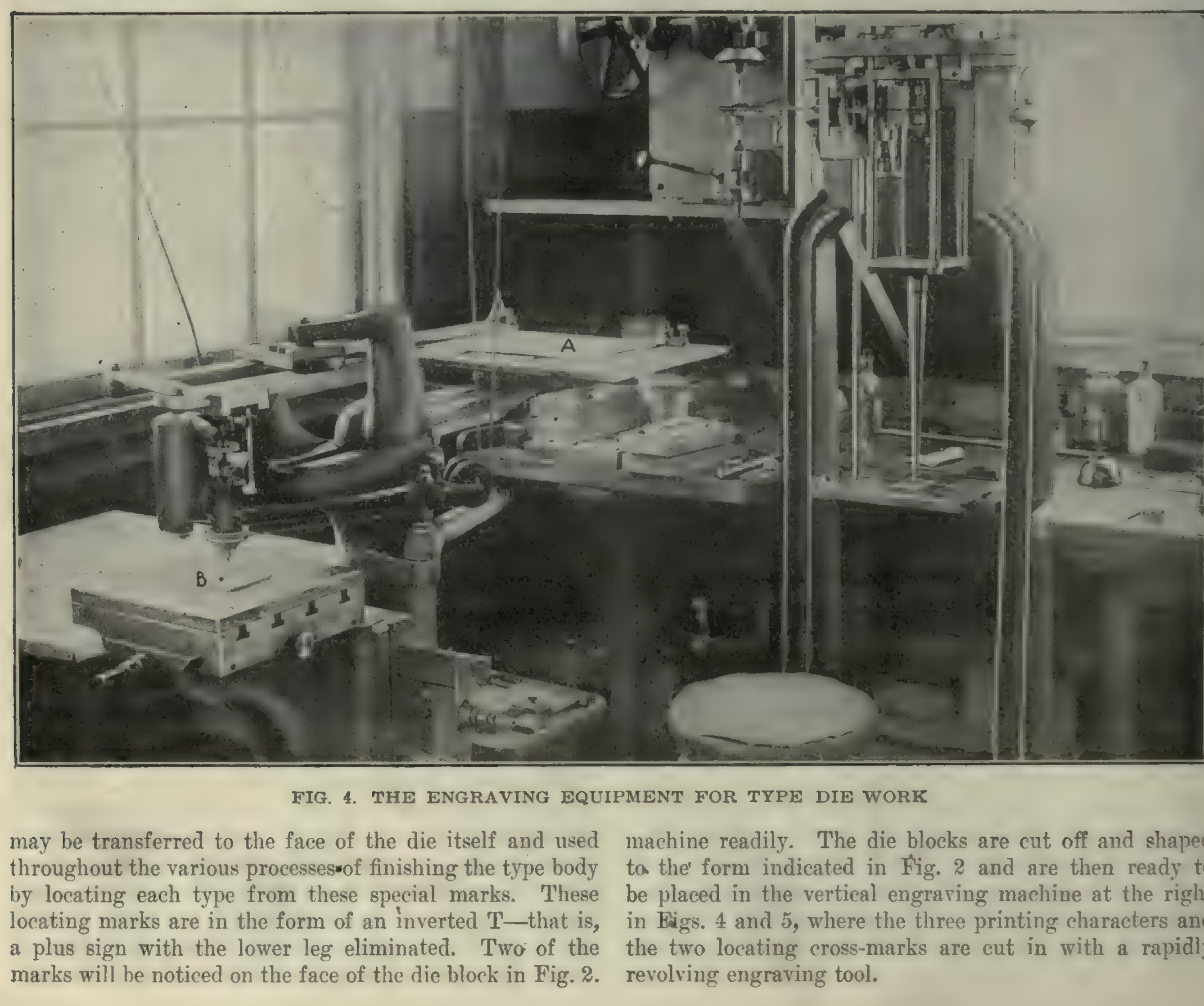


FIG. 4. THE ENGRAVING EQUIPMENT FOR TYPE DIE WORK

This engraving machine is well worth a little attention. Although the perpendicular carrying frame for the guide plunger is swung through various angles of arcs and different planes, the work itself is not swung at all, but

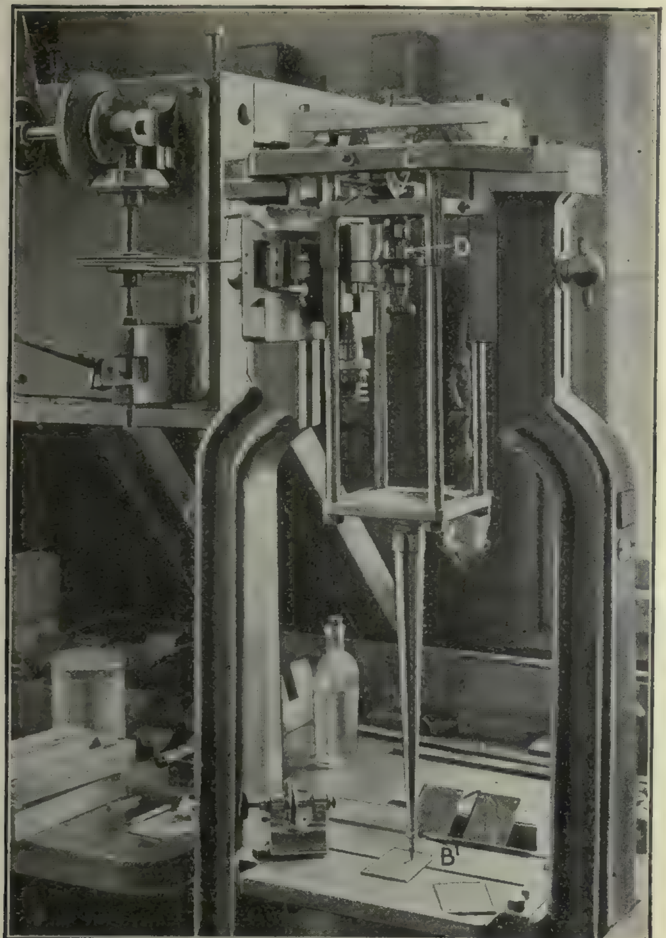


FIG. 5. APPARATUS FOR CUTTING THE DIES

is passed in a horizontal frame back and forth, and through the medium of the holding shoe it slides without rolling motion at the top of the machine. This holding shoe is seen at *C*, Fig. 5, and the spindle that drives the engraving tool may be seen at *D*. The rotation of the spindle at high speed is obtained through the round belt passing over the vertical shaft at the left side of the engraving machine, the vertical shaft having a double gear drive from the small shaft at the left. The spindle *D* of the engraving tool is part of a head in general form similar to a small bench-lathe or watch-lathe head. This head is removed bodily by loosening the thumb-screw, so that roughing and finishing heads are readily applied and changed. The slide upon which these small heads are mounted has a different position for each character, whether it is at the top of the lot, at the bottom, the center or at either end. An index pin at the point side is utilized to locate the slide correctly for the engraving of the corresponding character in the face of the die block. It will be understood that when the cutter spindle head is once set it is not moved about in the engraving operation, but the die block itself is swung to and fro over the cutter, receiving the action of the cutting tool which forms the die recess. Adjustment of the cutting tool to the depth is made by means of the knurled-head screw *E*, which works upon the micrometer principle so that close adjustments are readily made.

From the foregoing description of the cutting of the dies it will be seen that the characters are cut flat and not upon a curved surface. The type face in the typewriter must be perfectly flat, as these type characters in use strike on the dead-flat surface of the sheet of paper, which is backed up by the flat printing bar or platen; for a round platen or rubber roller is not used in the Noiseless typewriter for a printing platen. The rubber roll is retained merely for the purpose of feeding the paper. For backing up the paper a narrow, flat, hard-steel bar is employed. Consequently, the type faces themselves must be flat. Back of this, the engraving of the original type forms in the die block must also be in a flat plane.

Two cutters are used in engraving the die—one roughing, the other finishing. The roughing and finishing cutters are kept in their respective heads all the time, and the heads are changed as a unit when changing from roughing to finishing or vice versa. These routing cutters are made with an angle of 30 deg. on a side—that is, 60 deg. included angle. These tools are so proportioned that the finishing tool cuts 0.0025 in. wide at the end, and this is the right width for a type face. When it comes to printing in the typewriter, the actual impression on the paper from a type face of this width is about 0.00358 in., or 0.001 in. wider than the other, due to the pressure of the type on the ribbon.

Keeping the Engraving Cutters in Order

Fig. 6 shows the equipment for keeping the cutting tools and the tool-engraving heads in proper condition. These small cutters are made with four sides, or four corners, and they are kept in perfect condition by stoning on the fixture seen on the watch lathe in Fig. 6. The fixture consists of an angle block with a depending leaf that drops down at the right slope in relation to the axle line of the head spindle, so that an oilstone may be placed upon its surface and be rubbed over the four sides of the cutting tool to bring the corners to a right angle. Both the roughing and the finishing heads are shown in this picture, one of them being in place upon the watch-lathe bed, the other resting upon the work bench. Several type dies are shown upon the bench and tray in the foreground,

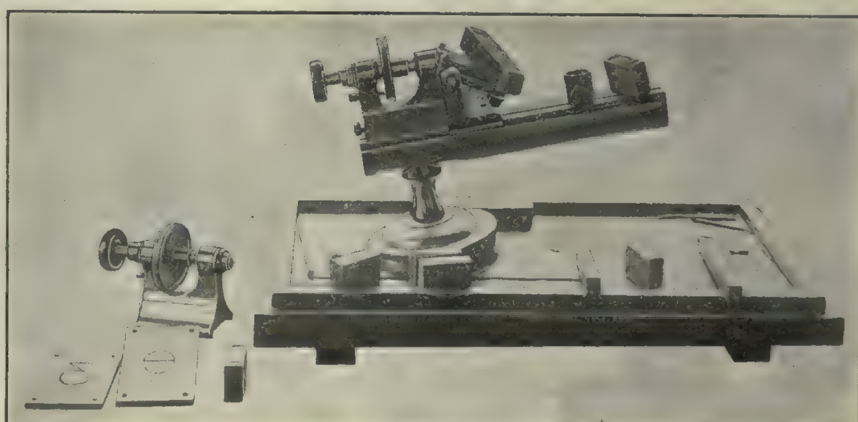


FIG. 6. THE ENGRAVING TOOLS FOR THE DIE BLOCKS

and a series of templets for guiding the vertical engraving-machine plunger for the engraving of other dies will be seen immediately in front of the lathe head resting on the bench. These heads are put into place and removed almost instantly. It is a simple matter, after one has a little practice, to keep the tools stoned up to cut at the correct angle.

As stated previously, both the roughing and the finishing tools for the engraving of the steel die block have four sides or cutting corners. The corresponding cutter with which the templet is made in the horizontal engraving machine has one cutting side only, and this operation in the brass plate was pointed out before.

After the die block has been engraved, it is hardened by heating, and quenching in a salt bath. These dies do not seem to change at all in the hardening process, but seem neither to expand nor contract to any measurable degree. It would be permissible to allow a total of 0.002 in. in the total length of these blocks, but as a matter of fact the blocks expand less than 0.001 in. About the only change that can be detected in the die block is that sometimes the block bulges out a trifle in the middle, so that it is thicker than the ends by, say, 0.0005 in., but this does not seem to affect the length of the die in any degree. It will be understood of course that these die blocks are usually engraved on both edges, so as to utilize all possible working space to the greatest advantage as a matter of economy in high-grade material.

Upkeep of Tools

Referring again to the upkeep of the engraving tools with the equipment in Fig. 6, it is interesting to mention that the tool maker taking care of these devices is enabled to do this easily and accurately with his experienced eye and the glass. However, a test is actually made by cutting a die and measuring it with a microscope. In regard to this taking care of the cutting tools and the accurate cutting of the die block, it should be emphasized that, as the type in this form of typewriter has to strike up against a dead-flat surface, the most exacting degree of workmanship is required in making and testing the tools, the dies and the finished type. As a matter of fact, of the type which is scrapped under inspection, a large percentage would be entirely suitable for use in a machine that made use of a rubber platen instead of a flat printing plate having no flexibility and requiring absolute alignment of surface of the characters to which it is opposed when the printing operation takes place.

The dies made in this way must also receive a shallow cross-channel at each end, as represented in Fig. 2 and as will be noticed again in the view of the blocks themselves as seen resting on the table of the hand miller in Fig. 7. Here an operation is shown consisting of fastening these blocks in the device with the edge up and with a pair of cutters to cut the narrow sloping grooves, one on each end of the die. The purpose of these grooves is to roll up a pair of shoulders on the type itself, one at the top and one at the bottom of the type body. These shoulders are known as the printing guide. After the type is finished, they form a locating surface which, passing into the center guide on the machine, assures the type being held in alignment at top, bottom and each side at the point of printing.

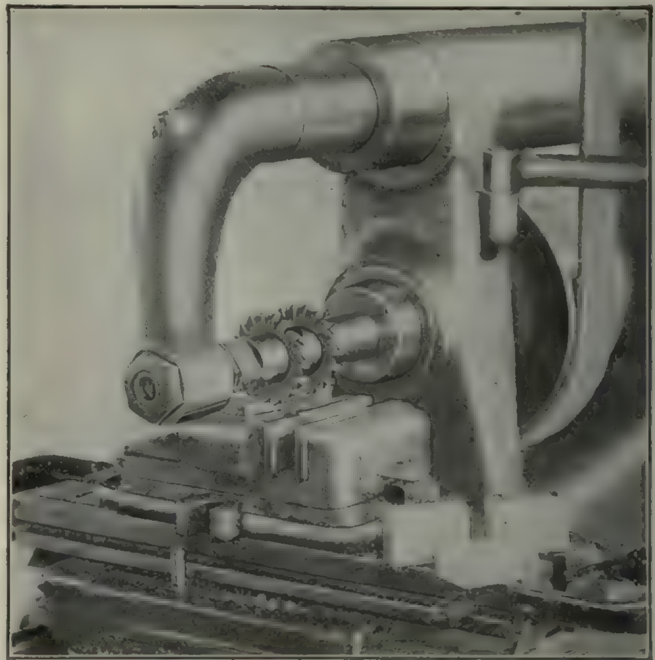


FIG. 7. MILLING THE GROOVES IN THE DIE FOR THE PRINTING GUIDES ON THE TYPE

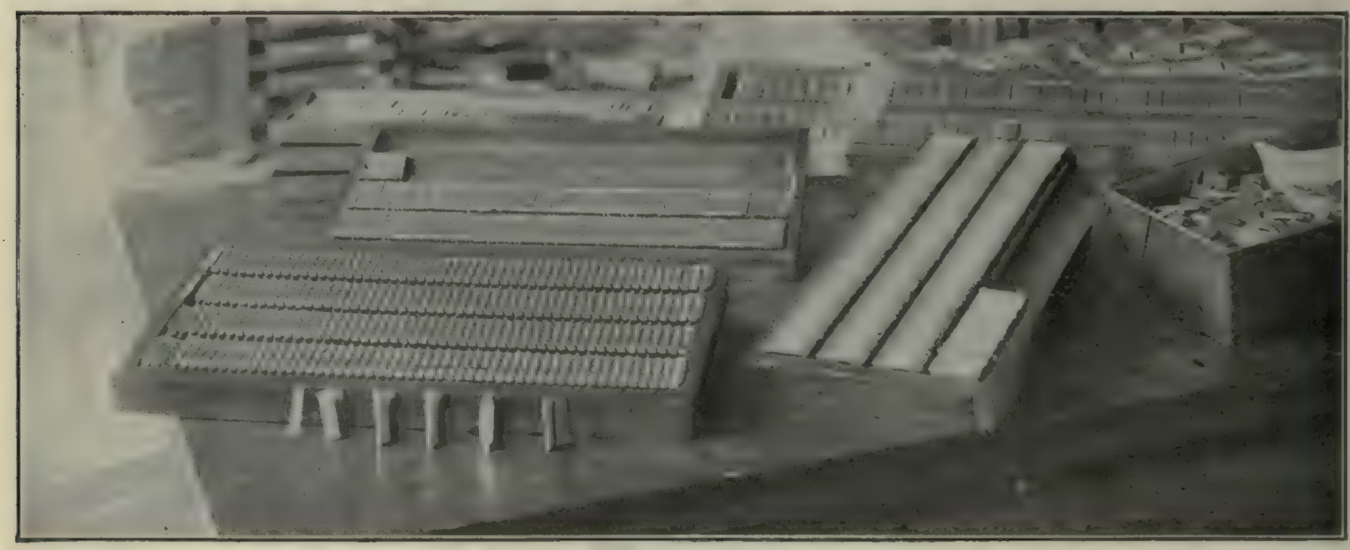


FIG. 8. COMPLETED DIES AND TYPE

As to the life of these dies, it may be said that ordinarily each will roll about 1,000 type, while each face of the die will last for 500 type, although this varies somewhat with the shape and nature of the character formed on the type. In any event a good many dies have to be made right along in this department, and some idea of the extent of the work is given by Fig. 8, which shows a considerable number of finished dies in the double rack in the background. The type bodies themselves in their various stages of progress, as well as some fully completed type, are shown in the tray in the foreground. At the right is a pan nearly filled with type blanks, of which more will be said in a later article.

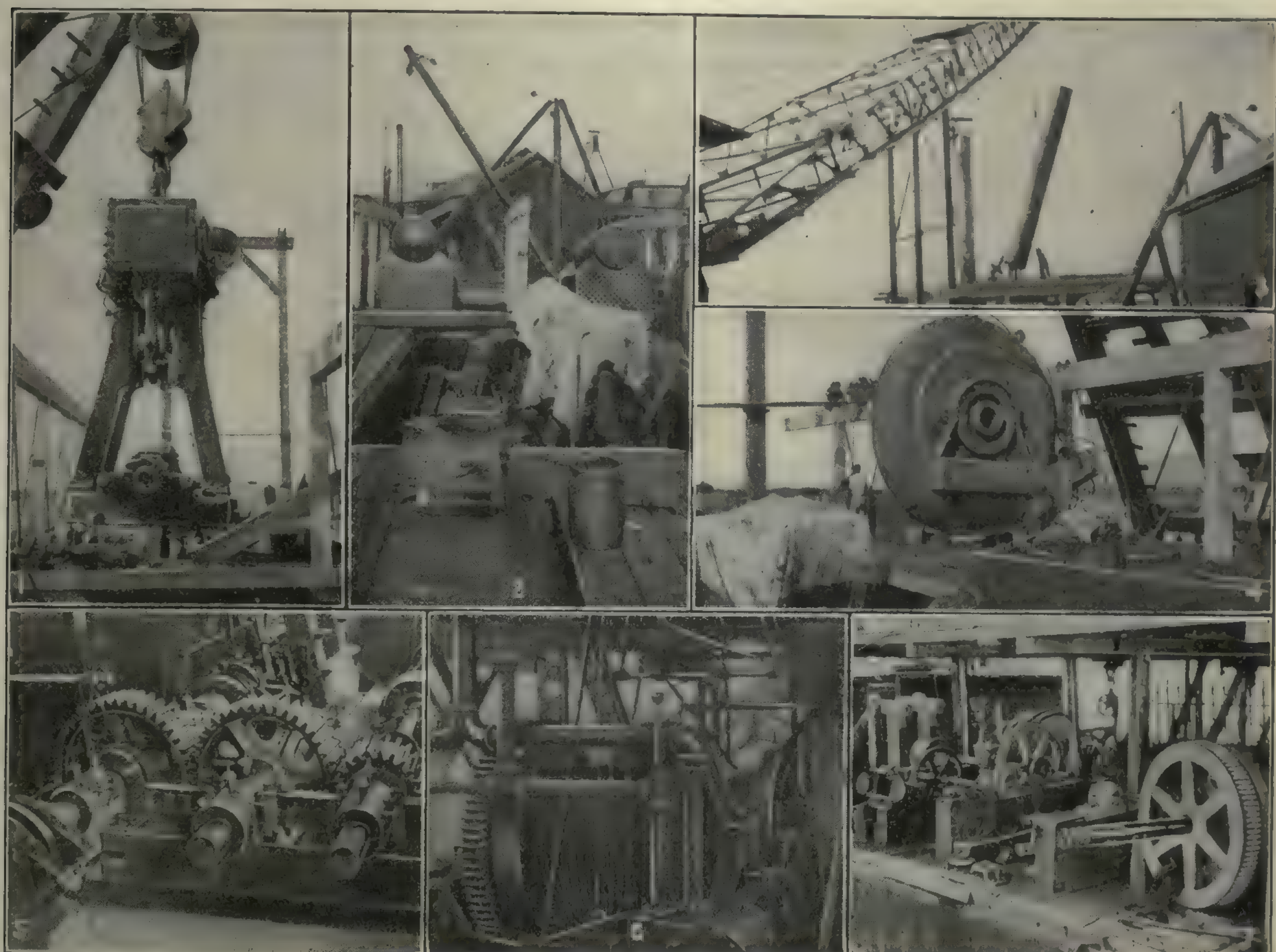
The whole process of making these type is a most interesting one. The rolling or swaging up of the character in the die is only one of a number of unpatented processes, although it is perhaps the most difficult of all and the one upon which the ultimate success of the type depends. Without an accurate die, accuracy in the type character is impossible; and if the locating characters in the type die were not correctly spaced, there would be no possibility of carrying the type themselves through the many stages with accurate results. The process, however, of establishing these locating points—that is, the crosses—with the top and bottom of the die is such that it is impossible for them to be placed incorrectly. As mentioned, they are transferred to the die on a special templet located with certain absolute relationship to all the other templets used in engraving the die blanks.

Installing Heavy Dredge Machinery

Editorial Correspondence

The illustrations herewith represent some of the interesting methods employed in the process of installing heavy equipment on dredges. These views were all taken while work was under way by the Hawaiian Dredging Co.

In Fig. 1 is represented the installation of the main engines on a dredge. These are compound engines



FIGS. 1 TO 7. INSTALLING HEAVY DREDGING MACHINERY AT HONOLULU

coupled and connected to a driving sprocket with Morse silent chains. The engines have cylinder bores of 15 and 30 in. and 12 and 24 in. respectively and 16-in. stroke. They are of 450 hp. As will be noticed upon examining the engine that is being swung aboard in Fig. 1, it is put in practically as a complete unit, with the exception of shaft and connecting-rod, thus saving the greater part of the work of assembling and erecting on board.

In Fig. 2 is shown the installation of two Heine boilers of 375 hp. each and for 175 lb. steam pressure. In Fig. 3 is illustrated the method of placing the smokestacks on the dredge, the one at the right being shown suspended from the 120-ft. boom of another dredge alongside. A fair idea of the proportions of this immense boom is gathered upon comparison of the lattice-work structure with the workmen themselves, seen at the base of the funnel.

Another interesting view is that in Fig. 4. This represents the method of installing a 20-in. suction sand pump on the dredge, and here again the relative sizes of the pump and the surrounding apparatus are well illustrated.

All of the equipment on such dredges is of very heavy character, and its installation requires a pretty thorough all-round knowledge and training on the part of the men in charge and the workmen themselves. Some conception of the proportions of the gearing and shafts in the pump transmission may be gathered from Fig. 5, and another illustration of value as showing the heavy character of the work is presented in Fig. 6, which shows the main hoisting engine on the big dredge; the mooring gears are seen in the background. This mooring gearing in process of installation is represented in Fig. 7, which shows six drums on the dredge, the one in the foreground still awaiting the operation of being mounted in position. This view shows the various slings and hoisting tackle used in such work.

Swaged Pipe To Replace Tubing

By Robert B. Treat

The present-day difficulty in obtaining special materials makes it necessary to find substitutes wherever possible. A certain small size of electrical motor was in a fair way to be removed from the sales list, because of the 10 to 12 months' delivery required on the tubing used for the manufacture of the magnet frame. At the time the motor was designed, several years ago, the tubing manufacturers offered prompt deliveries of list sizes. The designer selected a tubing $6\frac{3}{4}$ in. in outside diameter by $5\frac{5}{8}$ in. in inside diameter, to be cut in lengths of 4 in. and bored to $5\frac{11}{16}$ in. in diameter.

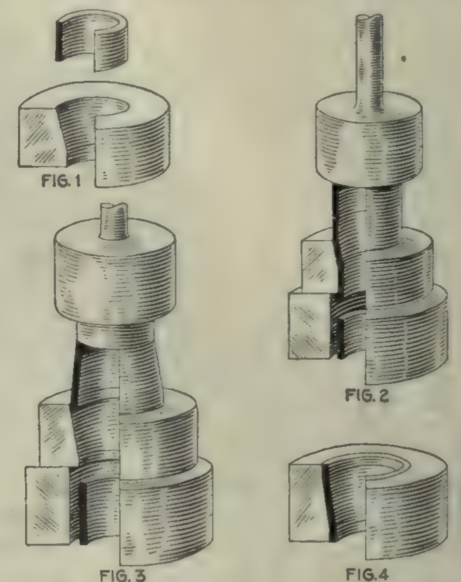
The replenishing of stock motors was based upon expectation of delivery of this tubing four to six weeks after ordering. In this case there was a period of about 10 months during which time none of this size of motor would be available for sale. It was found, however, that the designer had been liberal in the quantity of metal used in the magnet frame. The thickness of wall could be greatly reduced without affecting the electrical properties. Six-inch extra-strong black pipe had sufficient wall, but would not bore to $5\frac{11}{16}$ in., which was necessary for the pole and housing seats. It could, however, be decreased in diameter by the simple means finally adopted in the following description:

Six-inch extra-strong pipe is $6\frac{5}{8}$ in. in outside diameter by $5\frac{3}{4}$ in. inside. An old forged pinion was found that measured about 10 in. in diameter by 5 in. long. The hole was bored out to $6\frac{3}{4}$ in. at one end and $6\frac{1}{2}$ in. at the other, as shown in Fig. 1. The 4-in. length of pipe was forced cold through this taper ring by a drop hammer, which closed it sufficiently to machine to $5\frac{11}{16}$ in., as shown in Fig. 2. Shims were used under the feet to make the height of the shaft the same as before. The lot of motor frames was completed in less than four weeks from the time of starting the order on the books.

The next smaller size of motors was in the same state. The tubing required was 6 in. in outside diameter by $5\frac{1}{4}$ in. in inside diameter by $3\frac{1}{2}$ in. long, bored out to $5\frac{5}{16}$ in. The same size of pipe was used, but this time the reduction was so great that it was decided to heat the pipe and force it through a die having the hole $6\frac{3}{32}$ in. at the small end, as shown in Fig. 3. Previously it had been found that by the cold process a reduction of only $\frac{1}{8}$ in. could be made in one operation, followed by another $\frac{1}{8}$-in. reduction and then annealing. Giving one anneal after two $\frac{1}{8}$-in. reductions required too many operations and too many dies.

The hot method of obtaining the reduction all in one operation disclosed an interesting feature. It was found that after the pipe had completely entered the die, it cooled rapidly and was forced through with difficulty. This latter trouble disappeared entirely when the method was changed.

The pipe would be forced completely into the die, Fig. 4, giving it a diameter of about $6\frac{1}{8}$ in. at one end and $6\frac{5}{8}$ in. at the other. It was then knocked out and inverted, entering the large hot end into the die. This



FIGS. 1 TO 4. THE DIES AND THE WORK

preserved the heat longer in the pipe, because of less area of contact with the die. The pipe was not reduced to the old diameter, 6 in., as it was found that advantage could be taken of the tolerance in height from the floor to the shaft center, resulting in less boring than if reduced to 6 in. in diameter. The time and labor for reducing the smaller pieces were roughly only double that of the single cold reduction. The one cold reduction required one special die, three operations and the usual blacksmiths' tongs. The one hot reduction required one special die, four operations, the usual blacksmiths' tongs and some convenient follow block, as shown in Fig. 3.

Coolants for Cutting

For shaving in the slotter and similar work at the Springfield arsenal, fish oil seems to give best results. It is put on the tool with a brush. This comes from the hardening room after having been used for quenching springs and other parts.

The different oils used are lard oil, best-grade winter-strained; Triumph oil, a mineral oil produced by the Clarkson & Ford Co.; cutting oil, a lower-grade mineral oil made by various concerns; Nagle oil, made by the Ulco Oil Co.

Screw machines and profilers use the Triumph oil almost entirely. This is particularly true of small cutters. Compound is, however, used on the larger profiling work.

Dynamic Reaction of the Connecting-Rod

BY WALTER RAUTENSTRAUCH*

SYNOPSIS—The author presents a method of finding the dynamic reaction of a connecting-rod that is believed to be new. The method appears to lend itself to the solution of many dynamic problems involving the motions of masses about instant or variable centers.

The connecting-rods of reciprocating engines have a motion with respect to the frame about an instant or variable center, as a consequence of which the dynamic reaction of the rod to force application is not so easily predicted as is the case with masses rotating about fixed and permanent centers.

In the latter case the force relations are represented in Fig. 1, where A is a rod hinged to B (a fixed body) at the center C. A force F acts on A with a torque Fl. In order to impress the torque Fl there must be an equal and opposite torque which in this case arises from the resistance of the mass to acceleration. The reacting torque is easily seen to be

$$\textit{Reacting torque} = \int_{r_0}^{r_1} m a_n r_n = \int_{r_0}^{r_1} m \omega r_n^2 = I\omega$$

where I is the moment of inertia of the mass of the rod about the center C, m the unit mass of the rod, ω the angular velocity and r_n the radius of the point of application of the reacting torque. This fundamental equation is broadly applicable to all kinds of rotating masses and is true for masses rotating about instant or variable centers, as well as permanent or fixed centers. It is therefore true for the case of the connecting-rod.

Let us inquire into the behavior of the connecting-rod as it moves with a uniform crankpin velocity tangential to the crankpin circle and under the action of the force behind the piston. Let us learn particularly the history of the reaction of the rod to acceleration for all points in the cycle. Let us first take the case of a rod of uniform cross-section throughout the length in consequence of which it follows that each unit length, each inch of length for example, is of equal mass.

It will appear upon examination of Fig. 2 that the crankpin end of the rod is accelerated toward the shaft center with an acceleration A_p. With uniform rotation of the crank, A_p is constant in magnitude. Any other point of the rod such as the point N distant y from the wristpin end of the rod, is accelerated $A_p\frac{y}{l}$ parallel to the crank. The wristpin end of the rod as shown in Fig. 3 is accelerated toward the crank with the acceleration A_o. This acceleration is variable throughout the rotation of the crank. With uniform rotation A_o is expressed

$$A_o = A_p(\cos d \pm \frac{r}{l}\cos 2d)\ \textit{approx.}$$

Any point N, x distant from P, has an acceleration parallel to the line of piston stroke equal to $A_o\frac{x}{l}$.

Both A_p and A_o are known quantities for given proportions and speed.

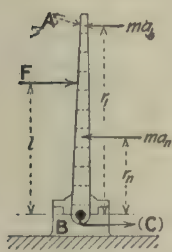


FIG. 1

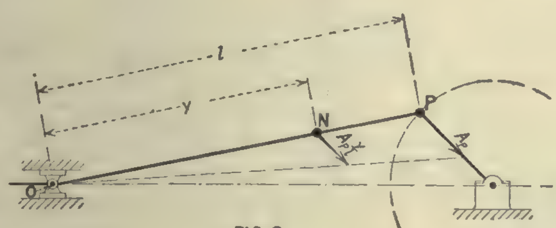


FIG. 2

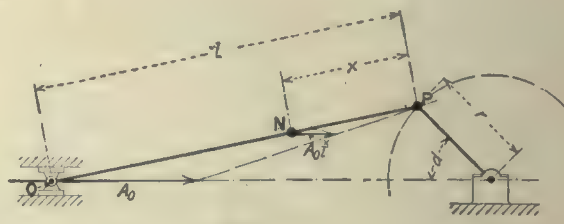


FIG. 3

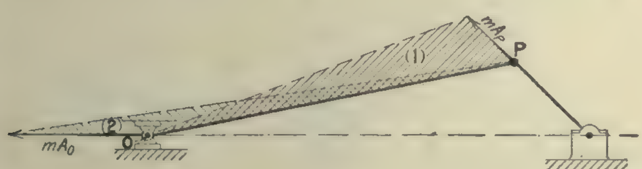


FIG. 4

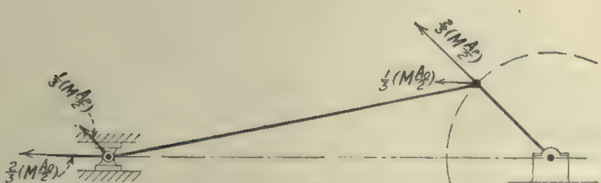


FIG. 5

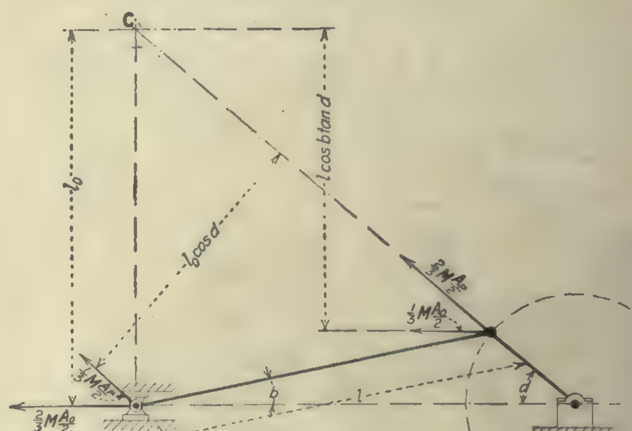


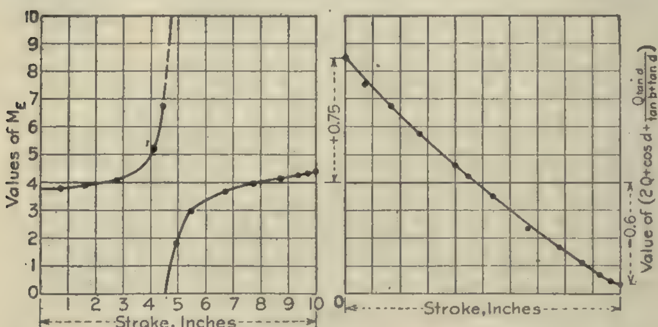
FIG. 6

FIGS. 1 TO 6. DIAGRAMS OF DYNAMIC REACTIONS OF A CONNECTING-ROD OF UNIFORM SECTION

*Professor of mechanical engineering, Columbia University, New York City.

Accordingly the forces acting on the rod as a result of the resistance of the masses to acceleration are as shown in Fig. 4. For example: At the crankpin end, one inch length of the rod of mass m exerts a force outward from the crank equal to mA_p, while at the wristpin end one inch length of rod exerts a force as shown equal to mA_o. The rod then is acted upon by two triangular loads (1) and (2). Let M = the mass of the entire rod; then the reaction of the rod at the two pins due to load (1) will be $\frac{2}{3}\left(M\frac{A_p}{2}\right)$ at the crankpin end and $\frac{1}{3}\left(M\frac{A_p}{2}\right)$ at the wristpin end and due to load (2) will be $\frac{1}{3}\left(M\frac{A_o}{2}\right)$ at the crankpin end and $\frac{2}{3}\left(M\frac{A_o}{2}\right)$ at the wristpin end. These reactions are shown in Fig. 5.

When the crank stands at any angle d as shown in Fig. 6, the connecting-rod moves with respect to the frame about the instant center C and therefore the reac-



FIGS. 7 AND 8. VALUES FOR VARIOUS PISTON POSITIONS

tions listed in Fig. 5 occasion a reacting torque about the center of rotation C, which is

$$T = \tfrac{2}{3}M\frac{A_o}{2}\,l_o + \tfrac{1}{3}M\frac{A_p}{2}\,l_o\cos d + \tfrac{1}{3}M\frac{A_o}{2}\,l\cos b\tan d$$

But

$$A_p = \frac{A_o}{\cos d \pm \frac{r}{l}\cos 2d}$$

and

$$l\cos b\tan d = l_o\frac{l\cos b\tan d}{l\sin b + l\cos b\tan d}$$

Therefore

$$T = \tfrac{2}{3}M\frac{A_o}{2}\,l_o + \tfrac{1}{3}M\frac{A_o}{2}\,l_o\frac{\cos d}{\cos d \pm \frac{r}{l}\cos 2d}$$

$$+ \tfrac{1}{3}M\frac{A_o}{2}\,l_o\frac{\cos b\tan d}{\sin b + \cos b\tan d}$$

$$= \tfrac{1}{6}MA_ol_o\left(2 + \frac{\cos d}{\cos d \pm \frac{r}{l}\cos 2d} + \frac{\cos b\tan d}{\sin b + \cos b\tan d}\right)$$

Let M_E be a mass which if placed at the wristpin would require the same torque T about C to accelerate it with the acceleration A_o.

In its effect then M_E would produce the same reaction as the rod and may therefore be termed the equivalent mass. Then

$$T = M_EA_ol_o$$

The value of M_E in terms of M is

$$M_E = \tfrac{1}{6}M\left(2 + \frac{\cos d}{\cos d \pm \frac{r}{l}\cos 2d} + \frac{\cos b\tan d}{\sin b + \cos b\tan d}\right)$$

It is seen that M_E is variable and depends on the crank

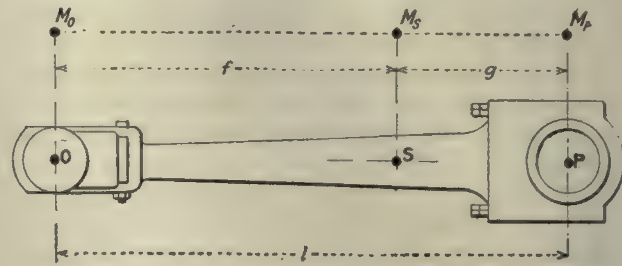


FIG. 9

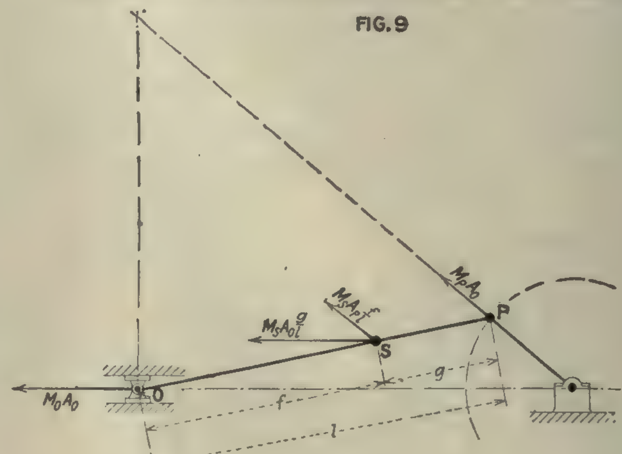


FIG. 10

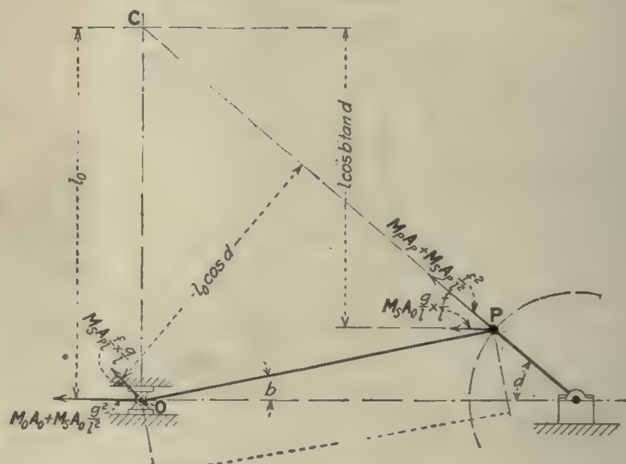


FIG. 11

FIGS. 9 TO 11. DIAGRAMS OF DYNAMIC REACTIONS

angle d as well as the ratio of r to l. To learn the extent of the variation of M_E throughout the stroke of the piston let $\frac{r}{l}$ = 6, whereupon the values of the quantity in the parenthesis become for different crank angles and uniform crank speed as given in Table 1.

When plotted as ordinates to the corresponding piston positions in the stroke as a base it is found that a curve as shown in Fig. 7 results. It is seen that the value of the quantity in the parenthesis is approximately 4. It is further apparent that the value of $\frac{r}{l}$ will not affect the average value 4 but simply change the slope of the curves. Again it will be seen that the high and low values occur near the middle of the stroke and since A_o approaches

zero at this same place the variation in M_E does not substantially affect the product $M_E A_o$.

Since

$$M_E A_o = M \tfrac{1}{6} A_o \left(2 + \frac{\cos d}{\cos d \pm \frac{r}{l} \cos 2d} + \frac{\tan d}{\tan b + \tan d} \right)$$

$$= M \frac{v^2}{r} \tfrac{1}{6} \left(2Q + \cos d + \frac{Q \tan d}{\tan b + \tan d} \right)$$

where

v = Speed of crankpin;

r = Crank radius;

$Q = (\cos d \pm \frac{r}{l} \cos 2d)$.

Now $M \frac{v^2}{r}$ is constant and the quantity in parenthesis varies throughout the stroke as shown in Fig. 8. It is at once apparent that Fig. 8 is precisely the form of the curve of inertia of the reciprocating parts.

Therefore for the usual values of $\frac{r}{l}$ obtaining in practice and for a *rod of uniform cross-section* throughout its length $M_E = \frac{2}{3} M$. In other words, for the conditions specified above, two-thirds of the mass of the rod may be considered acting with the reciprocating parts as far as the force necessary to accelerate the rod is concerned.

Since the connecting-rods as manufactured for engines do not have uniform cross-sections throughout the length, the value of M_E is altered from that given above because the mass distribution throughout the rod length is altered and consequently the reactions listed in Fig. 5 no longer obtain. To determine the mass M_E at the wristpin center which with an acceleration A_o is equivalent in its reaction to the mass of the whole rod each unit length of which is variable in both mass and acceleration, it will be found convenient to replace the rod by three masses, one at the crankpin center, one at the wristpin center, one at the center of gravity of the rod, which in their combined reactions to their respective accelerations will be equivalent to the reaction of the whole rod.

These substitute masses are determined as follows: Let Fig. 9 represent a connecting-rod of length l whose center of gravity is at s. Let the mass of the rod be M. This rod is the dynamic equivalent of the three masses M_o M_s and M_p, provided their weights are equal,

$$M = M_o + M_s + M_p$$

and provided they have the same center of gravity, or

$$M_o f = M_p g$$

and provided they have the same moment of inertia, or

$$M_o f^2 + M_p g^2 = M k_s^2$$

where $M k_s^2 = I_s$, the moment of inertia of the rod about its center of gravity s.

Accordingly

$$M_p = \frac{M k_s^2}{gl}$$

$$M_o = \frac{M k_s^2}{fl}$$

$$M_s = M - (M_p + M_o) = \left(M - \frac{M k_s^2}{fg} \right)$$

These substitute masses, being equivalent to the mass of the rod in kinetic energy in rotation about the instant center of the rod with respect to the frame, will require the same torque for their acceleration and consequently present the same reactions to acceleration as the mass of the rod itself. Accordingly, therefore, the reactions of a rod of non-uniform cross-section will appear as shown in Fig. 10. The reactions at the crankpin and wristpin are as given in Fig. 11.

TABLE I

d (degrees)	$\left(2 + \frac{\cos d}{\cos d \pm \frac{r}{l} \cos 2d} + \frac{\cos b \tan d}{\sin b + \cos b \tan d} \right)$
0	3.716
15	3.730
30	3.791
45	3.895
60	4.122
75	5.198
90	3.000
105	3.[illegible]91
120	3.948
135	4.[illegible]36
150	4.270
165	4.367
180	4.400

From which is had

$$T = \left(M_o A_o + M_s A_o \frac{g^2}{l^2} \right) l_o + \left(M_s A_p \frac{gf}{l^2} \right) l_o \cos d$$

$$+ \left(M_s A_o \frac{gf}{l^2} \right) l \cos b \tan d = \left[M \frac{k_s^2}{fl} + \left(M + M \frac{k_s^2}{fg} \right) \frac{g^2}{l^2} \right] l_o A_o$$

$$+ \left[\left(M - M \frac{k_s^2}{gf} \right) \frac{gf}{l^2} \right] l_o A_o \frac{\cos d}{\cos d \pm \frac{r}{l} \cos 2d}$$

$$+ \left[\left(M - \frac{M k_s^2}{gf} \right) \frac{gf}{l^2} \right] l_o A_o \frac{\cos b \tan d}{\sin b + \cos b \tan d} = M_E A_o l_o$$

where M_E is that mass which concentrated at the wristpin will require the torque T for an acceleration A_o.

It will be seen that

$$M_E = \left[M \frac{k_s^2}{fl} + \left(M - M \frac{k_s^2}{gf} \right) \frac{g^2}{l^2} \right] + \left\{ \left[\left(M - M \frac{k_s^2}{gf} \right) \frac{gf}{l^2} \right] \times \left[\frac{\cos d}{\cos d \pm \frac{r}{l} \cos 2d} + \frac{\cos b \tan d}{\sin b + \cos b \tan d} \right] \right\}$$

It was shown above that the quantity

$$\left[\frac{\cos d}{\cos d \pm \frac{r}{l} \cos 2d} + \frac{\cos b \tan d}{\sin b + \cos b \tan d} \right]$$

is approximately equal to 2.

It was found by Mollier[1] and also by Moss[2] that the connecting-rods for steam engines have values of $g = 0.35l$ and $f = 0.65l$.

Upon substitution of these values in the above equation for M_E it is found that

$$M_E = M \frac{k_s^2}{(0.65l)^2} + 0.13M - M \frac{k_s^2}{2l^2} + 0.46M - M \frac{2k_s^2}{l^2}$$

$$= 0.59M - \frac{M k_s^2}{l^2}$$

Let

k_o = radius of gyration of the rod about the wristpin O

$= k_s^2 + (0.65l)^2 = k_s^2 + 0.43l^2$

whereupon

$$M_E = 0.59M - M \frac{k_o^2}{l^2} + 0.43M = M \left(1 - \frac{k_o^2}{l^2} \right) \textit{approx.}$$

[1]"Zeitschrift des Vereines deutscher Ingenieure," 1903.

[2]"Transactions," A. S. M. E., 1905.

The values of k_o^2 usually found in practice vary from $0.5l^2$ to $0.6l^2$ so that

$$M_E = 0.5M \text{ to } 0.4M$$

Accordingly, therefore, in determining the inertia effect of the reciprocating parts of an engine there should be included that part of the mass of the rod as above determined.

While this fact is not new, it is believed that the method of analysis by which it is found is new. It is at once apparent that this analysis lends itself to the solution of all sorts of dynamic problems which involve the motion of masses in machines about instant or variable centers.

Reboring a Variable-Speed Cone

By Donald A. Hampson

A boring job out of the ordinary is shown in Fig. 1. The piece is a 24-in. and 12-in. cone 64 in. long, from a Moore & White variable-speed device that got loose on its shaft and wore the holes so badly that they had to be rebored.

The point of interest about the work is how, without expensive special fixtures, to support for boring accurately this rather heavy and awkward-shaped piece. The

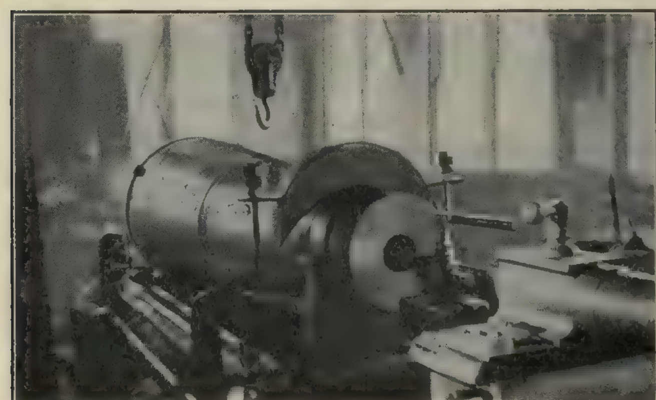


FIG. 1. REBORING THE CONE

steadyrest used was cut out of a 2-in. maple plank and consisted of three pieces, one lower piece for the large end and another for the small end, and an upper piece cut to two different radii on its under side. A piece of steel bent to the outside of the upper piece completed the special parts needed, except a few stock bolts and clamps. This arrangement was entirely satisfactory. In Fig. 1 the big end is shown chucked. The casting was reversed for boring the other end.

In connection with these speed cones, another little problem has presented itself. It is sometimes required to remove the shaft from the cone where nothing but hand power is available. When the original fitting and assembling of the shaft and cone have been well done, and the two keys driven home with a 16-lb. sledge, the machinist straightens up and says, "If you ever want to get that out whole, don't send for me." That is the kind of fit we seemed to strike every time a shaft had to be taken out. The assembly weighed well over a ton, which weight was finally used in disassembling.

The shop portable crane was run under an overhead beam and braced, as shown in Fig. 2, so it could not rise from the floor; then the chain was unhooked but was left in the block which, inverted, was caught in a rope sling around the beam. The cone and shaft were raised to a vertical position, braced, and guyed so they could rise and fall, but not topple over. This latter precaution was highly important from a safety standpoint. The rest

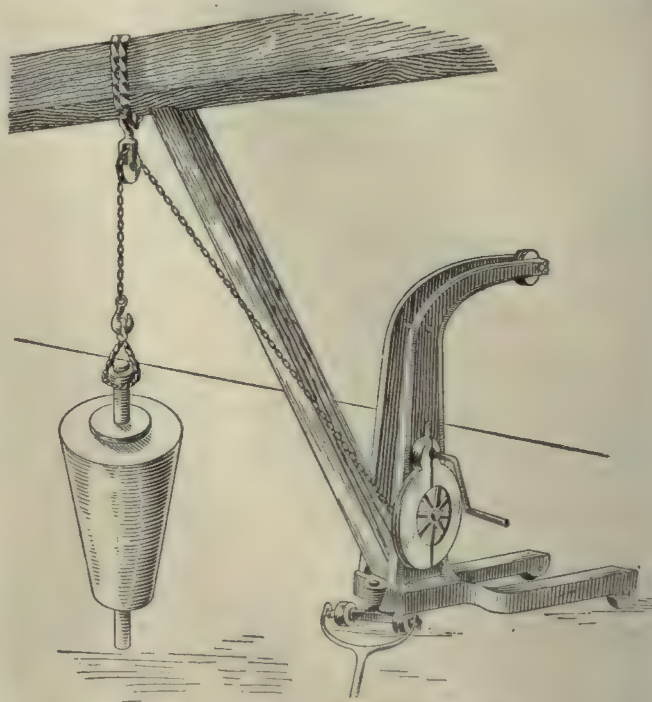


FIG. 2. REMOVING THE SHAFT

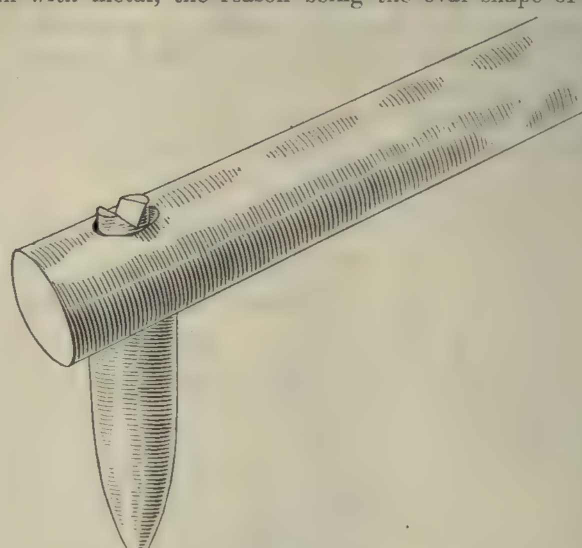
was easy: Raise the load a few inches with the crane and let it fall; if the cone doesn't move, raise it a few inches higher and try again. A few such "trys" invariably did the deed.

Riveting Pins in Round Stock

By B. Davidson

Recently I had several bars of 1-in. bright drawn iron in each of which I had to drill a dozen $\frac{7}{16}$-in. holes and countersink them to receive pins 3 in. in length.

I had much difficulty in completely filling the countersink with metal, the reason being the oval shape of the



METHOD OF RIVETING ON ROUND STOCK

countersink, which was much in evidence on this small diameter. I made a much stronger and neater job by filing a V in the end of the pin to be riveted, crosswise with the length of the shaft.

Casting High-Speed Steel Tools to Shape

EDITORIAL CORRESPONDENCE

SYNOPSIS—The method of producing shop tools here described will be of considerable interest to mechanics in general. In certain lines of work the saving in time and material on tools will be quite an item, if they can be successfully made in this way.

The commonly accepted idea is that ordinary lathe or planer tools—milling cutters, boring cutters, gear cutters and the like—have to be made from bar stock or special forgings. To think that tools of this class can be made in practically the same manner as common castings is out of the ordinary, especially when these tools are of high-speed steel. However, Anton Boerder some time ago invented a process by which high-speed metal-cutting tools of all kinds may be cast to shape, leaving from $\frac{1}{16}$ to $\frac{1}{8}$ in. for finishing. Tools of this kind are now being cast by the High Speed Tools Corporation, Toledo, Ohio. From reliable sources the steel in these tools is reported as comparing favorably in edge-holding qualities with forged or bar machined stock, and it may be forged into various shapes when necessary. The large saving in time and material in finish-machining these tools will at once be apparent to any practical shopman. This company also casts bars and billets for various purposes.

To give an idea of the class of tools now being produced, a number are shown in Fig. 1. As can be seen, these comprise form tools, milling cutters, gear cutters, counterbores, countersinks, drills, tool-holder bits, boring-bar cutters, bar steel and almost every form of everyday shop tools.

In obtaining the data for this article a number of tools were broken to show the grain. Some of these pieces are illustrated in Fig. 2. The arrows at *A* point to the grain of a broken milling cutter; *B* to the shank of a counterbore, broken just above the flutes; *C* is the grain of a sprue of a casting runner; at *D* is a partly machined gear cutter, showing the way it machines and also the closeness of the grain and the entire lack of blow-holes.

FIG. 1. TOOLS CAST FROM HIGH-SPEED STEEL BY THE NEW PROCESS

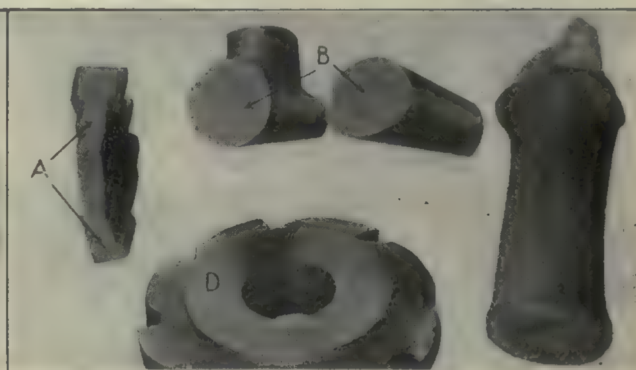


FIG. 2. EXAMPLES OF GRAIN AND MACHINING PROPERTIES

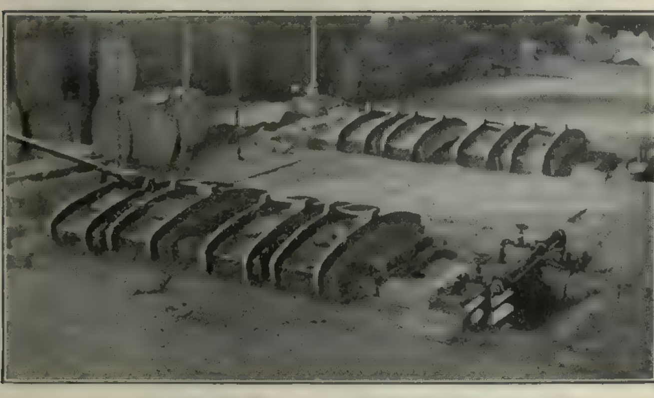


FIG. 3. SOME OF THE MELTING FURNACES

FIG. 4. A FEW OF THE MOLDS FOR TOOL CASTING

The company has its own laboratory for analyzing the various heats, and some of the results are tabulated below:

Heat No.	Tungsten	Chromium	Vanadium	Carbon	Manganese
11	17.89	3.29	0.89	0.67	0.12
26	18.89	3.54	0.77	0.77	0.07
32	18.63	3.80	0.65	0.72	0.10

These are a few representative analyses, but others chosen at random from a number made by James H. Herron, consulting chemist, Cleveland, Ohio, run as follows:

Heat No.	Tungsten	Chromium	Vanadium	Carbon	Manganese
3	19.82	3.37	0.59	0.761	0.15
6	18.88	3.30	0.57	0.552	0.15
7	18.22	4.19	1.15	0.805	0.20
8	17.71	3.35	1.04	0.680	0.15
9	18.36	1.74	0.75	0.590	0.09

The last two also showed phosphorus, 0.028 and 0.034; sulphur, 0.008 and 0.008, respectively. However, tests for these were not made on all the heats. The heat num-

bers given are for identification purposes only and do not represent consecutive heats.

The company does not machine the tools, but supplies them to shops as ordered, just enough extra metal being put on to clean up well and give a good edge where needed. The tools are cast from patterns exactly as if pouring cast iron and, after being cleaned, are carefully annealed and sent to customers.

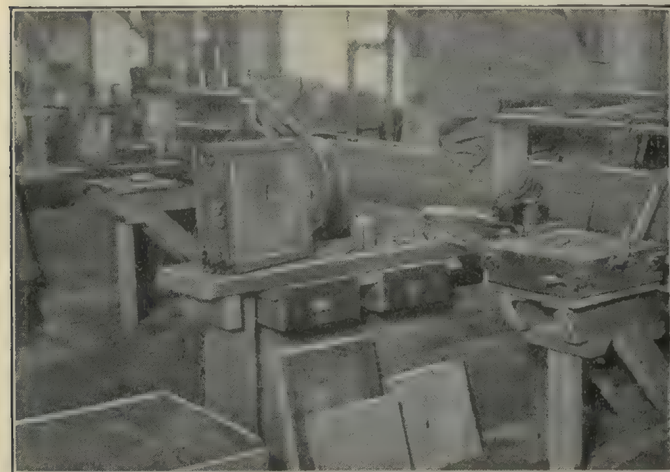


FIG. 5. MOLDERS' BENCHES

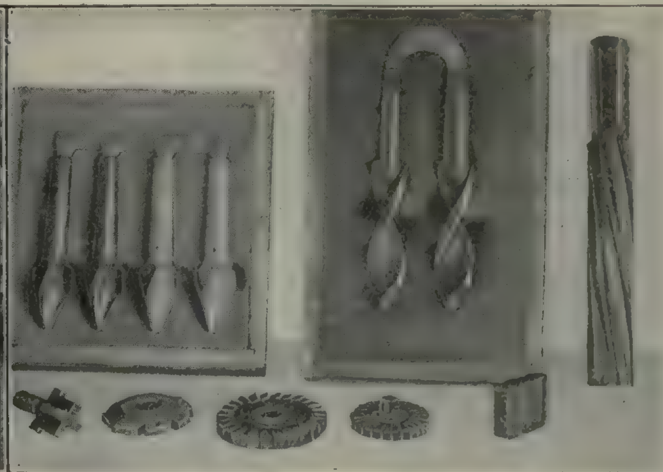


FIG. 6. PATTERNS FOR CUTTERS OF VARIOUS KINDS

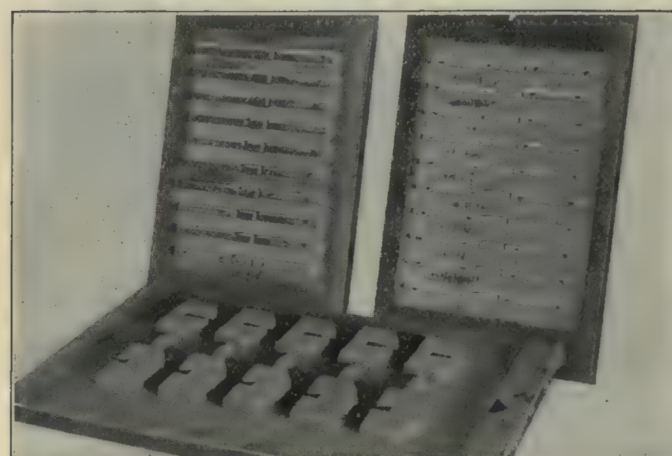


FIG. 7. PATTERNS FOR TOOL-HOLDER AND BAR BITS

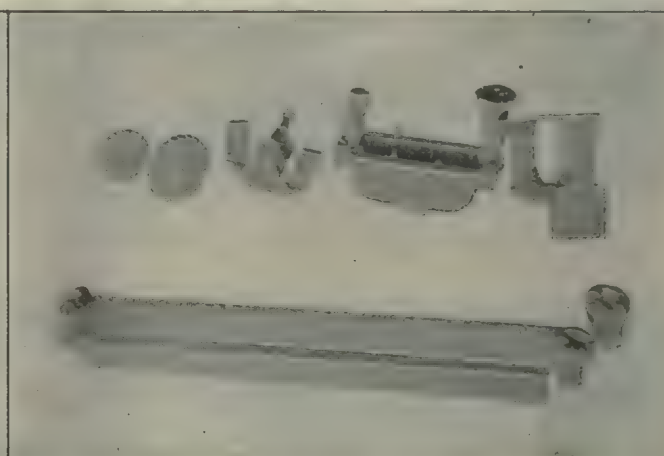


FIG. 8. CASTINGS JUST FROM THE MOLDS

The mix is placed in crucibles and melted in the type of oil furnaces shown in Fig. 3. The heat has to be carefully watched, and the pouring must be done at just the right time to produce good results. The exact method of mixing cannot be given here, for obvious reasons. After the melt is ready to pour, the crucibles are taken out of the furnace and the metal poured into molds like those seen in Fig. 4. The row of molds in the background is ready to pour, but in the foreground only the drags have been placed ready for the copes. These molds are for casting large counterbores used in shipbuilding and heavy machinery work. Some of the molders' benches are shown in Fig. 5.

The Patterns Used

A representative group of patterns is given in Fig. 6, of which no explanation is needed. Another set of patterns is shown in Fig. 7. The two boards at the back are for tool-holder bits, and the one in front is for special bar cutters. A few of the castings, just as they come from the molds, are shown in Fig. 8. These illustrations will give the reader a good idea of the variety and class of work produced.

As already explained, this company does not finish the tools; but in sending them to customers the hardening instructions are given, as follows: Bring the steel slowly to 650 deg. F.; raise to 1200 deg. F.; then raise quickly to 2250 deg. F. and quench in fish oil until cool. If a gas furnace is used in this work, supply more gas than air in order to prevent the steel from having a soft cutting edge. This method of casting tools should enable a large part of the expense to be eliminated.

American Equivalents of Russian Units of Measure*

The following list of weights, measures and money will enable a quick transformation, with approximate accuracy, of Russian units into those used in this country.

Pood	= 36.114 lb. avoirdupois
Funt (96 zolotniks of 96 doli each)	= 0.9028 lb. avoirdupois (14.45 oz.)
Doli	= 0.686 grains Troy
Lot	= 0.45 oz. avoirdupois
Kilogram	= 2.2046 lb. avoirdupois
Arshine	= 28 in.
Sazhen (16 vershoks)	= 7 ft.
Meter	= 1.0936 yd. = 3.281 ft.
Centimeter (10 mm.)	= 0.39 in.
Square arshine	= 5.44 sq.ft.
100 square vershoks	= 2.13 sq.ft.
Square meter	= 1.196 sq.yd.
Ruble (100 copeks)	= 51.5c.
1 ruble per pood	= 1.426c. ($0.01426) per lb. avoirdupois
1 ruble per funt	= 57c. ($0.57) per lb. avoirdupois
1 copek per square vershok	= 24.179c. ($0.2418) per sq.ft.

*From a table printed in Russia.

United States Munitions*

The Springfield Model 1903 Service Rifle

Making the Guard—I

SYNOPSIS—While this piece carries the sear and trigger mechanism as well as the magazine, it is under no particular stress from the firing of the cartridge. It is, however, a rather intricate piece on account of its being finished all over, and particularly because of the very thin walls of the magazine. These as well as the trigger guard and other parts are all carefully profiled.

The guard, which forms the body for the magazine, is shown in detail in Fig. 1158. This is a drop forging that weighs 3½ lb. After machining, it weighs less than ½ lb. It is made from Class D steel, and its dimensions are 1⅝x1$\frac{3}{16}$ in. Its main parts are the trigger-guard bow *A*, front tang *B*, rear tang *C*, front screw stud *D*, magazine walls *E*, rear end of magazine *F*, floor-plate pin hole *G*, front guard-screw hole *H*, rear guard-screw hole *I*, trigger slot *J*, floor-plate lug slot *K*, floor-plate spring hole *L*, floor-plate catch slot *M*, ramp *N* and the lightening cuts *O*.

The working points are the top and bottom of the magazine walls *E* and the front and rear guard-screw holes *H* and *I*. As the walls are very thin after being profiled, a steel block is used to fill the space between the walls so as to avoid springing in some of the clamping operations. The guard is finished by bluing.

OPERATIONS ON THE GUARD

Operation
A-1 First blocking from billet
B First dropping
B-1 Pickling
C Trimming
D Dropping to finish
D-1 Pickling
E First trimming (inside of bow)
E-1 Second trimming (outside)
F Cold dropping and straightening
1 Milling top crosswise
2 Milling left side crosswise
3 Milling right side crosswise
4 Milling bottom crosswise
4½ Burring operations 2, 3 and 4
5 Milling top of tangs crosswise
5¼ Burring operation 5
6 Drilling, reaming and counterboring guard-screw holes and drilling for floor-plate lug
7 Spotting two holes for magazine opening, drilling for floor-plate catch pin and counterboring for floor-plate lug
8 Drilling to remove stock for magazine opening
9 Milling to remove stock from top of magazine opening
10 Milling to remove stock from bottom of magazine opening
11 Profiling rough to remove stock from magazine opening
12 Profiling inside of magazine to finish
13 Shaving rear end of magazine opening
13½ Filing to finish operation 13
14 Drilling floor-plate catch-spring cavity and counterboring for head of guard screw, rear
15 Hollow-milling and counterboring front guard-screw stud
16 Hand-milling to remove stock in rear of front guard-screw stud
17 Profiling outside of guard bow

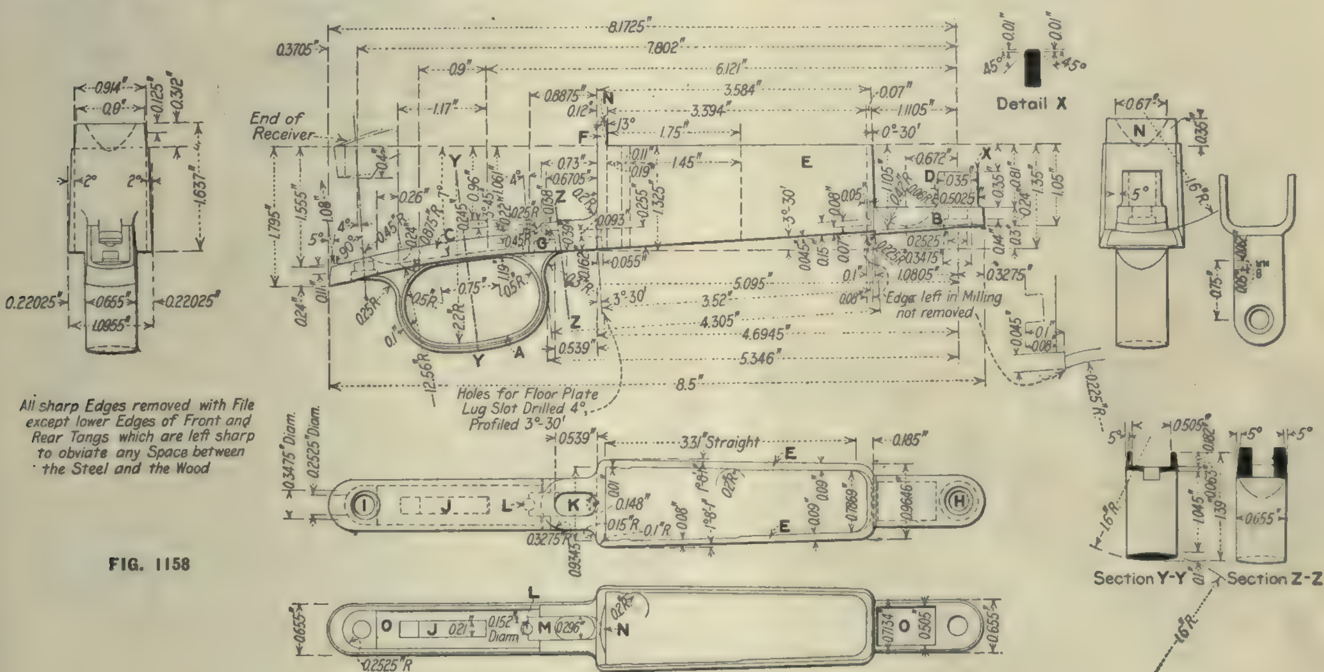


FIG. 1158

Guard (*Forged Steel, Blued*)

18 Profiling inside of guard bow
19 Milling lightening cut in top of rear tang
21 Profiling floor-plate lug slot and rear-end floor-plate seat
22 Hand-milling slot recess for floor-plate catch
23 Hand-milling trigger slot
24 Milling bottom of guard for floor-plate seat
24½ Burring for operation 24 and broaching operation 23
25 and 26 Profiling recesses for floor-plate tenons in front of magazine opening and in floor-plate lug slot
27 Hand straddle-milling sides of projecting rear magazine wall
28 Hand-milling ramp cut in rear magazine wall
29 Profiling edges of guard bow and of front and rear tangs
30 Milling edge of tangs
31 Milling left side of tangs
32 Milling bevel on outside of right wall of magazine
33 Milling bevel on outside of left wall of magazine
33½ Counterboring guard-screw holes to finish and reaming floor-plate catch-pin hole
34 Filing, general
35 Polishing
36 Filing, cornering
37 Bluing

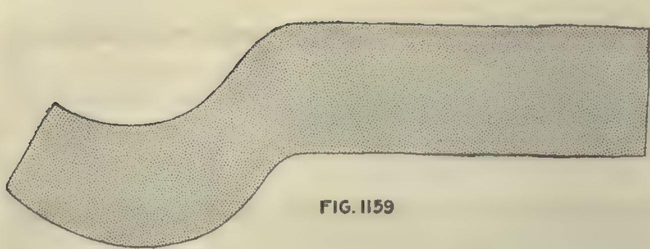


FIG. 1159

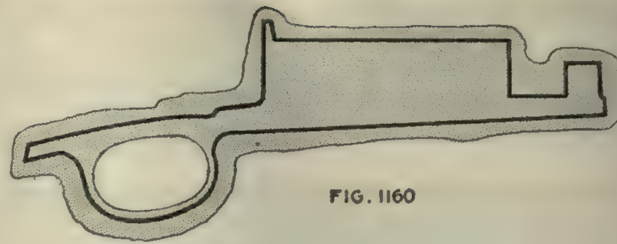


FIG. 1160

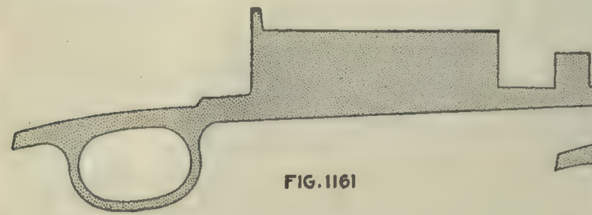


FIG. 1161

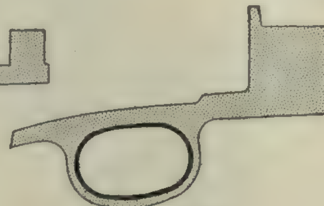


FIG. 1162

FIG. 1163

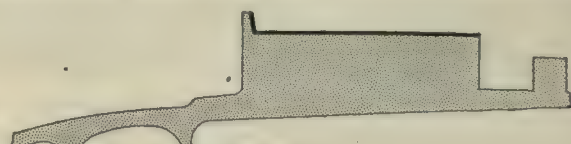


FIG. 1164

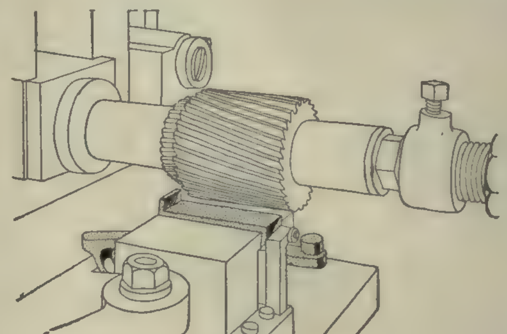


FIG. 1165

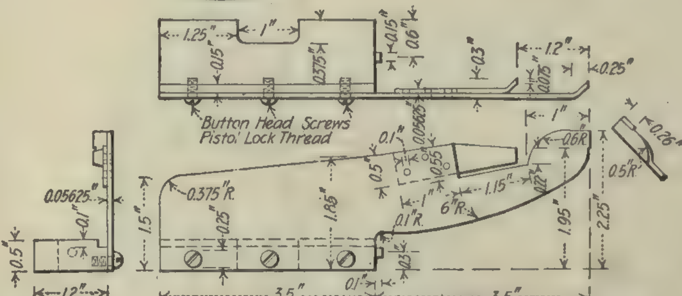


FIG. 1166 A STEEL, (Harden)

OPERATION 1

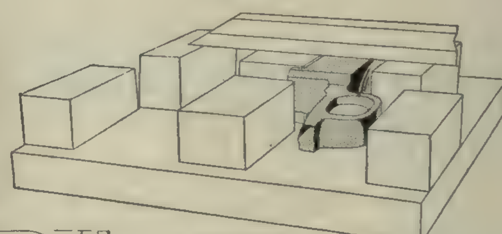


FIG. 1166 D

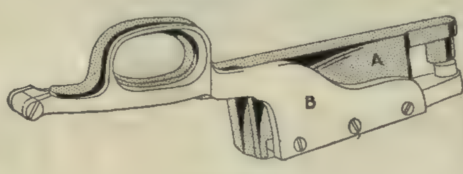
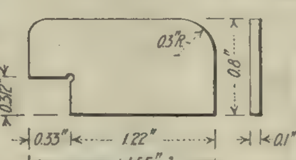


FIG. 1166 C



STEEL (Harden)
FIG. 1166 B

FIG. 1167

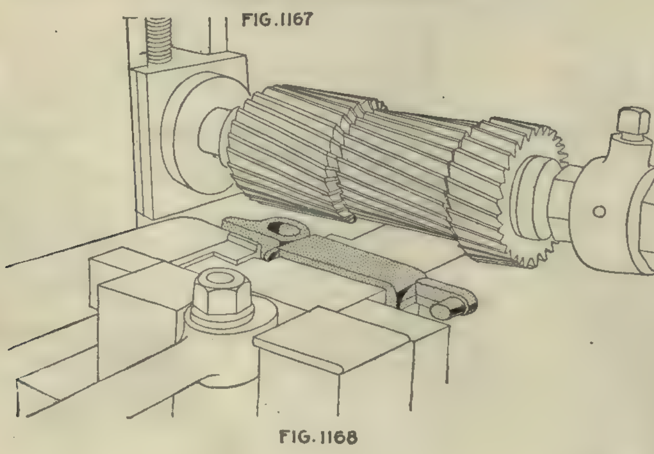


FIG. 1168

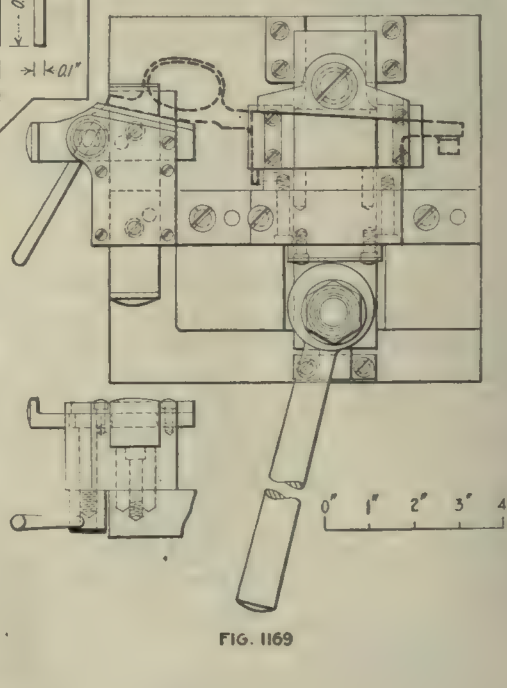


FIG. 1169

OPERATION 2

OPERATION A. FIRST BLOCKING FROM BILLET

Transformation—Fig. 1159. Number of Operators—One. Description of Operation—Shaping from billet. Apparatus and Equipment Used—Billings & Spencer 1,000-lb. drop hammer. Production—40 per hr.

OPERATION B. FIRST DROP FORGING

Transformation—Fig. 1160. Number of Operators—One. Description of Operation—Drop forging to shape. Apparatus and Equipment Used—Billings & Spencer 1,000-lb. drop hammer. Production—35 per hr.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water, and left from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hoists.

OPERATION C. TRIMMING

Transformation—Fig. 1161. Machine Used—Bliss press, 3½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Stripping Mechanism—Punch down through die. Average Life of Punches and Dies—15,000 pieces. Production—Grouped with operation B.

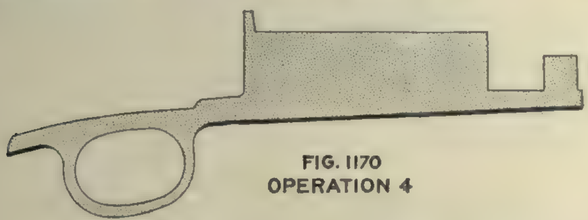


FIG. 1170
OPERATION 4

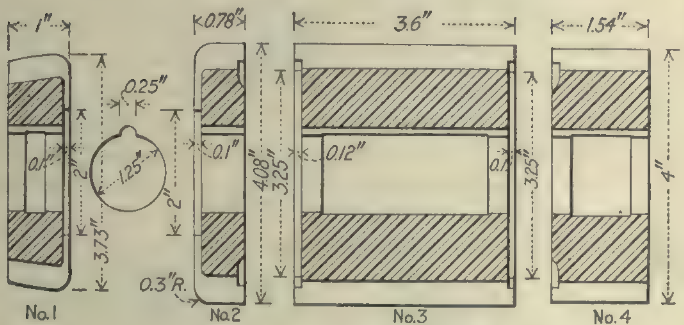


FIG. 1172

OPERATION D. DROPPING TO FINISH

Number of Operators—One forger and one helper. Description of Operation—Finished drop forging; simply sizes the guard to closer limits than first dies. Apparatus and Equipment Used—Billings & Spencer 1,000-lb. drop hammer. Production—50 per hr.

OPERATION D-1. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling operation.

OPERATION E. FIRST TRIMMING (INSIDE OF BOW)

Transformation—Fig. 1162. Machine Used—Bliss backgeared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Stripping Mechanism—Piece of stock screwed to shoe in back of punch. Average Life of Punches—20,000 pieces. Production—450 per hr.

OPERATION E-1. SECOND TRIMMING (OUTSIDE)

Transformation—Fig. 1163. Machine Used—Bliss backgeared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Stripping Mechanism—Punched down through die. Average Life of Punches and Dies—1,500 pieces. Production—400 per hr.

OPERATION F. COLD DROPPING AND STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening after being trimmed. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—300 per hr.

OPERATION 1. MILLING TOP CROSSWISE

Transformation—Fig. 1164. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—In vise jaws, Fig. 1165. Tool-Holding Devices—Standard arbor. Cutting Tools—Two spiral mills, one 3.375 in. diam. by 3.75 in. long; one 2.75 in. diam., 0.50 in. long; 30 teeth left hand. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, two 1/8-in. streams. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1166; A, surface and projection with relation to underside of guard; B, thickness of projection; C, contour of tang to see if it will finish up in future operations; if not, a little bending is permissible at this stage of the process; D, squareness of sides. Production—20 per hr.

OPERATION 2. MILLING LEFT SIDE CROSSWISE

Transformation—Fig. 1167. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 1168; details in Fig. 1169. Tool-Holding Devices—Standard arbor. Cutting Tools—Interlocking milling cutter 3.22 in. diam., center cutter 2.78 in. diam., 28 teeth, left-hand spiral, one turn in 48 in., right hand. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, two 1/8-in. streams. Average Life of Tool Between Grindings—3,500 pieces. Gages—A form gage with guard laid on side. Production—20 per hr.

OPERATION 3. MILLING RIGHT SIDE CROSSWISE

Transformation—Fig. 1167. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, same as Fig 1169, but reversed. Tool-Holding Devices—Standard arbor. Cutting Tools—Same as operation 2. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, two 1/8-in. streams. Average Life of Tool Between Grindings—3,500 pieces. Gages—Same as in operation 2. Production—20 per hr.

OPERATION 4. MILLING BOTTOM CROSSWISE

Transformation—Fig. 1170. Machine Used—Pratt & Whitney No. 2 Lincoln miller, Fig. 1171. Number of Machines per Operator—Five. Work-Holding Devices—Special vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang mill, Fig. 1172. Number of Cuts—50 r.p.m.; ⅝-in. feed. Cut data—One. Coolant—Cutting oil, 1/8-in. stream. Average

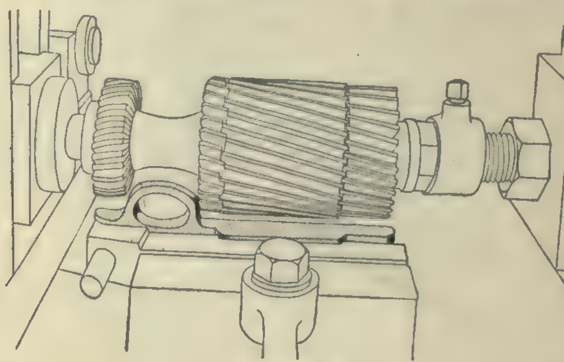


FIG. 1171

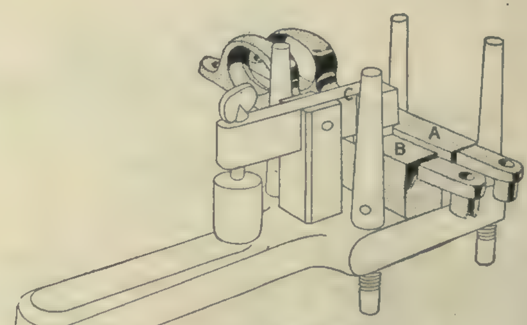


FIG. 1173

Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1173; a master guard is fastened at A; work is clamped at B by clamp C; gaging is done by laying a straight-edge across the work and the master; can be turned over to gage other sides. Production—20 per hr.

OPERATION 4½. BURRING OPERATIONS 2, 3 AND 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 2, 3 and 4. Apparatus and Equipment Used—File. Production—75 per hr.

OPERATION 5. MILLING TOP OF TANGS CROSSWISE

Transformation—Fig. 1174. Machine Used—Garvin No. 17 miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise; vise jaws, Fig. 1175. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1176. Number of Cuts—One. Cut Data—80 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—For contour, thickness and front tang. Production—20 per hr.

OPERATION 5½. BURRING OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATION 6. DRILLING, REAMING AND COUNTERBORING GUARD-SCREW HOLES AND DRILLING FOR FLOOR-PLATE LUG

Transformation—Fig. 1177. Machine Used—Pratt & Whitney four-spindle 16-in. vertical drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1178. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore for screw hole; reamer for guard-screw hole. Number of Cuts—Four. Cut Data—350 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1179; A, location of holes; B, depth of counterbores gaged from top of guard. Production—15 per hr.

OPERATION 7. SPOTTING TWO HOLES FOR MAGAZINE OPENING, DRILLING FOR FLOOR-PLATE CATCH PIN AND COUNTERBORING FOR FLOOR-PLATE LUG

Transformation—Fig. 1180. Machine Used—Dwight Slate 16-in. three-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1181; details in Fig. 1182. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1183. Production—35 per hr.

OPERATION 8. DRILLING TO REMOVE STOCK FOR MAGAZINE OPENING

Transformation—Fig. 1184. Machine Used—Pratt & Whitney 16-in. vertical drilling machine. Number of Machines per Operator—Two, one front and one rear. Work-Holding Devices—Drill jig, Fig. 1185. Tool-Holding Devices—Taper shank. Cutting Tools—Twist drill. Number of Cuts—Two.

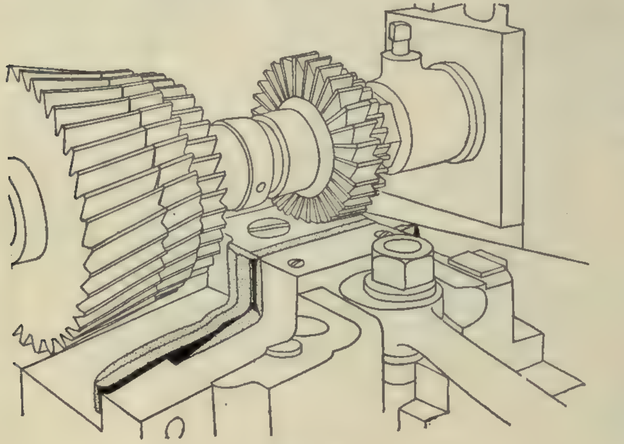


FIG. 1175

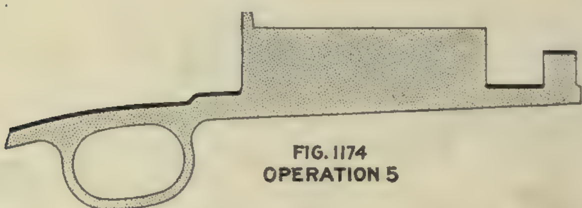


FIG. 1174
OPERATION 5

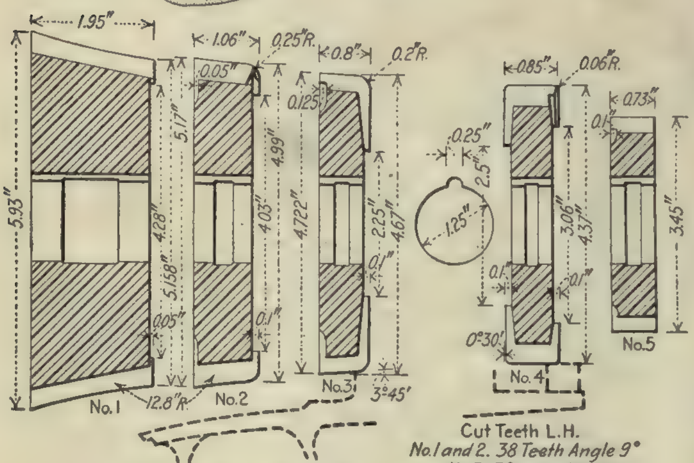


FIG. 1176

Cut Data—350 r.p.m.; ⅜-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—150 pieces. Gages—None. Production—85 per hr.

OPERATION 9. MILLING TO REMOVE STOCK FROM TOP OF MAGAZINE OPENING

Transformation—Fig. 1186. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Six. Work-Holding Devices—Special vise jaws, Fig. 1187; details in Fig. 1188. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, 3.56 in. diam., 0.75 in. thick, 28 teeth, left-hand spiral. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—None. Production—30 per hr.

OPERATION 10. MILLING TO REMOVE STOCK FROM BOTTOM OF MAGAZINE OPENING

Transformation—Fig. 1189. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Six. Work-Holding Devices—Vise jaws (see Figs. 1187 and 1188). Tool-Holding Devices—Standard arbor. Cutting Tools—See Fig. 1190. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—None. Production—25 per hr.

The guard of the Springfield rifle is a more difficult piece to make than the similar part in the Enfield, largely owing to the latter having a separate magazine of pressed steel. Making this solid with the guard requires drilling the ends, milling out most of the stock with a gashing cutter and finally profiling to shape. The outside of the magazine is finished by milling with large slab cutters.

It will be noted that the first machining operation is to mill the top of the magazine. In the succeeding opera-

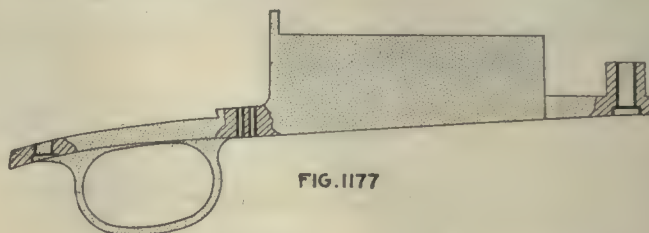


FIG. 1177

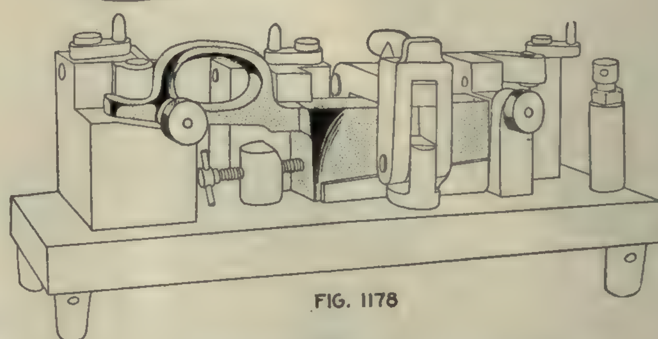


FIG. 1178

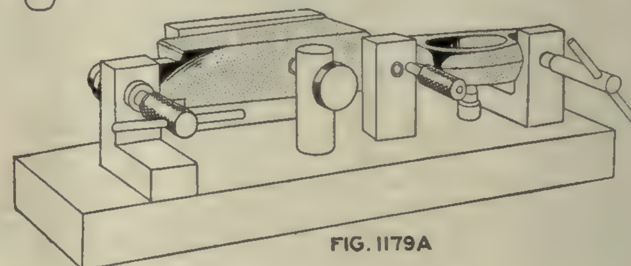


FIG. 1179A

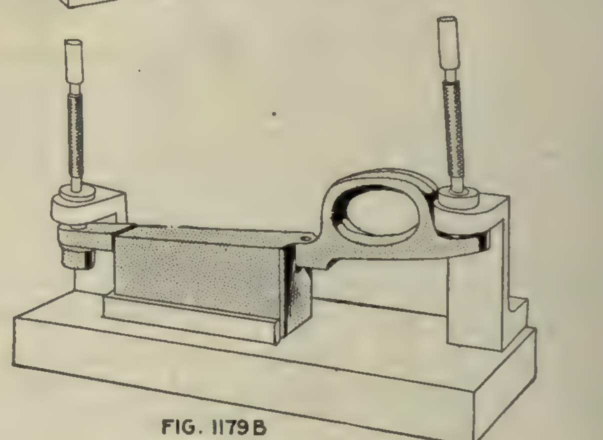


FIG. 1179B

OPERATION 6

tions, the guard is forced up against this surface as a locating point, as can be seen in Fig. 1175. Here the upper surface locates against ledges on the sides, which enables the operator to see when the guard is firmly located against this seating point. This requires means for forcing the point up from underneath, care being taken to avoid bending the tang out of shape. This is also looked after in some of the side milling fixtures as in Fig. 1169, and in milling the bottom in Fig. 1171.

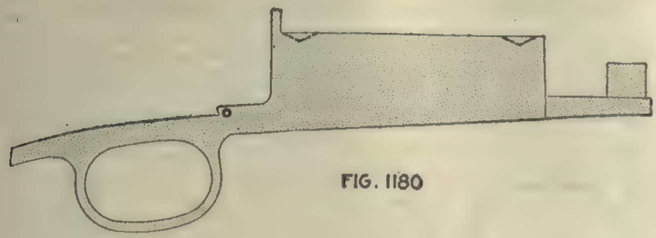


FIG. 1180

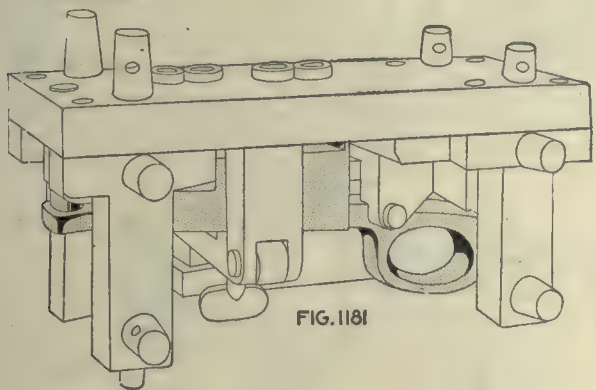


FIG. 1181

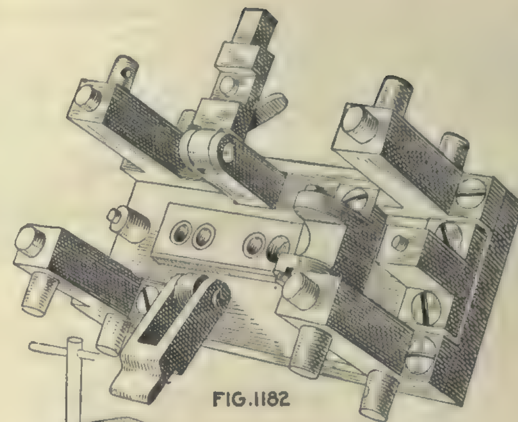


FIG. 1182

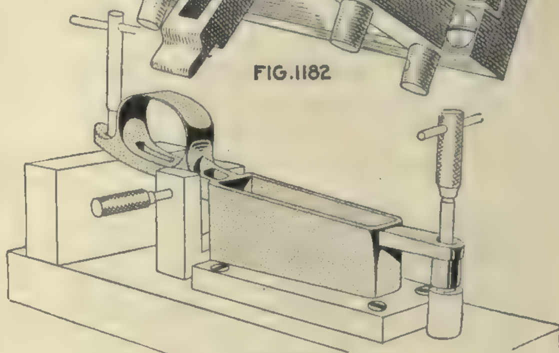


FIG. 1183
OPERATION 7

This operation has a rather unusual method of gaging as seen in Fig. 1173. The master guard or sample *A* is fastened to the fixture and the work *B* is clamped in place by *C*. A straight-edge is then laid across the bottom of the guards to see how they compare. This can also be rolled over to see how they compare in other ways.

Milling the top and bottom requires rather complicated gangs of cutters, both of these being shown, with dimensions, as the contours are quite particular owing to the fit in the stock. These are all interlocking cutters as can be seen.

The drilling jigs locate from the top also. The holes at each end for the screws are drilled and counterbored in Fig. 1178, the two end holes for the floor-plate lug opening being drilled at this setting. These are gaged in Figs. 1179-A and 1179-B; the first gages the location of the holes and the latter the depth of the counterbores.

The drilling of the end holes for removing the stock from the magazine is also on a "holding up" fixture, the magazine portion of the guard being supported by the crossarm underneath. Next, the center portion is almost entirely cut away by sinking in a milling cutter as previously mentioned. The back end is shaved or slotted as shown in Fig. 1197.

Another fixture where the guard is pressed up against the top guides is shown in Fig. 1201. Fig. 1202 shows one of the few indicating gages. This gages the height of the tang seat for the rear screw thimble, with regard to the top of the guard, where it fits against the bottom of the receiver. The need of this measurement is to prevent the back end of the tang from being drawn out of shape.

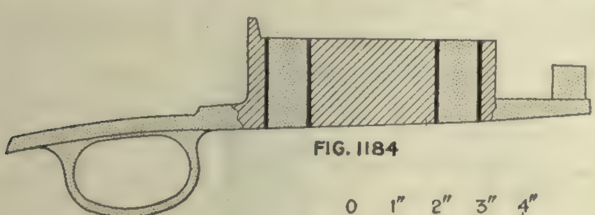


FIG. 1184

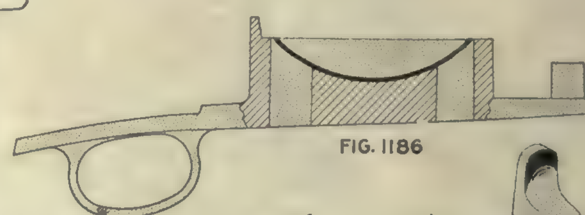


FIG. 1186

NOTE:
FIG. 1184, 1185-OP. 8
FIG. 1186, 1187, 1188-OP. 9
FIG. 1189, 1190-OP. 10

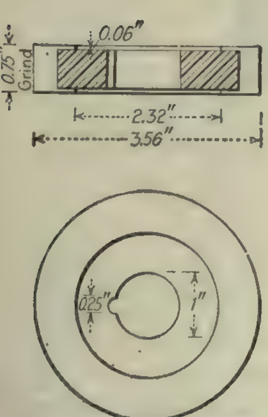


FIG. 1190

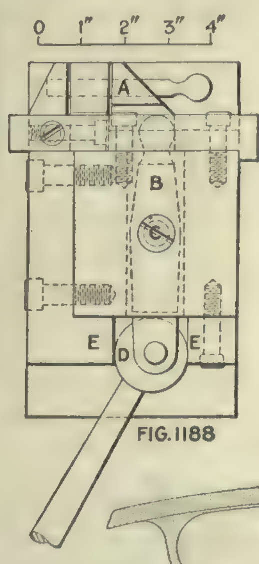


FIG. 1188

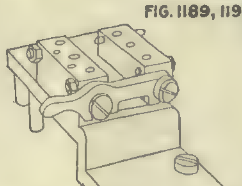


FIG. 1185

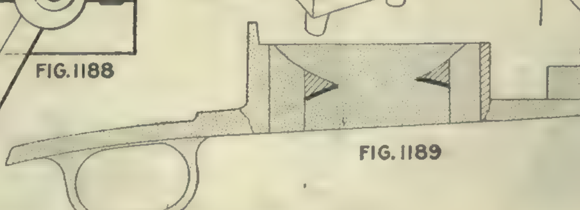


FIG. 1189

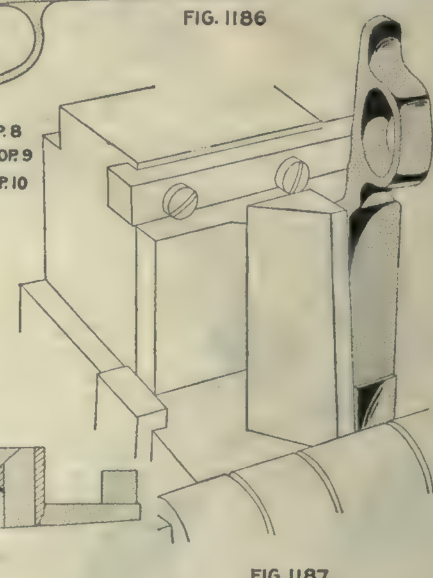


FIG. 1187

OPERATION 11. PROFILING ROUGH, TO REMOVE STOCK FROM MAGAZINE OPENING

Transformation—Fig. 1191. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Clamped by vise jaws; located by pin A, Fig. 1192. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters. Number of Cuts—Two. Cut Data—

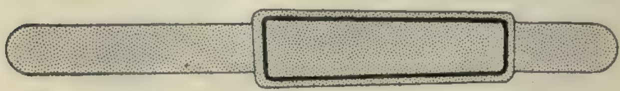


FIG. 1191

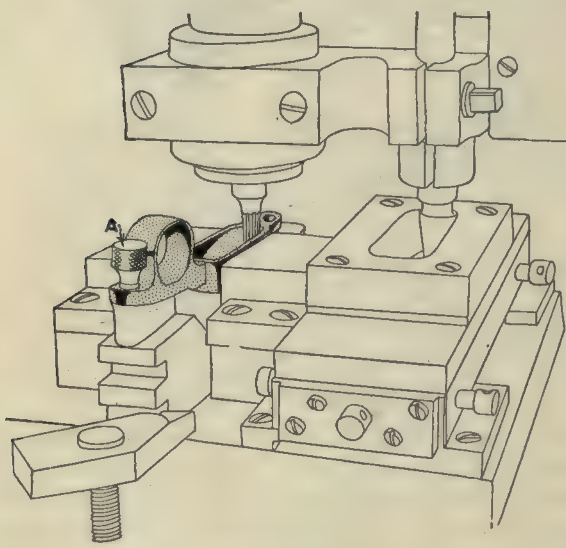


FIG. 1192

OPERATION 11

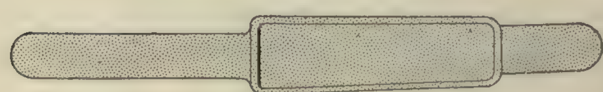


FIG. 1196

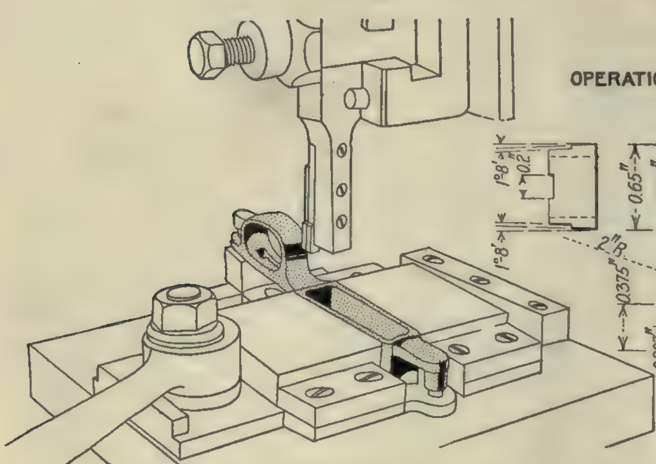


FIG. 1197

1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—200 pieces. Production—15 per hr.

OPERATION 12. PROFILING INSIDE OF MAGAZINE TO FINISH

Transformation—Similar to Fig. 1191. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—See Fig. 1192. Tool-Holding Devices—Taper shank. Cutting Tools—Roughing and finishing cutters; same as operation 11. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Figs. 1193 to 1195; pins locating guard on gage, opening is compared with hole in gage; plug for hole through guard; form of end. Production—20 per hr.

OPERATION 13. SHAVING REAR END OF MAGAZINE

Transformation—Fig. 1196. Machine Used—Bement-Miles slotter, 24-in. table. Number of Operators per Machine—One. Work-Holding Devices—Clamped by vise jaws; located by pin, Fig. 1197. Tool-Holding Devices—Regular holder. Cutting Tools—Shaving tool, Fig. 1198. Number of Cuts—One. Cut Data—50 strokes; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in.

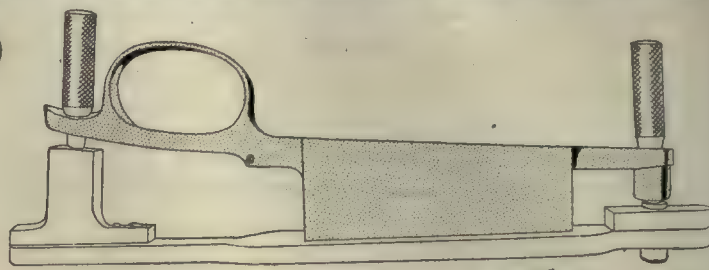


FIG. 1193

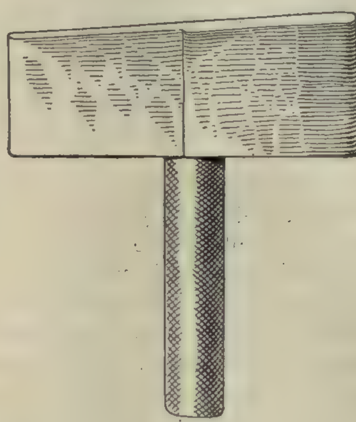
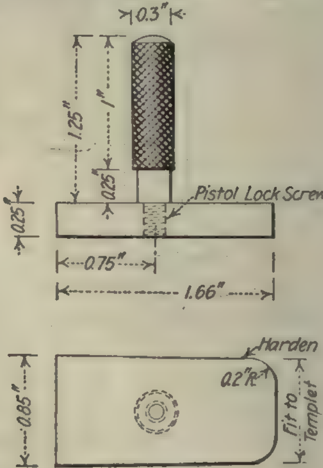


FIG. 1194



STEEL
FIG. 1195

OPERATION 12

OPERATION 13

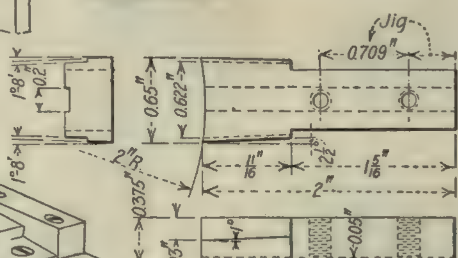


FIG. 1198

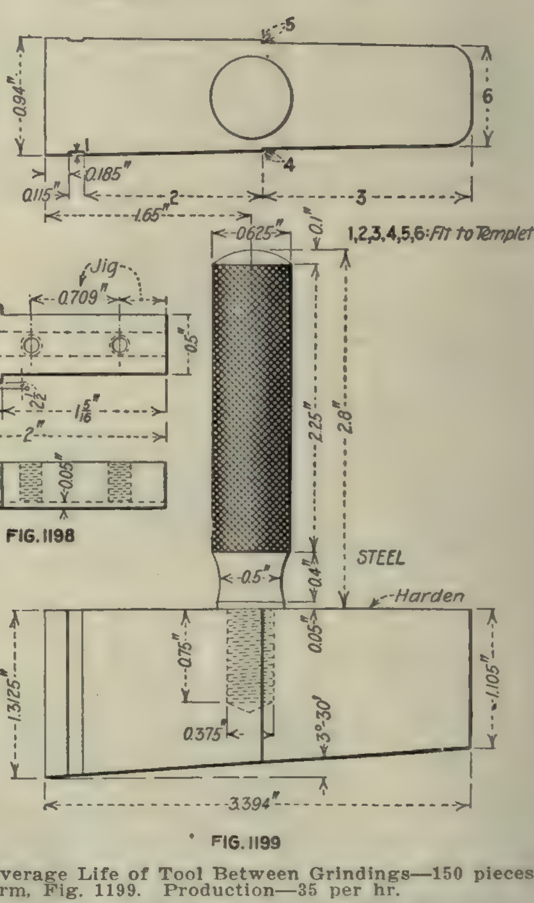


FIG. 1199

stream. Average Life of Tool Between Grindings—150 pieces. Gages—Form, Fig. 1199. Production—35 per hr.

OPERATION 13½. FILING TO FINISH OPERATION 13

Number of Operators—One. Description of Operation—Operation 13 leaves the piece rough, and 13½ smooths it up. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATION 14. DRILLING FLOOR-PLATE CATCH-SPRING CAVITY AND COUNTERBORING FOR HEAD OF REAR GUARD SCREW

Transformation—Fig. 1200. Machine Used—Dwight-Slate three-spindle 16-in. vertical drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1201; guard is held down by latch A, is supported by wedge B and held sidewise by thumb-screw C and D. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore and drill. Number of Cuts—Two. Cut Data—Speed of drill, 600 r.p.m.; speed of counterbore, 450 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1202, needle gage for locating rear screw hole from the magazine opening; also, gage for catch-spring cavity. Production—50 per hr.

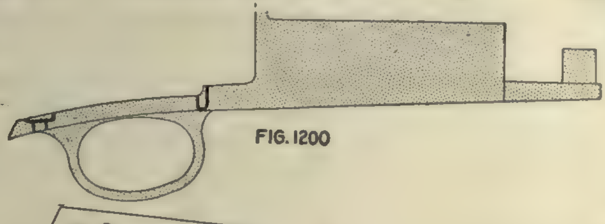


FIG. 1200

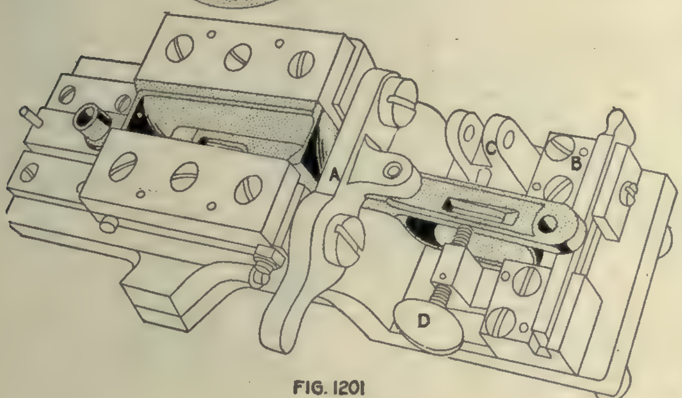


FIG. 1201

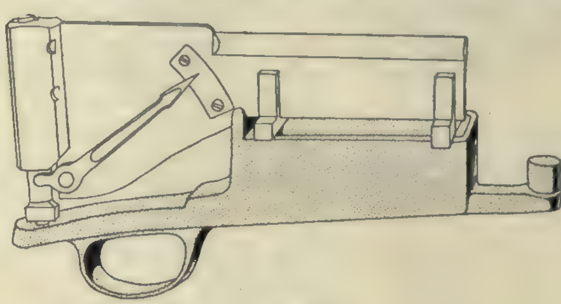


FIG. 1202

OPERATION 14

Truck for Drilling, Reaming and Countersinking

By William M. Kennedy

Owing to the unprecedented demand for skilled labor in the shipbuilding industries, and the increase in wage following the demand, the ability to supplant crude methods at the "tool point" will enable employers to offset high wages by large output.

It must be understood that the increased production must be obtained through methods of management and the use of tools best adapted for the job in hand, and not by any extra effort on the part of the workmen.

The portable countersink truck, fitted with a suitable drill machine, is a means by which considerable reduction may be made in the cost of countersinking on certain classes of drilling and reaming.

Handlings and Cost of Countersinking

With the wall radial type of machine the following operations are necessary to accomplish the work: Handle to pile at countersink, hoist to table, countersink (if a movable table is not in use, work must be turned; in the case of long bars it is necessary to have a man assist in the handling), remove from table to completed pile, remove from pile to next operation, or ship.

Material is delivered to the pile and removed by the handling gang, handling to and from the table being done by the countersinker. When an extra man is required for handling long bars, his services are furnished without extra cost to the pieceworker.

The cost of countersinking by this method (piecework) is 14c. per 100 holes of ½-in. diameter, the price increasing 2c. per 100 for each ⅛-in. increase in diameter. This price does not include the handling to and from machine, or pay of extra hand when used.

By using the portable truck the handling operations are reduced to a minimum. After the last shop operation, the plates are removed to the rack, where they are to be stowed. Instead of immediately stowing them in the rack, they are spread on the ground for countersinking. The portable truck is then put in service, completing the work in short order; after which the plates are racked. In the event of plates that require rolling, the countersinking is, of course, done first. These plates are spread out in reach of the crane, at the rolls, to obviate an additional handling. As manifolds are located in numerous places throughout the yard and shop, it requires little time and preparation to move and connect the portable truck. The price per hundred, using the portable truck, is 5c. for ½-in. holes, the price increasing 1½c. per 100 holes for each ⅛-in. increase in diameter.

The economy of countersinking with the portable machine is very evident, no gang-handling being required for rolled work; and for straight work, only the spreading out of the material before racking.

The handling operations at the machine are entirely eliminated, the results being a reduction in the price per hundred, without extra effort, added fatigue, or a decrease in earnings for the operator. Fatigue is really reduced in having no handling to do.

Other Operations Performed to Advantage

Reaming decks, inner bottom, bulkheads on the ground, drilling holes for wood decks, and any similar horizontal work may be successfully executed as hereinafter described.

Owing to fitting bolts interfering with the operation of the truck, boards with cleats or lights channels are laid along the work; the wheels of the truck then operate without interference. It will be found advantageous to work fore and aft along the seams, then turn the truck and work athwartship, along the beams.

By using a combination reamer and countersink, holes that require recountersinking can be completed when reaming.

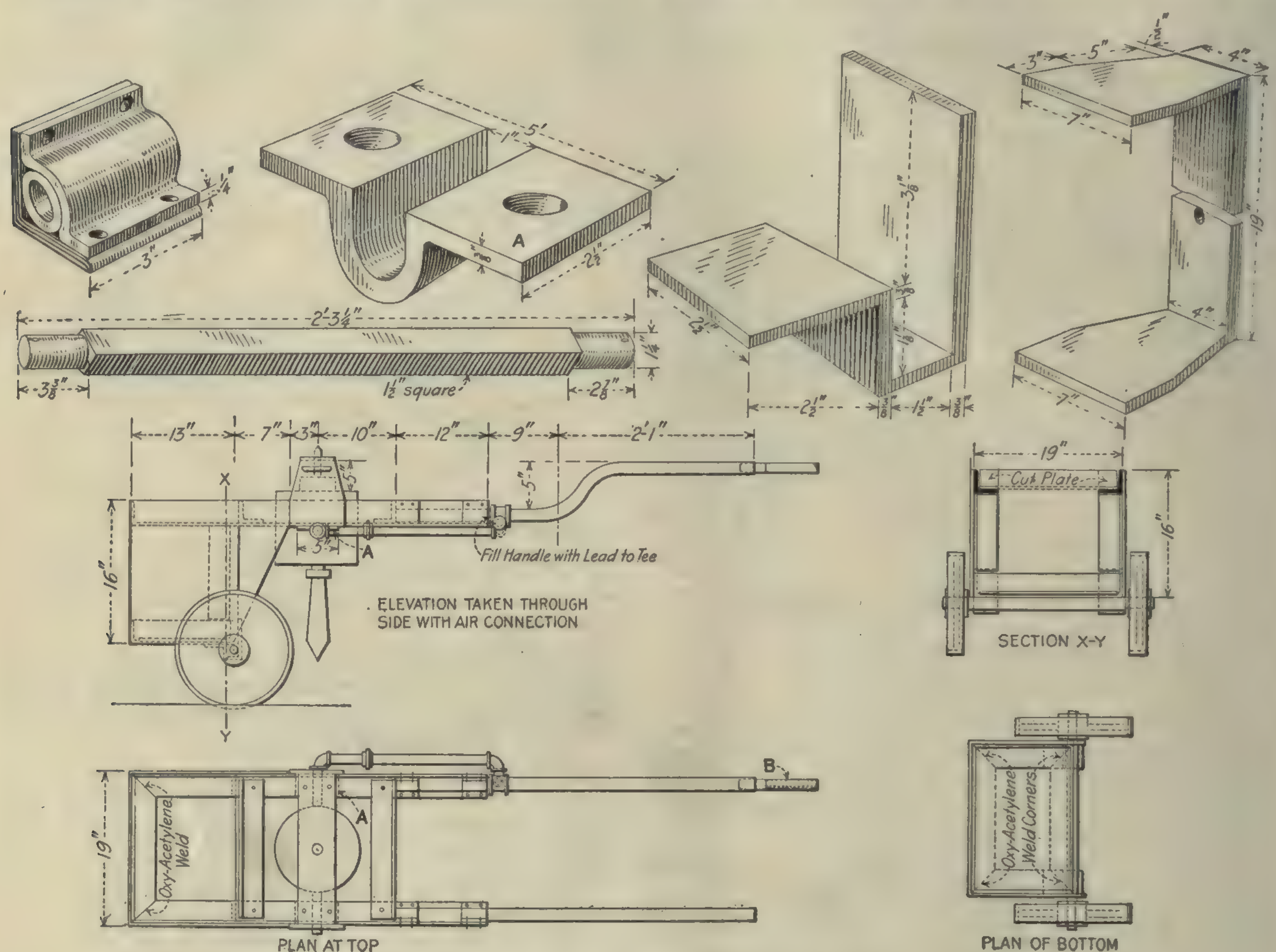
The machine should at all times be perpendicular to the work, especially when reaming, the detail *A* being fitted to allow the machine to pivot quickly. Unless this is done many reamers will be broken.

Where a wood deck is laid, the cost of drilling holes for deck bolts is exorbitant, because of the many settings up, the holes being widely spaced. With the portable

truck, this drilling can be accomplished speedily and economically, the cost being 40c. per 100.

Where there is a steel deck throughout, the rivets are driven before the wood deck holes are marked off, thereby giving the machine a smooth surface to work over. Where the decks are laid on beams and tieplates, stage planks can be utilized for making up the track upon which the truck runs.

A portable truck made according to the drawing can be successfully applied to this work. No special material or equipment is required in its manufacture, as the structural material is procured from scrap plates and angles; the pipes and fittings are standard. The handle, item *B*, is taken from the pneumatic drill in use. The back of the truck is filled with punchings to obtain the required weight, which acts as a counterbalance for the front part of the machine.



PORTABLE TRUCK FOR DRILLING MACHINE

Improvements Not Illustrated

The following are some improvements that have been applied since the completion of the accompanying drawing: A toolbox in the counterbalance box; a single handle in the center instead of two handles; a lubricant tank between the counterbalance and the drill machine, with ⅛-in. pipe lead to the point of countersink. The necessity of this last item depends on the grade of steel of which the drills and countersinks are made and the material of which the work to be drilled and countersunk is constructed.

Report Regarding the Partly Destroyed Industries of France

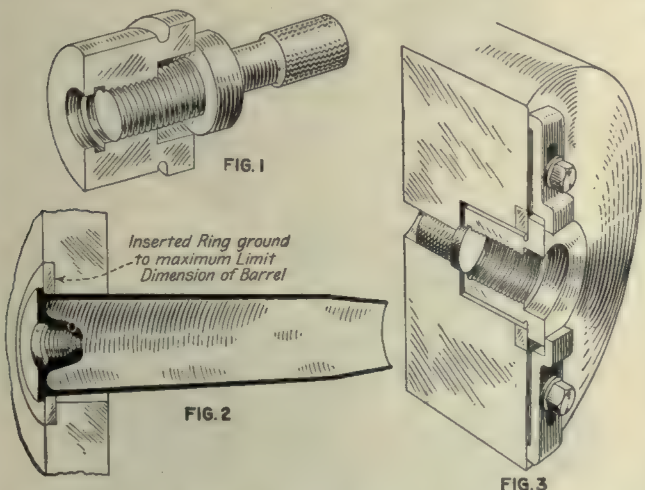
The French Government has made a survey of the regions of France that have been invaded and have since passed into British or French control. The information collected shows how many buildings have been destroyed, how much farm land has been devastated and what industries have been affected by the war. From this compilation the following list has been taken showing the manufacturing industries, connected with metal working, whose plants have been destroyed either wholly or partly in the invaded area:

Automobiles; files and small tools; wire of different metals; bolts and nuts; nails, tacks and screws; chain and cable; electric motors; large and small electric machinery; electric lamps; steel, copper and aluminum tubes; hardware; fabricated sheet metal; boilers; agricultural machinery; iron castings; bronze, aluminum, zinc, platinum, nickel, lead and copper castings; machine tools; railway material of all kinds; steel castings and steel forgings; heating appliances; balls and ball bearings; contractors' machinery; woodworking machinery; steam engines; gears; molds and dies; springs; automobile parts; horseshoes; structural steel. It is very probable that other industries not mentioned have suffered, and are in as bad a condition as those mentioned. The upbuilding of these industries will be one of the problems the invaded countries must face when the war is over.

Letters from Practical Men

Problems of Thread Milling

The increase in the use of thread millers as effecting an improvement in quality and accuracy over cutting threads with tap and die has brought forward some new problems which it does not appear that even the manufacturers of the millers themselves have solved. It has always been recognized that on certain parts produced on hand or automatic turret lathes, whereon the outside surfaces are generated with a form tool on the cross-slide and the inside work with turret tools, some degree of eccentricity will be found between the bores and the outside diameters. This may not occur on every successive part produced, but it will occur on some, and in consequence must be reckoned with all the time.



FIGS. 1 TO 3. PROBLEMS IN THREAD MILLING AND THEIR SOLUTION

Where holes in such parts were tapped, or where threads were cut on an outside surface with a die, the thread took the same center as the surface on which it was cut, due to following the line of least resistance. This was the case whether the threads were generated as an operation on the turret lathes or as a separate operation with a different setting, as in the latter case there would always be sufficient float to the tap or die to allow it to accommodate itself to any reasonable degree of eccentricity.

When these same parts are threaded on a miller, a different condition may exist. It is almost universal practice at the present time to fit these machines with some form of draw-in collet, holding parts by an outside surface. In cutting internal threads in this manner, it will readily be seen that any degree of eccentricity between the hole and the outside will be reproduced between the hole and the thread, since the milling cutter has no float or accommodation, and will mill on a true radius with the surface gripped in the chuck. On parts where the internal thread is a straight threaded hole from a flat surface—in other words, where it is not a shouldered hole—this threading off-center would rarely ever cause trouble; but where the thread is cut in a counterbored hole, and the part to be assembled with it has a shoulder close fitting in this counterbore, it becomes a serious mechanical problem.

In Fig. 1 is shown a form of part met with in everyday experience, the plan view showing in exaggerated form how work of this character comes from a thread miller. The first remedy that suggests itself is to correct the eccentricity of the first-operation machining by performing a second correcting operation. But to this there are two objections: It adds another operation and additional expense of production that in only a few cases would be warranted by conditions, as in most instances the slight amount of eccentricity of machining does no harm whatever for the purposes for which the part is used. Assuming that the correcting operation is perfect, it does not insure against eccentric threads, because this would require that the collet on the miller always run perfectly true, which everybody with experience knows is too much to expect under continuous operation.

It is apparent that a better method would be to correct the trouble on the machine itself, naturally by devising a manner of holding that will if possible centralize the part to be milled with reference to the surface on which the thread is to be cut. On certain classes of work this is easy; take the part shown in Fig. 1, for instance. The body diameter for the thread is reamed all the way through, and later a recess cut near the bottom and the thread cut down to this recess. The reamed surface of the hole to be threaded must necessarily be concentric with the part below the recess, and it is necessary only to mount the part on a faceplate, using a locating plug in the unthreaded portion of the hole, to obtain perfect concentricity. Such a mount is shown in Fig. 2. It will be noticed that the faceplate is recessed so that an important surface of the part being held bears on its face. The object of this is to use as a reference point on the operation the same surface that is to be the fitting surface when the part is later assembled. On such particular work as thread milling this should always be done, where practical, as it eliminates one possible source of error.

There are certain parts, however, which from their form cannot be held on a locating plug. Take for instance a cartridge case, as illustrated in Fig. 3. This presents unusual difficulties, because the tolerance on the outside machined portions of the rim and barrel is in each instance 0.008 in., while the tolerance on the thread is only 0.003 in., and on the counterbored mouth 0.004 in. The first device I ever saw on a miller, cutting the thread for the primer in cartridge cases, was doing better work than they had got from the spring collets, but not good enough by any means, because of the trouble caused by the above-mentioned tolerances. A faceplate and holding straps had been provided, on the same order as shown in holding the part (Fig. 2), but the reference point was an outside surface, a hole in the faceplate having been ground to the maximum limit dimension of the barrel. It is obvious that, while some cartridge

cases would fit this hole snugly, and some might centralize themselves approximately, a case to the minimum limit could chuck 0.004 in. eccentric with its mount—altogether too much to permit of the shoulder on the minimum thread gage entering the counterbore. I have never seen it done, but have often wondered why it would not be possible to follow the practice in the ball-bearing grinding plants in problems of this kind. In such plants it has been a determined fact for years that spring collets do not often run true, or once true, do not stay so for any length of time under service. Consequently, it is practice to supply the master collets with cheap false jaws that are ground true at the start of every job, and often checked and reground at intervals during the progress of a job, or even of a single day's operation. Instead of making permanent collets for the thread millers, designed to fit every separate part to be held, a form of collet could be designed to which thin plate jaws could be attached in a manner to accommodate quite a wide variety of work. Some form of adapter could then be attached to the cross-traveling carriage of the miller, on which a tool-post grinder could be mounted, and every time a job was set up, or at any time inspection showed the machine was producing eccentric work, it would be possible to put the chuck in perfect working condition in a matter of fifteen to twenty minutes' time.

Regarding the method of operating thread millers, I have noted two distinct systems in practice. In a large plant, using a number of machines of this class, the operators had been trained by a representative from the manufacturer to this order of procedure: After setting the cutter to position relative to the work, it was brought to cutting depth with the work spindle standing still. The work spindle was then started, revolved exactly one turn, and stopped, after which the cutter was backed out of the cut and moved out of the way. The work produced by this order of movements showed a very pronounced marking where the cutter started or stopped, and in case the work crept to the slightest degree during the cutting revolution, there would be a high spot in the thread at the meeting point, which had to be dressed off with a file.

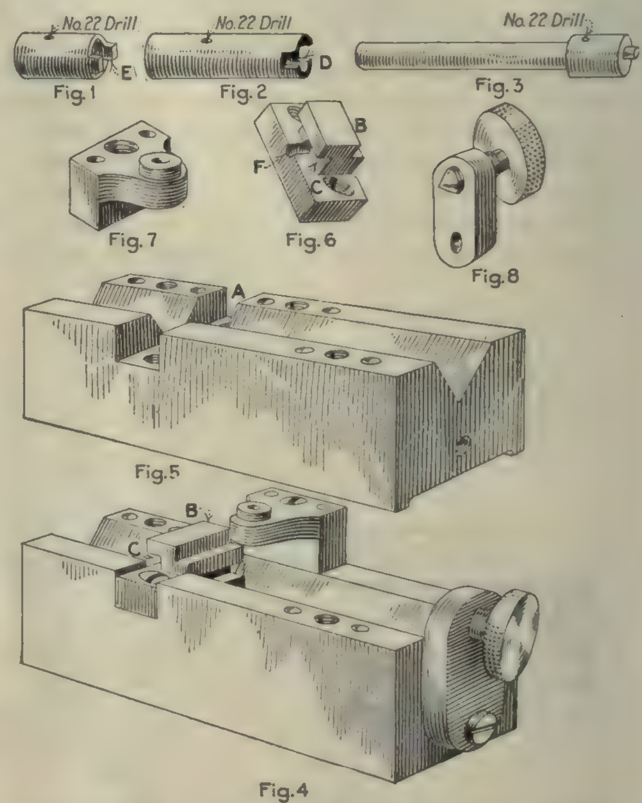
A much better method, beyond question, is to start the work spindle in motion before starting the cut, and to take one-quarter of a revolution, or slightly less, to bring the cutter to depth. After one and a quarter revolutions of the work spindle, the cutter is backed out, and last of all the work spindle stopped. This method may be condemned as being too slow and as wasting time, but if quality of work counts for anything, the slight increase in the time required to produce a part will be justified, as the closest scrutiny will not discover where the cut started or ended. F. H. Bogart.

Philadelphia, Penn.

Simple Drill Jig for Three Different Pieces of Work

Recently I had to design jigs for drilling the holes in the pieces shown in Figs. 1, 2 and 3. The holes are of the same size. Not having sufficient pieces to warrant making expensive jigs for each of them, I designed the jig shown herewith, to serve for all three pieces. The holes in the pieces shown in Figs. 1 and 2 had to be at right angles to the slot and an exact distance from it. The hole in the piece shown in Fig. 3 had a small allowance for error.

In Fig. 4 is shown the jig assembled, and in Figs. 5, 6, 7 and 8 are the details. The V-block shown in Fig. 5 is made of 1½x1-in. cold-rolled steel. The part, Fig. 6, fits the slot *A* in Fig. 5 and is so located in it that the projection *B* and the slot *C*, Fig. 6, accommodate the slot *D*, Fig. 2, or the projection *E*, Fig. 1, whichever piece is being drilled. The drill bushing is carried in the piece, Fig. 7. Provision is made for attaching it to Fig. 5 at three places suitable for the work under



FIGS. 1 TO 8. DRILL JIG ACCOMMODATING THREE DIFFERENT PIECES OF WORK

operation. In Fig. 8 is shown a swinging clamp made in such a manner as to be attachable to either end of the jig.

In drilling the piece shown in Fig. 1, it is laid in the V with its projection *E* pushed into the slot *C* of the piece shown in Fig. 6. The clamp in Fig. 8 is swung into position and the screw tightened. This screw, having its center line slightly below that of the work, holds it securely in the slot and down in the V. The piece shown in Fig. 2 is drilled in a similar way, placing it in the other side and attaching the drill-bushing holder and clamp to their proper places. In drilling the piece in Fig. 3, it is held by hand in the hole *F*, in Fig. 6, which is exactly coincident with the center line of the work when lying in the V. The drill-bushing holder is fastened solidly to the frame, by means of screws and pins, in the proper position over the center of the V groove.

The jig is easily kept clean of chips and is quick to operate, and is not as expensive to construct as the more complicated ones. C. F. Hahn.

New York City.

Discussion of Previous Question

The Design of Tumbler Reverse Gears

The article by Sherwood C. Bliss on page 781, Vol. 42, was very interesting. In Fig. 1 is shown the headstock end of a lathe manufactured in several sizes by D. Mitchell & Co., Keighley, Yorkshire, England. These lathes are fitted with a tumbler reverse designed on the same general lines as those advocated by Mr. Bliss. Since the lathes range from 12- to 32-in. swing, it is obvious that the reverse will be subjected to fairly heavy duty in the larger sizes, while the smaller machines will try it out more particularly from the viewpoint of easy and rapid operation. So far as I know, out of some hundreds of lathes fitted in this way no trouble has been experienced in their operation. However, I wish to call attention to Mr. Bliss' analysis of the turning moments and bearing pressures which he believes to be erroneous in several details, though he leaves himself open to correction.

For the benefit of those readers who have forgotten or did not see the original article it may be stated that its purpose was to show that the ordinary type of tumbler

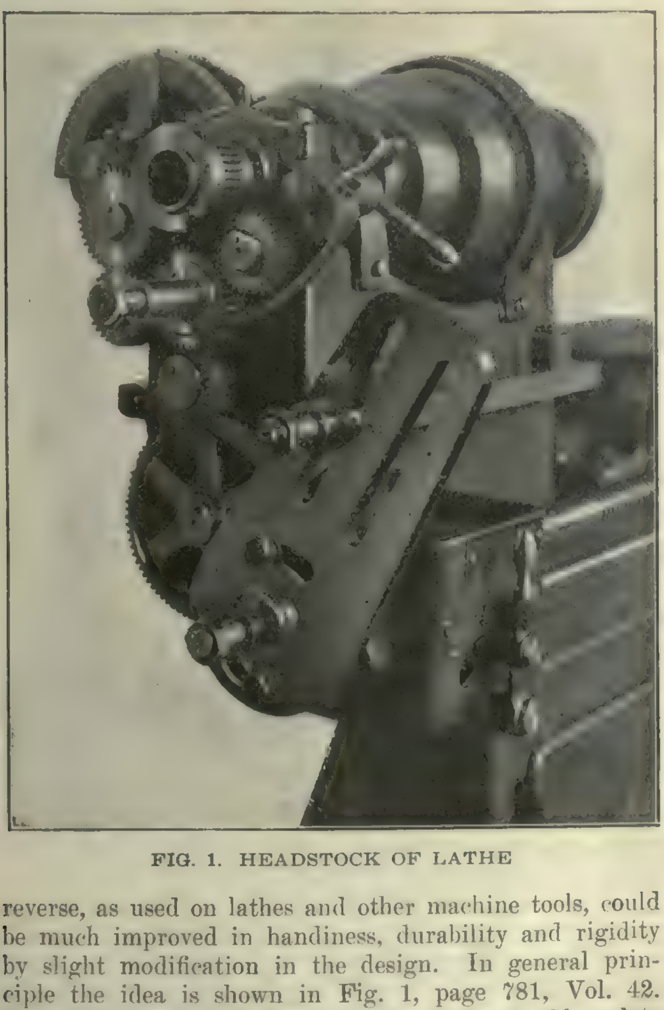


FIG. 1. HEADSTOCK OF LATHE

reverse, as used on lathes and other machine tools, could be much improved in handiness, durability and rigidity by slight modification in the design. In general principle the idea is shown in Fig. 1, page 781, Vol. 42. There is a single idler on one side of the tumbler plate and a couple of idlers on the other side. This disposition of the stud gears not only allows an easier and quicker engagement of the reverse gears, but also gives greater rigidity and durability by reason of the reduced pressure on the bearings of the idlers. In these claims

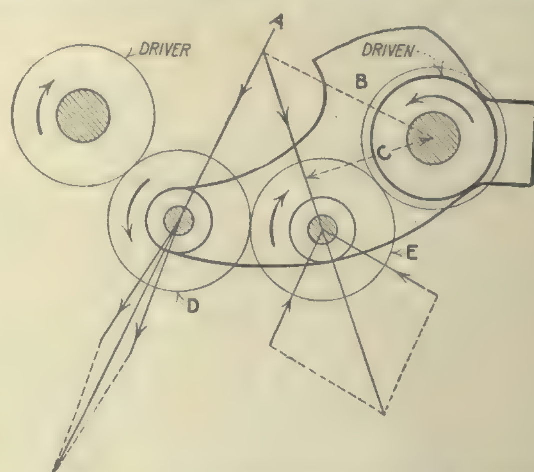


FIG. 2. DIAGRAM OF GEAR TRAIN AND MOVEMENTS

I am quite at one with the original writer; it is only a question of degree on which I differ with him.

Referring to Fig. 6, page 782, Vol. 42, he states that the resultant of the tooth pressures is so arranged as to give a zero turning moment to the plate. The construction necessary to achieve this desirable object is also indicated, and it is here where I begin to disagree with Mr. Bliss.

Fig. 2, shown in this discussion, is very nearly a reproduction of Fig. 6 (here noted) or at least that side of it having the two idlers. Now the force diagram for the stud of gear D shows that the resultant A has a magnitude of practically twice the pressure on the teeth, or $2 \times 1700 = 3400$ lb. This force is tending to turn the plate in a clockwise direction and has an arm B. The gear E, on the other hand, has a resultant pressure of 2600 lb. acting on its stud. This force multiplied by the distance C gives the moment tending to turn the plate counter-clockwise. If these two moments balance, the plate will be in equilibrium when under load. It does not appear to me that Mr. Bliss' method takes into account the resultant of its forces on the stud of gear E, which resultant will vary considerably with the diameter of the gear.

As applied to a lathe headstock, the following points should be noted in designing a reverse gear of this type: The centers of the driving and driven gears should be as small as possible; the single idler should be as large as convenient; the double-idler side should be so arranged that there is a tendency for the gears to draw deeper into mesh. This can be resisted by a positive stop and has the advantage that both sides then tend to draw in and not one out and the other in; the single idler is better if located on the in-running side of the driver—this applies to all idler gears; the feed and

screw-cutting transmission gears should be arranged so that when feeding toward the headstock the single-idler side of the tumbler plate is in use, because in this position there is only one stud under load and the load is less than if the double idlers were in mesh. Obviously, any ordinary lathe will be most often used for cutting right-hand threads and feeding toward the headstock; therefore, it is best to provide for the best conditions for working under the circumstances which will most often occur.

In a power-raising device the greater load should come on the single-idler side, while in other cases the design should be arranged so that the greater pressure, if any, is similarly located. ALBERT CLEGG.

Keighley, Yorkshire, England.

Deceptive Working Limits in the Manufacture of Munitions

The article "Deceptive Working Limits on Munitions," by F. H. Bogart, page 1021, Vol. 45, reads as if it was a leaf taken out of our own book of experience.

When the specifications for such parts as the primer body reached the subcontractor, the proposition looked like an ordinary commercial one, with perhaps slightly closer attention to refinements. There was an intimation that while the foreign representatives were not inclined to be lenient, nothing drastic in the way of limitations would be encountered. This was borne out at the start, when the question of the formula for the metal came up. The direct contractors, upon being informed that no mill could be found that would supply raw material to the specifications, readily gave permission to use regular yellow brass. The only stipulation was that the metal must not split in undergoing the processes necessary for the completion of the work.

With the foregoing in mind, we actually presumed to use our own judgment as far as one or two minor dimensions were concerned, but were soon pulled up short by the inspector. As an example, on the recess at the end where the limit is plus or minus 0.002 in., we received an increase in the allowance. The inspector, however, continued to use the same gages for the overall dimension; consequently, the conceded tolerance was of no use to us. This in spite of the fact that the lip was peened over a cap set into the recess and an extra thousandth or so would not interfere with the utility of the body. All the rejected pieces had to be rechucked and turned off to satisfy the inspector.

While some of the processes of manufacture Mr. Bogart has observed, especially the sequence of operations, may be open to criticism, it is well to remember that the element of time was strongly impressed upon the subcontractors. This being the case they could not, any more easily than the direct contractors, secure the proper equipment of tools in time for specified deliveries. Great credit is due these firms for the ingenuity exhibited in adapting to this fine work machines that were built with no such purpose in mind. Furthermore, a far greater number of small manufacturers might have been expected to beg off than have done so. Many of us believe that the experience gained, when applied to future business, will have been well worth the money and energy expended.

Jersey City, N. J. H. D. MURPHY.

Employment Bureaus for Classifying Workmen

Everyone wants to reduce the labor turnover and will agree with that much of E. W. Johnson's article on page 64. But this turnover will never be reduced a bit, so long as employees are considered a marketable commodity, called labor, whose price fluctuates like that of raw material, according to the law of demand and supply. Labor travels from place to place, not in the hope of landing a soft job, but in the hope of finding a square deal; there are a few exceptions, of course.

In this connection let me recall an incident that came under my observation. There were several men of ability whose salary had remained unchanged for a time long enough to exhaust "Miss Patience." With entire confidence that they were going to obtain what they deserved, each independently went to the boss and asked for an increase. It was not granted. Each one had been employed for more than a year, and new men had just been hired at a better rate than that which the old men were getting. One of them whom the devil could not scare started an argument:

The Man—Sir, I would like to have more money.

The Boss—We cannot give you any more.

Man—Why?

Boss—Well, you are up to scale now. We do not pay any more in this department.

Man—You mean that you have a uniform pay for almost everyone employed in this room and that you do not pay any attention if one man is better than another?

Boss—It is this: Men are considered as labor. The market price for men employed in this department is what you have, and that is the limit.

Man—Then if I should work harder, study, improve myself, become more efficient, which I am doing anyway, I could not expect to get more money?

Boss—You have to become an executive to receive more money. Men are like potatoes; when you can buy them for $2 a bushel, you are not going to give $3.

Man—I beg your pardon; men are more like silk than like potatoes. They are of different grades and qualities and of different values.

Boss—I have said all that I have to say on that subject.

The man knew what to do. He left, and others too.

I have found that the percentage of men leaving their employment to go for a soft job is very small. The ambitious man leaves one place for another to improve himself (the man who has not seen is a small man), after he is convinced that he cannot learn any more at a reasonable rate of speed. Men know that staying too long on one job does not help them to advance. I have found few reasons that induce men to leave their work, and I have always been very curious to know why a man quitted his job. I found that the majority were not satisfied with the way in which they had been treated—not only from a financial standpoint, but from the partiality or narrowness of a stupid boss.

In regard to classifying workmen there is no better place to do it than right where they are employed, where there are evidences of their ability. But when once a man is classified, this fact should not limit him to work exclusively along such lines as have warranted his classification. If he has the qualifications and can advance, let him progress.

It may interest the reader to know how these things are taken care of in Switzerland. Take the case of a machinist. A young man is accepted as an apprentice by a manufacturer, and it is understood that he shall be instructed and that at the end of three years he shall be ready to appear before the district board of examiners, where, if he is qualified, he will receive a certificate by which it is known that he is a machinist. If he does not qualify, an investigation conducted by the district authority will reveal whether he made good use of his time or whether he did not receive the proper instruction. If he has not been instructed, the employer is fined. If he did not make good use of his time, he must try next year; or if he wants to take a chance to go after a job without a certificate, that is up to him.

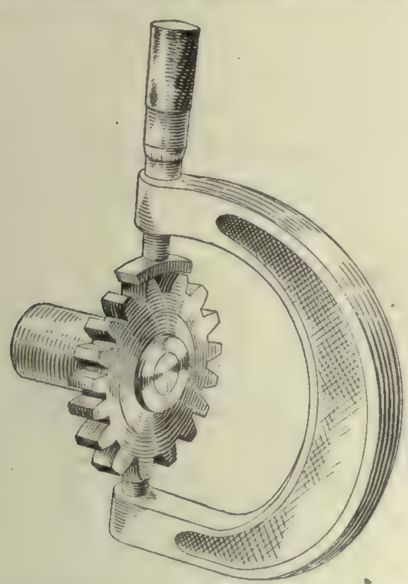
A man who has been employed by a manufacturer, upon leaving his job receives a discharge, which may be in a standard form with space for the man's name, his home town, length of time he has been employed, in what capacity he was working and whether he left of his own accord. A space is provided for special remarks, the foreman's signature, the superintendent's signature and the approval of these signatures by the town clerk or chief of police.

With all this a man is thoroughly identified, and when looking for a job he is asked to present his certificate. He is then given the regular two weeks' trial, during which time he is under observation. After two weeks, if he has made good, he is considered an employee of the company; if not, he is discharged on the spot. After he is an employee of the company, should the latter wish to dispense with his services they must give him two weeks' notice and allow him a day or two to look for another job. This is federal law and holds good for any trade.

New Haven, Conn. FRANCIS J. G. REUTER.

Measuring an Odd-Tooth Gear

On page 67 Mr. Duff describes the way in which he ground and measured the outside diameter of a short



MEASURING AN ODD-TOOTH GEAR

run of roughed-out gears, having an odd number of teeth, and invites suggestions for measuring another lot of these gears more rapidly.

I would suggest that if the lot is small (he already has a blank ground to the required size), he first rough grind all the gears from 0.002 to 0.004 in. over the finished size. This could be done without checking up more than 1 in 40 or 50, while for finishing to size a suitable wheel should hold its size for about 30.

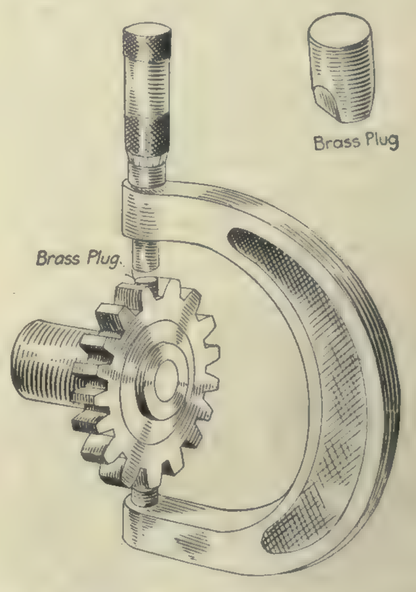
However, if the number to be ground warrants the additional expense, the best way of measuring these gears would be to make a collar with the bore to the high limit of the gear, and the outside diameter some suitable size, say 0.400 in. over the gear size, giving a wall of 0.200 in. A segment should then be cut out large enough to cover two teeth in the gear and used in conjunction with a micrometer to obtain the required diameter of the gear in question. A. E. BURRELL.

Detroit, Mich.

In an article entitled "Measuring an Odd-Tooth Gear," on page 67, Robin Duff seems to be at a loss to find means of calipering spur gears with odd numbers of teeth while grinding.

A short time ago I had a number of 13- and 21-tooth 6-pitch steel pinions that were formed, as in Duff's case, integral with the shaft.

Finding that the space width on the pitch line of his particular gear was 0.262 in., and having some



MEASURING ODD-TOOTH GEAR WITH INSERTED PLUG

$\frac{5}{16}$-in. round brass rod handy, I annealed several inches of the rod and cut off pieces a trifle longer than the gear tooth. I then filed one end of each of these brass plugs a trifle wedge-shaped and drove the plugs into the tooth space firmly with a hammer, leaving the outer end projecting beyond the line of the outer, or blank, diameter of the gear. The gear with the plug inserted was then ground and the measurement was obtained with a micrometer, measuring on the plug and the tooth, which were diametrically opposite, as shown in the illustration. No trouble was occasioned by the plug working loose while the grinding was being done, and the method proved to be quick and inexpensive.

After grinding, the plug may be removed quickly by tapping in the direction of the tooth groove.

Etters, Penn. SAMUEL R. BOYER.

Advantages of Plate Patterns

Mr. Holaday's article, "Plate Patterns," page 1089, Vol. 45, contains information that is interesting and instructive. He describes the many advantages in making castings from plate patterns, but like the story, he stops just when it is most interesting to the pattern maker.

Two reasons why so few match plate patterns are made are that the purpose for which they are intended and how to construct them are not understood by all pattern makers. Having had considerable experience in this line of work, I consider it a very interesting and important branch of pattern making and it should be given more attention, not only by pattern makers, but by shop managers and foremen in general.

Mr. Holaday says, "The cost of an aluminum plate of patterns is low, amounting on an average to about $75 for a simple pattern for first-class equipment." I have made some dandy match pattern plates from wood. Thousands of castings have been made from them; they stood the racket and were good for many more thousands of castings. I think the cost of wood plates, on an average, is less than that of aluminum plates.

What advantages aluminum has over wood I am not in position to state, because of the fact that I have had little experience with aluminum match pattern plates. However, my experiences with wood plates may be of interest to Mr. Holaday. Perhaps an exchange of ideas occasionally in the columns of the *American Machinist* might bring out some points of interest that would be appreciated by others who read this valuable journal.

One of the details in connection with making a match pattern plate most interesting to me is to learn how the other fellow locates or matches his patterns on the plate. Perhaps Mr. Holaday has a method all his own to suggest to other readers. M. E. Duggan.

Kenosha, Wis.

Crane Inspection and Operation

The article on page 957, Vol. 45, on the inspection and operation of cranes, is valuable, and a copy of the "Instructions to Crane Operators" should be hung in every shop having a crane as part of the equipment. Mr. Newcomb deserves credit for sending this important contribution and you for the excellent manner in which it is presented. Might I suggest that you get out an enlarged edition of it on heavy paper, say like the *American Machinist* decimal-equivalent sheet.

This matter of crane inspection and operation does not receive the attention it should, and it is only on the publication of such an article that we notice how remiss we have been and how many more or less serious accidents might have been avoided had such a system been installed.

During a strike, now many years ago, I was taken from the drafting room, where I was having the rudiments of machine design soaked into me via the blueprint tank, and put to running the crane. I was about 18 at the time and, even by my employer, was supposed to be moderately intelligent; but that job nearly cost the lives of all the strike breakers in the shop, besides leaving me at the close of the day a nervous wreck from the narrow escapes I had had from being an amateur murderer.

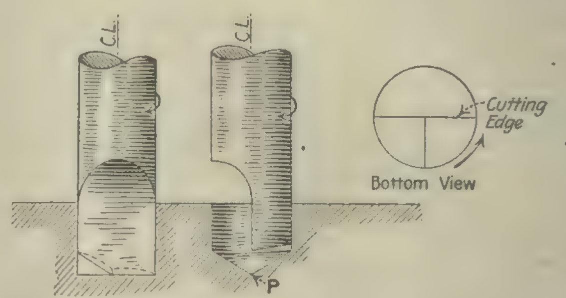
This condition was all due to the lack of a uniform method of signaling. One man would wave his hands and arms in a way that he thought would positively and unmistakably convey the impression to me that the load was to be lowered. The next man would make a duplicate set of motions to imply that the load was to be raised. After enduring this state of affairs for what seemed to be a lifetime, I spoke of it to the foreman, with the result that one man was told off to handle all the loads on the floor. In this way we got to understand each other, but it never occurred to any of us that the simplest way would have been to institute a uniform system of signals and drill the men in it. Robert Morris.

Hancock, Mich.

Methods Used for Bottoming Drilled Holes Flat

The subject of bottoming holes had been talked to death, I thought, until my copy of the *American Machinist* showed on page 36 a counterbore for a flat-bottomed hole.

The obvious way—one that has been the most common to me—is to make a tool like the one illustrated in



TOOL FOR PRODUCING FLAT-BOTTOMED HOLES

the accompanying sketch. It is simply a single-point tool, sharpened by grinding the end, including the angle, to keep the point *P* on the center line. Its diameter fills the drilled hole, and as many holes as desired can be squared up by simply drilling all the holes first and following up with the tool shown.

Hartford, Conn. George R. Richards.

Methods Used in Precision Gage-Making Work

On page 1047, Vol. 45, H. W. Johnson explains his method for making snap gages. A number of years ago my foreman gave me his verbal order for a set of snap gages (inside and out) ranging from 3 to 1 in. by thirty-seconds. After getting the gages ready to grind, my first idea was to swing the spindle of the grinder around a little and use a straight wheel. A little consideration, however, made me realize that if I did this the sides would be ground slightly concave, which would render the gages worthless. The method I finally employed was to clamp the gages on the grinder table, just as Mr. Johnson did, and with a saucer wheel grind them on one side first by feeding the wheel in and out. Turning the wheel around I then ground the other side, after which I lapped them with a three-cornered Arkansas stone. As yet I have failed to find a more accurate method. J. A. Raught.

Janesville, Wis.

Industrial Machinery in France

COMMISSION REPORT

SYNOPSIS—Impressions and conclusions of a group of American business men who had unusual opportunities for studying industrial conditions in France. At the close of the war, France will need American machinery, and we should prepare to "export" men to show how to use our machinery as well as the machines themselves.

Eleven American business men visited France during September and October of last year in order to study and report on industrial conditions. This commission was organized by the American Manufacturers' Export Association. The report,[1] which has just been issued, is without doubt the most enlightening document on the prospects of foreign trade after the war that has been written. It presents statistics and facts on many lines of industry and draws final conclusions that will benefit American manufacturers who are seeking foreign trade.

The following is the greater part of Section V of this report and deals with industrial machinery:

Our visits to industrial plants in France included mainly some of those in the central and southern portions and a few in Paris.

Northern France is the principal region for iron and steel and metal-working plants related thereto; but a large part of this region is in the hands of the Germans, or included within the lines of the allied armies. Its importance is shown by the reports of the department of public works, which state that 40 per cent. of the steam horsepower of the entire country is included in this district. The statistics of coal, coke, iron ore and steel production are even more striking, as about two-thirds of the entire production of the country comes from this region.

Any study of French practice from which the northern departments are omitted must therefore be very incomplete, and no final conclusions can be reached.

Some of the plants visited in central and southern France were thoroughly modern and well equipped with the best of machine tools and satisfactory labor-saving devices.

The munitions plant which has been installed in the fair buildings at Lyons was notable in this respect, and there was much to admire in the steel plants at St. Chamond, in the Berliet and Renault automobile factories, and in the steel and gun plant at Le Creusot.

The general impression was formed, however, that modern machine tools and labor-saving devices are not used in France to the same extent as in this country in plants of corresponding importance. This does not necessarily imply a lack of progressive management. The manufacturing conditions in many of the plants are very difficult. The demand which these factories supply is comparatively small, and it is therefore necessary to manufacture a wide range of product instead of concentrating upon a limited standard output. More effort also appears necessary to meet the varying views of customers as to their real or fancied needs.

AUTOMOBILE MANUFACTURING

France developed automobile design decidedly in advance of this country, and many of the best features of present practice have been copied from French models. There are, however, no automobile factories in France which appear to be able to compete with the large factories in this country in the manufacture of low-priced cars, and it is probable that the prospective demand would be too small to justify anything like the American scale of production. The same consideration would probably apply to many other lines. The inevitable tendency, therefore, is to produce a large variety of output with many changes of patterns.

The range of manufacture now covered at Le Creusot and St. Chamond would be startling to most American manufacturers. It includes almost all the processes from the ore to the highest grade of finished products of great variety. Such varied production demands the highest grade of supervision, and makes it almost impossible to apply details of efficiency which would be used by the manufacturer who can concentrate his attention upon one line, as Mr. Ford does, for instance, on the production of one simple, standard automobile.

The advantage which American manufacturers have in their enormous home market and in the comparative willingness of their customers to accept standard designs can be best appreciated by studying the more difficult conditions which their brother manufacturers have to meet in all of the smaller countries of Europe.

Aside from these considerations, cheaper labor has probably heretofore diminished the incentive to save by the use of devices which in many cases involve high first cost and a large amount of patience and supervising ability in establishing them in an old plant. All American manufacturers are familiar with the difficulties and prejudices to be met along these lines, and the problems are certainly no easier in France.

NEW LABOR CONDITIONS IN FUTURE

All of the countries at war, however, must face new labor conditions in the future. Millions of the best young men have been killed, and while the increased use of woman labor is of great value, it cannot fully supply the need. Labor-saving devices and improved machinery will be required as never before, and designs which have been developed under the high-labor costs and great

[1] "Report to American Manufacturers' Export Association by American Industrial Commission to France." Two hundred and fifty-six 7¾x10¾-in. pages; profusely illustrated; nine colored maps; indexed; cloth bound. Published by the American Manufacturers' Export Association, New York City. Price, $5.

This report is made up of twenty-five sections, or chapters, with these headings: The Inception of the Commission; The Tour; Trade and Tariff; Industry and Plant Construction; Industrial Machinery; Agriculture and Agricultural Machinery; Labor; Syndicates and Coöperative Societies; Chambers of Commerce and Courts of Commerce; Seaports and Shipping; Transportation; Hydro-Electric Power; Mining and Metallurgy; Coal; Chemical Industry; Alcohol; Social Welfare; City Planning; Hotel and Resort Industry; Education, General and Technical; Devastated Region; Association for Resumption of Industrial Activity; Belgian Reconstruction; Lyons Sample Fair; Bibliography.

The book is an excellent example of the printers' art. The illustrations have been selected with unusual care and are splendidly reproduced. The price of the volume is no more than enough to cover the mechanical cost of printing, and the sales of the book can in no way recompense the association and the individual members of the commission for the time and expense of making the visit to France and preparing the report.

production of America will probably receive favorable consideration. The war has already stimulated development along these lines more than many years of peace would have done. The few steel works which are outside the zone of warfare are pushed to their limit of production. Hydraulic forging presses and high-pressure pumping machinery to correspond have been in great demand for shell and gun forgings, and the most efficient types of turret lathes and other modern machine-tools have been ordered from the United States in great quantities.

The demand for machinery of this class has passed its maximum, and will no doubt practically cease with the end of the war. Much of this machinery will then be used in ordinary work and thus reduce the peace demand. The value of the lessons of high munitions manufacture, however, will be seen in increased production along other lines; and French manufacturers will be more ready to discard old machinery when sufficient proof is given that improved apparatus will pay in greater output and economy.

No detailed study of this subject was possible. Any manufacturer to whom these general statements may appeal can apply them to his special line of product and reach a fair preliminary conclusion as to his opportunity to help in the rebuilding and development of industrial France. Special inquiry may be made through the channels opened by the Export Association. Much useful information may be obtained from the American consuls in France and especially through the American commercial attaché in Paris, who will be found capable and active in replying to inquiries. If the answers to the inquiries so made are satisfactory, the proper method of developing business will be in most cases to send men to France who understand the language and are thoroughly familiar with their lines of manufacture.

Need of the "Export of Men"

One of the best informed Americans whom we met in Paris declared that "The country which expects to export its goods, must first export its men." This statement is probably fully as important in connection with machinery and labor-saving devices as in any other field, for the possible customer must in most cases be taught the best method of application to his business, and be convinced that he is warranted in purchasing new devices from abroad rather than follow technical methods of production. Plenty of time must be taken to lay the foundation of an export business, and no discouragement should be felt if progress is slow.

Perhaps the most important element of success is the method of handling the business after it is started. Some serious mistakes in this direction were called to our attention. In one case important machines for shell manufacture were obtained from the United States, but all of the frames broke due to defective castings, and had to be repaired at considerable expense and delay. A fair claim for the cost of repairs was made, and a long correspondence ensued, which had to filter through the general office in London before it reached the American manufacturer. The claim was finally allowed, but the narrow method of handling the matter diminished good will and resulted in the loss of a subsequent order. French manufacturers and railroad men have high business standards, and they are conscientious in meeting their obligations. They expect the same treatment from others, and when it is given, a sure foundation of business friendship will be laid.

The cost of coal will always be high in France, as 30 per cent. of the supply has to be imported. All practicable methods of steam economy in boiler and engine-room practice should, therefore, be studied. Increased use of compound engines would apparently be of value, and a study might be made of the exhaust steam turbine as a means of securing increased power without additional coal consumption. In some mills the power transmission through bevel gears and complicated belt arrangements indicated a possibility of power saving through a careful application of electric motor driving, while in other mills such electric driving has been applied in a very satisfactory manner. The use of machine and drop-forgings could probably be extended with much advantage and economy.

Some of the shops could be improved through a more systematic arrangement of machinery to permit the line of manufacture to progress in regular sequence, and thus diminish the cost of handling. The power crane service generally is good, especially at the docks and railroad terminals, but continuous study of this subject is necessary. Occasional examples of apparent lack of such study were seen.

Finish on Machines

There is apparently a profitable field for inquiry as to the degree of finish which is warranted in many machine-shop and forge products. The French delight in good workmanship, and its prevalence is one of the many evidences of the artistic genius of the people. In some cases, however, the finish appeared too careful and elaborate for the use to be served. For example, the highest degree of care may well be applied to an aëroplane motor, and those examined by us were models in this respect. The same is true of the rifling and breech mechanism of field artillery, but in some cases unnecessary time appeared to be taken in finishing unimportant parts of a gun carriage or a motor truck.

In France as in the United States, improved machinery and labor-saving devices can only secure the greatest economy through standardization of the details of production, and in this respect we believe that there is much room for improvement in both countries. Probably the French temperament delights in variety, but automatic machinery, hydraulic forging plants, drop hammers, flanging presses and other labor-saving equipment accomplish their best results only when the same article is made in large quantities, thus reducing the cost of dies and permitting ordinary labor to produce a large amount of well-finished product.

In all countries variations in the design of machine products are found which appear almost inexcusable in the careless disregard of cost and increased danger of defective work.

Committees of standardization of engineering details could apparently be formed to advantage, and with the foundation thus established, the cost of production of standard parts could be reduced by automatic machinery, conveying apparatus, and other labor-saving devices to a degree not possible with a varied product. For instance, the splendid method of handling the material in the munitions plant at Lyons was possible only because the product consisted almost entirely of a single design of shells.

Editorials

The Machine Shops Are Ready

"In patriotic purpose whatever the eventuality," were the words used by the Chamber of Commerce of the United States in voicing the sentiment of the business men of the country in these critical days. Through these words is given a solemn pledge to support the President amid the international difficulties that confront the nation.

None of the organizations composed of men in the machinery-building industry have taken formal action. Had they done so, they would not only have pledged support, but would have declared their own readiness and the readiness of their plants for instant service. Many machine-shop executives have done this as individuals.

There is probably no class of our people that realize the difficulties and estimate the necessary time of producing materials for the army and navy in so accurate a degree as do the men in our machine shops. They know that very heavy responsibilities may be placed upon their shoulders within the next few days, responsibilities that they cannot fully discharge for perhaps many months. This is a sobering thought. But the situation is faced with the utmost willingness to do whatever is required.

"Well begun is half done" is an old maxim that we learned in boyhood. "Preplanning is necessary for successful production" is but a newer wording of the same idea.

The machine shops of the United States are ready for any eventuality, and the men in them are today individually thinking and planning what each will do if the emergency of war comes. Both shops and men are ready.

Lessons for the United States*

A special meeting of the British Institution of Mechanical Engineers was held on June 11 to take action on the following motion:

"That, in view of paragraphs 3 (subsections A and B) of the Institution's memorandum of association, the highly technical character of the war and the dependence of the Allied forces on the product of mechanical engineering, it is desirable that the Institution should in its corporate capacity endeavor to assist the country by making arrangements for receiving from its members particulars of inventions relating to apparatus likely to be of service in prosecuting the war, for improving means of production, or otherwise, and considering, inspecting, reporting upon and, where considered desirable, bringing the same to the notice of the Government."

In the course of the discussion of this motion, which was not carried, E. W. Petter regretted the fact that in the early days of the war the Institution had not met and considered some of the war problems from the viewpoint of mechanical engineering. He believed it might have advantageously influenced some of the things that have been done. He said in part:

"I think perhaps the advice of this Institution might have saved the country the loss of something like 30 per cent. of its skilled mechanics who have been sent out to the front to fight, and many of them to die, when they might have been very much better employed at home. One other point on which I think we might have given very valuable assistance to the Government when they realized the difficulties connected with munitions is this: We might have pointed out to them the great advantage of reserving certain factories for the manufacture of such things as jigs and tools, so that when any new factories were taken over, as is being done almost every day, instead of sending the drawing and telling people who were probably very badly equipped with facilities for making tools to make their own tools and jigs, these people would have had the jigs and tools sent down with the order and would have been able to get on with the work at once."

This quotation indicates that in the hard school of experience the British Government has learned two lessons: Skilled workmen should not be permitted to enlist, and there should be a carefully organized method of producing jigs, fixtures and gages.

The recent announcement that 90,000 workmen have been registered in England for the manufacture of munitions emphasizes afresh the need of mobilizing the men who are to produce the material for fighting, as well as those who are to fight. The experience of both Canada and England has plainly demonstrated that in times of stress, regulations should prevent the stealing of skilled mechanics by rival manufacturers that are producing war material. Every loyal American is earnestly hoping that his great country will not be brought into this or any other war, but common prudence says that we should learn from the experience of others. In case of war four great lessons can be learned by the United States from the facts cited. These are:

Register and mobilize all machinists and workers, both male and female, who can be employed on the production of munitions.

Prevent skilled machinists from enlisting.

Prevent employers from stealing munitions workers from one another's plants.

Organize the production of fixtures, jigs and gages as carefully and systematically as the production of munitions themselves.

*Reprinted from the "American Machinist," Vol. 43, page 301.

Need for a Second Thought

Many manufacturers are offering their own services and those of their plants to the United States Government. Among these are machine-tool builders. In some cases, willingness is expressed to turn the entire capacity of the plant over to domestic orders. These offers are patriotic and praiseworthy, yet in connection with them there is the need for a second thought.

The machine-building plants of the United States have on their books a large volume of orders for Europe, particularly for the Allied nations. How are these to be treated if there suddenly arises a tremendous domestic demand?

This question has already received consideration among the representatives of European governments in this country, and there is reason to believe that Great Britain has made representation to the Government of the United States, pointing out that it is essential that the Allies' orders for machines be filled, even though this country should enter the war.

Americans want to see the European War ended. European nations still need our machine tools in order to carry on their work of producing materials and to prosecute the conflict to a conclusion. Therefore, machine-tool shipments to Europe must not be cut off. These facts are plain.

In the emergency of war, the United States Government will undoubtedly establish a Ministry of Munitions. That ministry must take charge of the production and distribution of machine tools in the same way that similar Government agencies have handled the same situation in Great Britain and France. Before that United States authority must come the claims of the European nations for machine tools as well as the demands and needs in the United States. In this way, the interests of all will be properly protected.

No one need fear nor give way to a feeling of panic because of the situation today as regards machinery production, or of what may follow in the eventuality of the United States entering the war.

Machine Tools in Great Britain

An editorial in a recent number of *London Engineering*, under the title "Machine Tools and Future Industry," vigorously combats the idea that Great Britain will not need machine tools at the close of the war. It is carefully argued, apparently from detailed information on the part of the writer, that British industry will take up the production necessary to peaceful trade only after a great number of new machine tools have been added to the equipment. It is pointed out that under the exigencies of munition manufacture machines were bought wherever they could be obtained and of whatever quality was offered. Many of these are of use only for shell turning or other specialized operations.

The rate of deterioration on such machines is very high. Wear and tear and depreciation are excessive. When the time comes to resume peaceful industry, it will be necessary to equip with highly specialized tools for the particular manufacturing in hand. This latter fact would seem to bar a great part of munition machine tools from a prominent place in after-war industry.

The opinion that Great Britain will need many machine tools at the close of the war is set forth in this quotation:

> It is quite wrong to presume that the demand for munitions of war of all kinds has involved such an accession to the machine-tool equipment of this country that little will require to be done in this connection for a long time. This idea ought to be combated now and strongly. It is true that a large number of new factories have been built and extensive additions have been made to existing works, principally to produce shells. Others, of course, are occupied in more general work; for instance, in the construction of guns and howitzers, with their mountings and carriages. Moreover, each shell requires a fuse, which for its manufacture involves a large number of machines suitable for repeat work. But, in any case, the great majority of machine tools introduced in the last two years have been more or less of a special character, and apart altogether from any question of a deterioration due to excessive use, it is important that manufacturing firms should carefully consider their applicability either to the standard piece work of the establishment or to that additional work which such firms intend to undertake at the close of the war.

With reference to the character and condition of the machine tools that have been put at munition work, the following opinion opposes the one too frequently held that there will be thousands of machines thrown on the general market at the close of the war:

> When the demand was first made for enormous augmentations in the manufacture of shells, official pressure was brought on firms capable of organizing the manufacture of such munitions to secure lathes or other machine tools wherever they could be got and however they might have been made. The exigencies of the case justified the purchase of tools hastily made and without due regard to the severity of the work demanded from them. As a consequence many such tools are already, or must be soon, of no further use. When the machine-tool makers were able to meet the demands with tools of suitable design and adequate strength, a better type became available for shell manufacturers; but the rate of depreciation is enormously greater than under normal circumstances, first, because of the continuity of work and, secondly, because of the neglectful use, due to the inexperience of unskilled or semiskilled workers. In reckoning depreciation it is not satisfactory to consider the time element alone. Today machines are worked with relays of operators for 120 and even 130 hr. per week, whereas in normal times 60 hr. would be a high average. But apart from this there is the fact that continuity of work prevents periodical examination; and in the absence of this, defects which would easily be remedied in the early stages develop into rapid and serious wear. Bearings constitute an example. Many of the shell manufacturers are consequently satisfied that only small proportions of the lathes which have been continuously at work for the past two years can be relied upon for efficiency in general engineering in the future.

An additional reason for the opinion advanced is that British manufacture will be made over at the close of the war. Improved and efficient methods will be adopted. High production will be demanded. War machine tools are not adapted to this kind of manufacture, and for that reason peaceful industry will include a large number of highly specialized, semi-automatic or automatic machines of the types that are now produced by American builders. The editorial which has been previously quoted goes on to call upon British machine builders to determine a policy for the future and prepare financially to meet the new conditions, if necessary obtaining the support of the Minister of Munitions and the Treasury. Quoting again:

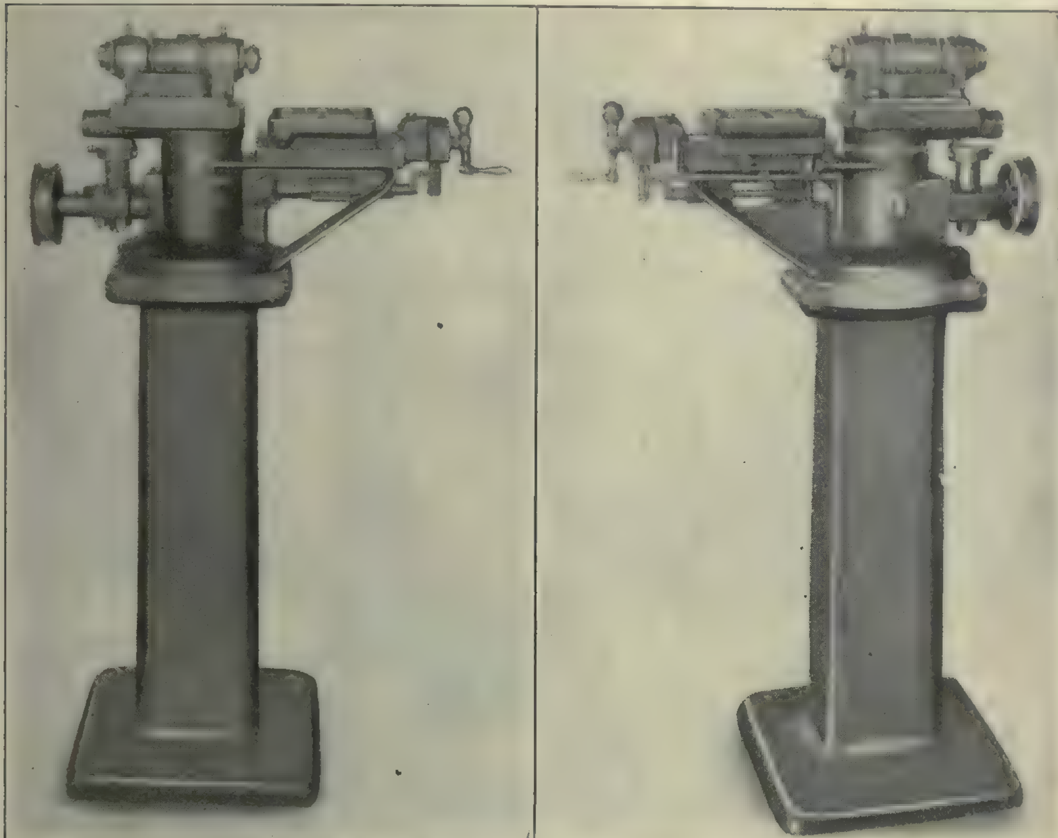
> What is required, therefore, of engineering manufacturers is at once to determine the policy to be adopted now in anticipation of peace manufactures, and to secure the support of the Ministry of Munitions, if not also of the Treasury, in preparing their financial reserve to meet the future conditions as regards machine tools. This is of vital importance, because the need immediately after peace is won will be to adapt our engineering establishments for mechanical manufacturing under the most efficient conditions. There is certainty of a great demand after the war, and an almost equal certainty that the rate of wages will continue, at all events for some time, at a high rate, probably at the present war rates. That contingency, at all events, has to be met, and it can only be met by the application of such machine tools as will achieve the maximum of output for the minimum of manual effort. If this is to be attained, every machine tool must be specially adapted for the particular operation for which it is intended.

All this testimony is of value, as it directly combats the idea that Great Britain will not need to buy machine tools at the close of the war in order to rehabilitate for peace.

Shop Equipment News

Oscillating-Head Miller

The oscillating-head miller shown in Figs. 1 and 2 may be used as either a bench or a pedestal machine. It may also be had with a chip or oil pan placed under the base of the machine and on top of the pedestal. This machine is especially suitable for milling small slots, as the oscillating movement of the cutter prevents chips from jamming between the cutter and the work at the end of the stroke. All parts are easily accessible, and protected from dirt and chips. The spindle bearings are bored straight and are tapered outside to take up wear. The tools are held in the spindle by a collet with a double taper and are also backed by a threaded rod in the bore of the spindle, which prevents end movement and acts as a guide in replacing a cutter after grinding. The method of oscillating the head by means of a crank disk, the pin of which works in a slot, prevents cramping at any point. The feed is from nothing up to as coarse as needed for any work of this kind, and it is operated by means of a pawl and ratchet shown just under the ball crank on the crossfeed screw. The spindle head is adjustable along a slide in the oscillating bracket, and the pin in the crank disk is adjustable. These two, together with the setting of the cutter, give a considerable range in the length of slots cut. The type of slots commonly cut is shown in Fig. 3. These are of a shape frequently required. However, blind slots, or slots completely through the piece, may be cut. This machine is made by the Superior Machine and Engineering Co., Detroit, Mich.



FIGS. 1 AND 2. FRONT AND REAR VIEWS OF OSCILLATING-HEAD MILLER

Size of mills taken, up to ⅜ in.; two-speed spindle runs 1880 and 2400 r.p.m.; cone pulleys, 1¼-in. face by 2¼ and 2¾ in. in diameter; bolting slots in oscillating head, 7¾ in. long; spindle-head bracket, 6 in. long by 5⅞ in. wide; clamping bolts in head bracket, 4⅝ in. c. to c.; oscillating pivot (taper), 3¾ in. at large end, 3 in. at small end and 6¼ in. long; front-spindle bearing, 1⅛ in. in diameter by 2½ in. long; rear-spindle bearing, 1x2⅜ in.; oscillating crank disk, 2½ in. in diameter; flanged pulley at back, for operating head, 1 in. wide by 4½ in. in diameter, to run 450 r.p.m.; center of spindle to top of table, 2⅞ in.; working surface of table, 3½x5 in.; slot in table, ½ in. wide; table with pan, 6x7¾ in.; size of table ways, 4⅝ in. wide by 8 in. long; height of pedestal machine from floor to center of spindle, 45 in.; base, 16x16 in.

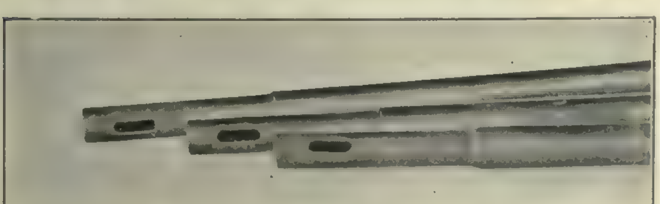
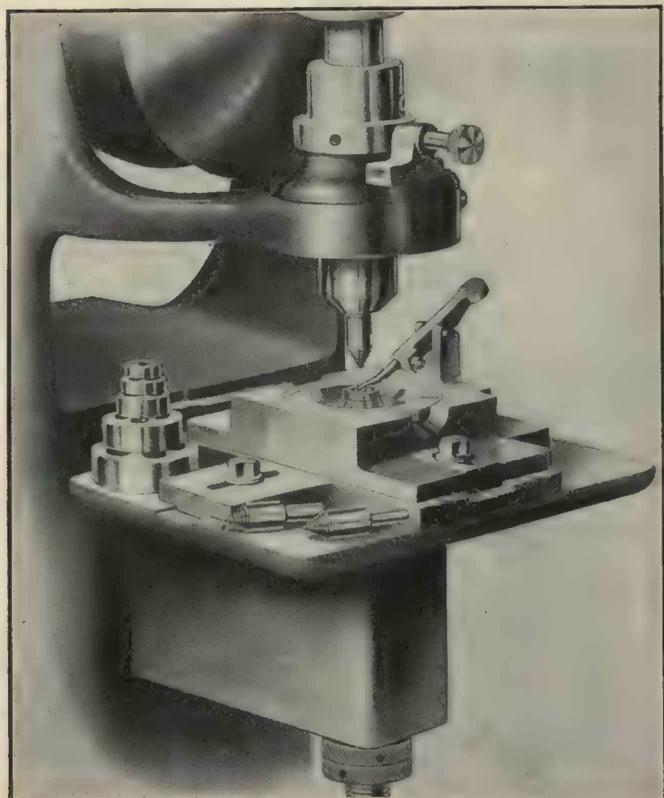


FIG. 3. EXAMPLES OF SLOTTING WORK

Die-Muzzling Machine

The most essential features of a machine recently placed on the market for die muzzling are shown herewith. The machine consists of a hollow vertical spindle mounted on ball bearings and driven by an electric motor through friction disks. The disk on the motor shaft is of the shape of a spherical segment, and the motor is pivoted horizontally in the frame of the machine in such a manner that by tilting the motor the driving radius of the friction disk is changed, and the speed of the spindle is varied. The chuck for holding the cutter is of the split-collet type operated by a knob on the upper end of the spindle. The cutters used are cone-shaped, the num-

ber of threads relieved being dependent upon the included angle between the sides of the cutter. The table, or fixture, is rectangular in shape and is provided with cross-slides for purposes of adjustment. The end of the spring finger shown fits into the openings of the die and insures

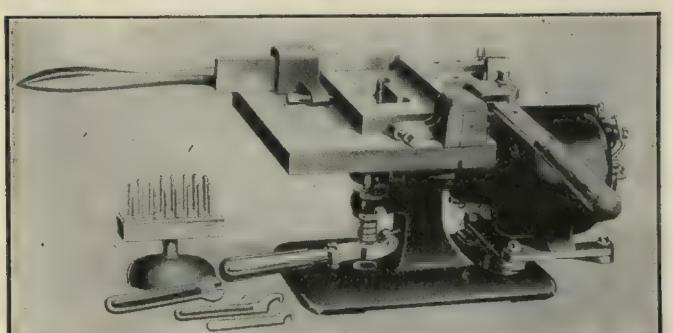


MACHINE FOR DIE MUZZLING

proper indexing. The portion of the finger engaging the die is removable, in order that the change necessary for different dies may be quickly made. The table is raised and lowered by means of a foot pedal and is provided with an adjustable stop to insure uniformity of the work. The machine is being manufactured by the Anderson Die Machine Co., Bridgeport, Conn.

Improved Die-Forming Machines

The Anderson Die Machine Co. has recently added an improvement to its No. 1 die-forming machine which is known as the universal pivoted feeding mechanism.



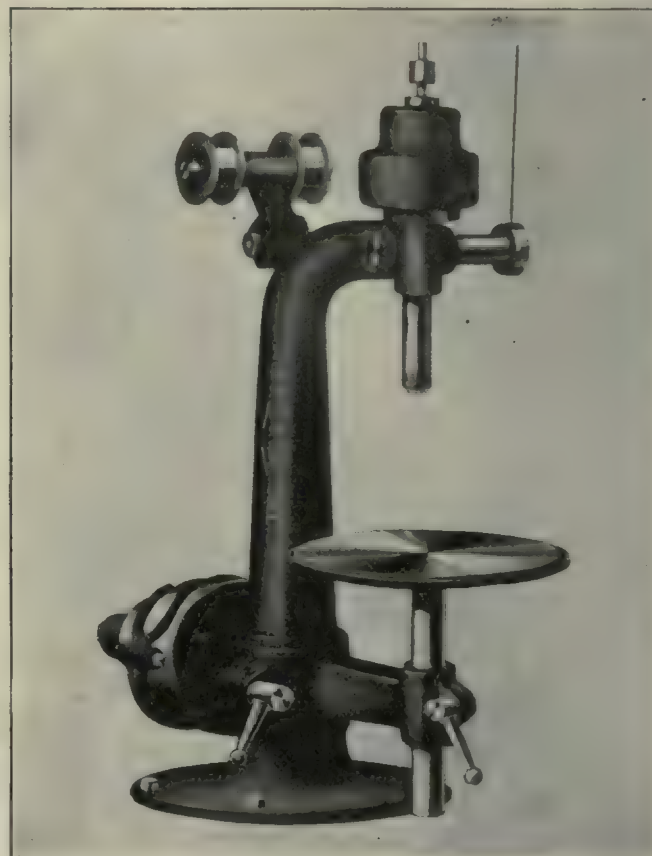
FEEDING MECHANISM FOR DIE-FORMING MACHINES

While being formed the die rests on a table, or platen, and is secured to an arm, or fixture, by means of a pair of adjustable clamps. The fixture is movable in either a lateral or a longitudinal direction by means of a pair of adjustable levers, and manipulation of these levers permits the die to be fed against the helical cutter in such a manner that intricate outlines may be followed.

In case it is desired to feed the die by hand the arm, or fixture, may be quickly removed, leaving the top of the table clear except, of course, for the projecting cutter.

Ten-Inch Sensitive Drilling Machine

This drilling machine is made by the Cleveland Lathe and Machinery Co., of Cleveland, Ohio. It is a very convenient form of sensitive bench machine. The spindle



TEN-INCH SENSITIVE DRILLING MACHINE

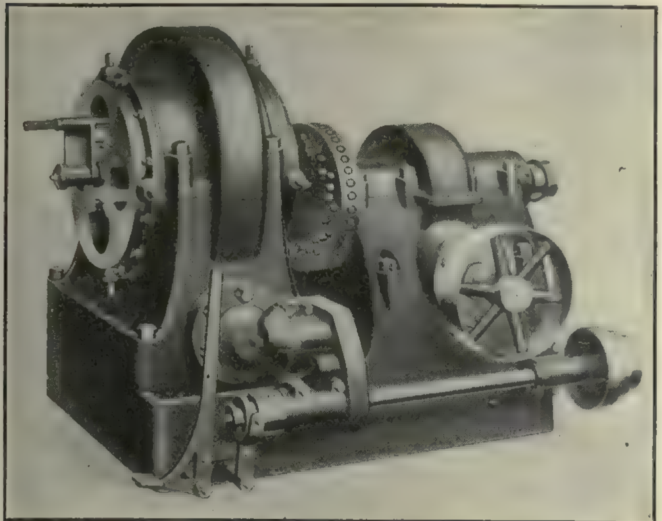
Greatest distance from table to spindle, 7½ in.; vertical spindle movement, 2½ in.; vertical table movement, 7½ in.; diameter of table, 8¼ in.; distance from center of spindle to column, 5⅛ in.; drilling capacity, 0 to $\frac{5}{16}$ in.; speed of driving pulley, 550 r.p.m.; weight, 50 lb.; crated, about 60 lb.

pulleys are guarded as shown. A simple bracket adjustment enables the operator to keep the belt tight at all times. All shifts and locking levers are within easy reach.

Shell-Base Facing Machine

One of the recent additions to the line of machinery for manufacturing munitions is the machine shown herewith, which has been built primarily for the purpose of rough-facing the bases of 6-in. shells. The feature of the machine is the magazine, or cylinder, in which the shells are held while being carried across the cutter head. The magazine is provided with bearings 24 in. in diameter and is driven by a steel worm running in oil. The shell pockets, four in number, extend axially through the cylinder and have hardened-steel inserts for gripping the shells, which are clamped to them by means of binder screws. A gaging device comes with the machine for lo-

cating the shells in the proper position. The cutter head is equipped with three rows of inserted cutters. The spindle runs in phosphor-bronze bearings and is driven by a worm. Three feeds are provided with a belt-drive



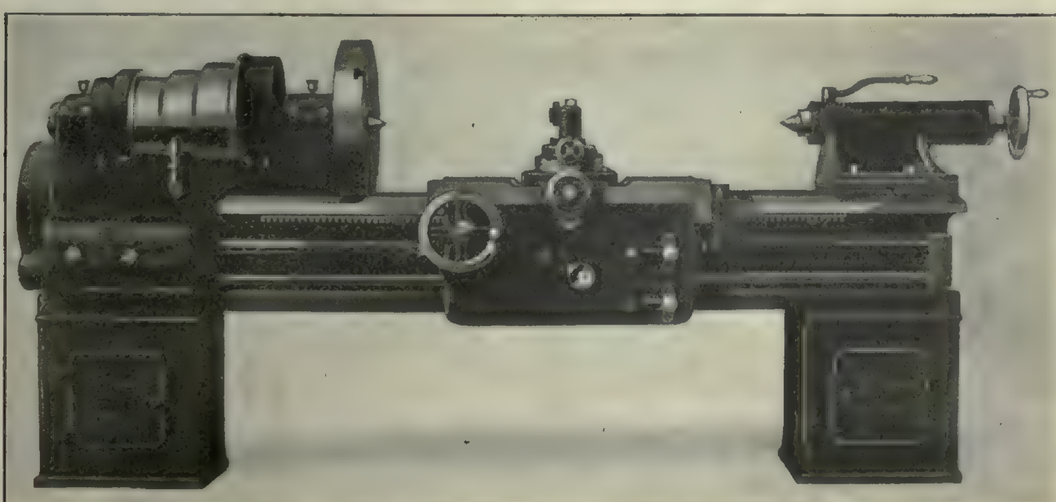
CONTINUOUS SHELL-BASE FACING MACHINE

Magazine bearings, 24 in. in diameter; magazine worm, 33 in. in diameter; bearings for wormshaft, bronze; cutter head, 19½ in. in diameter, 3 rows of tools; 2 spindle bearings, 5½ in. in diameter by 10 in. long; spindle worm gear, bronze, 16 in. in diameter; worm, steel; driving pulleys for wormshaft, 18x4¾ in., 360 r.p.m.; feed, three-step cone pulleys for 2-in. belt, or gear driven with four changes from 2.6 to 6.6 in. per min.; floor space, 5 ft. 3 in. by 4 ft. 9 in.

machine and four with a gear-drive, as desired. The machine is provided with a lubricant tank in the base and with a gear-driven lubricant pump. The machine is being placed on the market by the Chandler & Farquhar Co., Boston, Mass.

Double Back-Geared 20-in. Engine Lathe

The cabinet-leg, double back-geared lathe here shown, known as the Atlas, is made by the Cleveland Lathe



DOUBLE BACK-GEARED 20-IN. ENGINE LATHE

Swing over bed, 20 in.; swing over carriage, 12¼ in.; distance between centers, 8 ft.; bed, 48 in.; front bearing, 3½ in. in diameter by 6½ in. long; rear bearing, 2¾x6 in.; length of carriage on ways, 30 in.; hole through spindle, 1⅝ in.; diameter of tailstock spindle, 3 in.; tailstock travel, 7½ in.; spindles bored for No. 5 Morse taper shanks; cone pulleys, 9, 10½ and 12 in. in diameter for 4-in. belt; ratio of back gears, 3.7 and 10 to 1; pitch of lead screw, 4; cuts threads from 2 to 24; approximate shipping weight, 3650 lb.

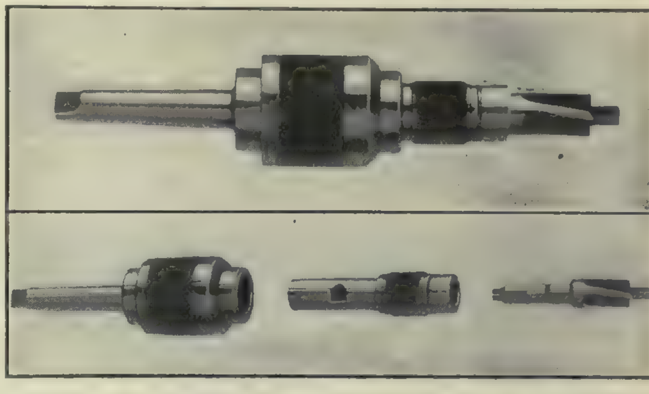
and Machinery Co., Cleveland, Ohio. The apron is of the double-plate type. The spindle is made from 50-point carbon steel. The feedshaft and lead-screw drives are both reversing in the head; the apron has separate reverse for feeds, and the carriage has an indicating dial for thread cutting. The lathe has power crossfeed and positive quick-change drive feedshaft, with 18 speeds. Equipment includes steadyrest, large and small faceplates, change gears, double friction countershaft and wrenches.

Solidified Oil

The Sun Co., Toledo, Ohio, is bringing out an oil, solidified with tallow to a jelly-like consistency, under the name of Nusco. The lubricant is intended for use in grease cups, and it is claimed that it will not become solid at temperatures considerably below 0 deg. F.

Combination Holders

The Eclipse Interchangeable Counterbore Co., Detroit, Mich., maker of Wiard chucks and Eclipse counterbores,



CHUCK, HOLDER AND COUNTERBORE READY TO USE. ALSO SEPARATED

is now manufacturing Eclipse holders with integral Wiard collet shanks, as shown. This combination eliminates the necessity of buying two separate tools. It is also a big time saver and an exceptionally handy tool for drilling, reaming and counterboring. All these combination holders are supplied with a knurled collar that may be safely grasped when placing or removing the holder from the chuck while the spindle is running. This provision lessens the likelihood of the operator's cutting his hands on the tool. The holders are made in Nos. 0, 1, 2 and 3 sizes, to correspond to similar chuck sizes. The illustration not only shows the chuck, holder and counterbore assembled and ready to be placed in the machine spindle, but shows each part separately, that details may be seen.

New Publications

Manual for Engineers—By Charles E. Ferris. Twentieth edition; one hundred and sixty-one 2¾x5½-in. pages; indexed; flexibly bound. Published by the University Press, Knoxville, Tenn. Price, 50c.

When a technical book passes through twenty editions no one can dispute that it contains valuable information and has found a place for itself. This litle manual of useful tables compiled for the busy engineer has had twenty revisions and twenty opportunities for the correction of errors and the selection of fresh material.

While it is not called a pocketbook, it is nevertheless of vest-pocket size.

Plain and Ornamental Forging — By Ernest Schwarzkopf. Two hundred and sixty-seven 5x7⅝-in. pages; 228 illustrations; indexed; cloth bound. Published by John Wiley & Sons, Inc., New York City. Price, $1.50.

This book is one of the Wiley technical series edited by Joseph M. Jameson and is intended to be of assistance to beginners in forgework practice. It is well illustrated by examples of work suitable for instruction purposes in technical high schools and vocational schools.

Many volumes covering this general topic are on the market, these having been written primarily as elementary textbooks. This one, however, seems to be of a higher order than some of its predecessors. The language is simple and the use of obscure technical terms and mathematical formulas has been avoided. There are 12 chapters with these headings—General Properties of Iron; The Forge; The Blacksmith Tools; Practice Exercises; Upsetting, Offsetting, Shouldering, Drawing, Forming and Bending; Welding; Forging Exercises; The Properties of Steel; Annealing, Hardening and Tempering; Tool Making; Advanced Forging; Art Forging. The appendix covers a number of special operations that may fall to the lot of the blacksmith or the forger, such as bending brass and copper pipes, marking pipes, inspecting sheet metal, cleaning the surfaces of metal, brazing, soldering and similar operations.

The illustrations are simply and carefully worked out so as to show the important features that it is desired to emphasize. The book is of value to every student of forge practice and ranges from the very simplest exercises to advanced art work.

Fatigue Study—By Frank B. Gilbreth and Lillian M. Gilbreth. One hundred and fifty-nine 5x7½-in. pages; 33 illustrations; cloth bound. Published by Sturgis & Walton Co., New York City. Price, $1.50.

The work of Frank B. Gilbreth in motion study has led to the investigations that form the basis of this book. Fatigue study is an aspect of the study of wasted motions. The aim of this book, as stated in the preface, is "to outline both these preliminary methods and the scientific method of fatigue elimination, and to put the available material for fatigue study into such shape that anyone interested may make immediate, definite and profitable use of it."

The opening chapter describes and gives a general outline of fatigue study and states in general terms what must be done. Two classes of fatigue are outlined—that which is unnecessary and results from unnecessary and avoidable efforts, and that which is a result of work that must be done.

Chapter 2 takes up the matter of a fatigue survey, pointing out the aims of such an investigation, states what is to be looked for and then gives hints as to what should be done to make the survey serviceable.

The next three chapters take up several aspects of means for overcoming fatigue, including provisions for rest, means for recreation as developed by the "Home Reading Box" of the City of Providence, R. I., and then fatigue elimination. Under the latter topic there are discussions of factory lighting; the heating, cooling and ventilating of work places; fire and safety protection; convenient work tables; comfortable work chairs; the handy arrangement of tools and working devices; and comments on the clothing of the workers.

Chapter 6 is devoted to "The Fatigue Museum." A number of its exhibits, principally of chairs for factory workers, are illustrated. The final chapters take up fatigue measurement, a discussion of the period of making adjustments based on work done in a machine shop and, finally, some words as to the future. The ending is a plea to every reader to interest himself in the work of eliminating fatigue.

There never was a time when more consideration was given to the matter of fatigue in industry than today. Anyone who is really interested in the subject should read this little book.

How To Build Up Furnace Efficiency—By Joseph W. Hayes. Tenth edition; paper; 7¼x5 in. Published by Joseph W. Hayes, Rogers Park, Chicago, Ill. Price, $1.

This latest edition of this little book, so well known to engineers and firemen, is enlarged a trifle by the addition chiefly of matter that has not added appreciably to the value of that contained in previous editions. The idiosyncrasies of the author crop out and are manifested by homely quotations from "Down East Tales" and Omar Khayyam, which are unusual company for carbon dioxide and boiler efficiency; but no harm is done, and the readers will enjoy them.

Engineering of Power Plants—By Robert H. Fernald and George A. Orrok: Five hundred and eighty-six 6x9-in. pages; cloth; 310 illustrations. Published by McGraw-Hill Book Co., Inc., New York City. Price, $4.

This, like a number of other books that have appeared in recent years, is the bringing together, in a form for convenient classroom use and for the assistance of the engineer, of the notes that have served the author in professional work. In this case, however, Professor Fernald has called into collaboration, in Mr. Orrok, a man who for years, as a mechanical engineer of the New York Edison Co. and as a consulting engineer, has dealt with the practical application of the subjects taught, and who brings to the task not only a knowledge of that which should be taught, but a fund of precedents and data from successful practice. The material is most simply and understandingly presented, with very little mathematics.

A definite idea of the plan and scope of the book may best be gained by an enumeration of the subjects of the 26 chapters into which it is divided: Sources of Energy; The Steam Engine; Electric Generators and Motors; Foundations; Condensers; The Steam Boiler; Chimneys and Mechanical Draft; Smoke and Smoke Prevention; Boiler Auxiliaries; Piping; Coal and Ash Handling; The Steam Power Plant; Variable Load Economy; Cost of Power; Hints on Steam-Plant Operation; Power Transmission; District Heating; The Power Plant of the Tall Office Building; The Power Plant of the Steam Locomotive; Fuels; Internal-Combustion Engines; Producer Gas and Gas Producers; Comparative Efficiencies and Operating Costs for Different Types of Installation; Compressed Air; Refrigerating Machinery, and Hydraulic Power. Fifteen of these chapters have lists of problems to be solved by the student. The book is replete with charts and tables and aims to bring to the student a realization of the fact that engineering, although based on the exact sciences, is not itself an exact science. Many cost figures are given, but it is advised that they be used with caution on account of local conditions and market variations.

Personals

W. J. Radcliffe has been elected president and general manager of the E. A. Kinsey Co., Cincinnati, Ohio.

L. C Parrott, for four years assistant purchasing agent of the Standard Parts Co., Cleveland, Ohio, has resigned.

L. S. Hall has been appointed sales agent for the Steel Improvement and Forge Co., to cover the State of Michigan.

E. F. Roberts has been promoted from general superintendent to factory manager of the Packard Motor Car Co., Detroit.

A. K. Smith has been appointed production manager of the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

J. O. Heinze has become engineer and production manager of the Simms Magneto Co., East Orange and Bloomfield, N. J.

C. F. Tollzien, purchasing manager of the Packard Motor Car Co., Detroit, has been promoted to manager of production.

M. F. Sergeeff, Petrograd, Russia, who has been in this country for about a year purchasing machine tools, will return to Russia about Feb. 1.

Lloyd Brown, of the Lakewood Engineering Co., has returned to the Cleveland office as manager of sales of the car and factory truck department.

Henry Lindenkohl has recently been appointed engineer of construction of the American Locomotive Co., with headquarters at Schenectady, N. Y.

P. B. Stonerod, formerly steel inspector of the Carnegie Steel Co., has become construction engineer at the New York branch of the Berger Manufacturing Co.

A. H. Bromley, Jr., has been appointed chief engineer of the sales department of the Berger Manufacturing Co. and will hereafter be located at the Canton office.

The Omar Machine Co., Chicago, Ill., will hereafter be known as the Fulton Machine Tool Co. William Ganschow is president and C. F. Goedke is secretary and treasurer.

Paul R. Ketzer, formerly Eastern manager for the Metalwood Manufacturing Co., has formed the Ketzer Machinery Co., Philadelphia, and will handle special machinery and tools.

R. B. Holladay, formerly with the Fairbanks, Morse Co., Beloit, Wis., has become assistant to the general superintendent of the Power and Mining Machinery Co., Cudahy, Wis.

C. B. Rearick has been made vice-president and general manager of the Covington Machine Co., Covington, Va. Mr. Rearick was formerly manager of sales of the same company.

H. A. Shier, formerly of the Bethlehem Steel Co., has taken a position with the Onondaga Steel Co., Inc., Syracuse, N. Y., and will represent it in southern Ohio and western Pennsylvania.

Charles Herman, assistant superintendent of the foundry department of Fairbanks, Morse & Co., Beloit, Wis., has resigned to become foundry manager for the Hooven-Owens-Rentschler Co., Hamilton, Ohio.

John A. B. Patterson has retired from the secretaryship of the Standard Gage Steel Co., of Beaver Falls, Penn. Mr. Patterson was one of the incorporators of the company in 1892 and has been continuously with the firm since that date.

C. R. Courtenay and **R. E. Cahill** have formed a partnership under the name of the Watertown Engine and Machine Co., which will make repairs and replacements on Watertown engines and boilers and will do engineering work along power-plant lines.

The Quality Saw and Tool Works and the **Napier Saw Machine Works**, of Springfield, Mass., have formed a corporation known as the Napier Saw Works, Inc. The officers of the new corporation are: Charles Napier, president; F. T. Sey, vice-president; C. H. Parsons, treasurer.

R. W. Van Horn has been transferred from the New York branch to the home office of the Berger Manufacturing Co., Canton, Ohio. Norman A. Hill, formerly efficiency engineer for the Du Pont Powder Co., Wilmington, Del., has taken a like position with the Berger Manufacturing Co.

Trade Catalogs

Napier Metal Band Sawing Machine. Quality Saw and Tool Works, Springfield, Mass. Circular; illustrated.

Beaudry Power Hammers. Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalog; pp. 20; 6x9 in.; illustrated.

Universal Convertible Grinders. Warren F. Fraser Co., Boston, Mass. Catalog; pp. 8; 5½x8 in.; illustrated.

Mesta Automatic Plate Valves (Iversen Patent). Mesta Machine Co, Pittsburgh, Penn. Bulletin D; pp. 8; 6x9 in.; illustrated.

Fairbanks Power Hammers (Dupont Patent). United Hammer Co., 141 Milk St, Boston, Mass. Catalog; pp. 24; 6x9 in.; illustrated.

Bending Machines, Bar and Rod Cutters, Punches, Shears, Etc. Wallace Supplies Manufacturing Co., 412-20 Orleans St., Chicago, Ill. Bulletin No. 12; pp. 32; 6x9 in.; illustrated.

Welded Steel Kerosene Torches. Hauck Manufacturing Co., 140 Livingston St., Brooklyn, N. Y. Bulletin No. 76; pp. 8; 6x9 in.; illustrated. The application of these torches in machine shops is described.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

Panama Canal Shops at Balboa

By Frank A. Stanley

SYNOPSIS—Twenty-six buildings comprise this large Government plant for repairing equipment and machinery. Work for private firms and individuals is also done. The views and drawings show the general arrangement of buildings and yard equipment.

The great shops of the Panama Canal, located at the Pacific terminal, Balboa, are of unusual interest, owing not only to their magnitude and their thoroughly up-to-date features of construction, but also because of the diversified character of the work handled therein.

These shops were authorized by Act of Congress, Aug. 24, 1912. As completed, they consist of 26 buildings, 12 of which may be considered as main buildings; the others are smaller and less important structures used for various purposes. The shop buildings of this plant, as completed and equipped with machinery, form important object lessons in building design and construction, in arrangement of machinery and in the methods of conducting the operations in the plant.

The buildings all have steel frames, with the main structures covered with tile roofing and with closure features for sides and ends of novel arrangement to engineers whose experience has been confined to the colder latitudes of the United States. In general, the sides and ends are provided with complete systems of movable metal louvers and rolling steel doors, making it possible to give the greatest amount of opening at all points for free admission of the air and at the same time permitting a complete closure to keep out the heavy rainfall that is prevalent at certain seasons of the year on the Isthmus.

FIG. 1. BALBOA, CANAL ZONE; A VIEW FROM ADMINISTRATION BUILDING

These shops are unique in their purpose. While they constitute a Government plant, they are intended also to do machine-shop work for private establishments, for private lines of steamships and for the Panama R.R. They not only take care of construction and repair work for the Panama dredging and towing fleet, for naval vessels passing east and west, for passenger and cargo steamers of all kinds, but they overhaul and repair equipment for mines up and down the coast, for local mills of one kind or another and for companies and individuals who may require machine or foundry work of any kind whatso-

ever. Thus, in addition to the operations peculiar to the maintenance and operation of the canal itself and to governmental work of all kinds this establishment constitutes a thoroughly equipped jobbing and general machine plant that is at the service of anybody who wishes to have work handled at this point.

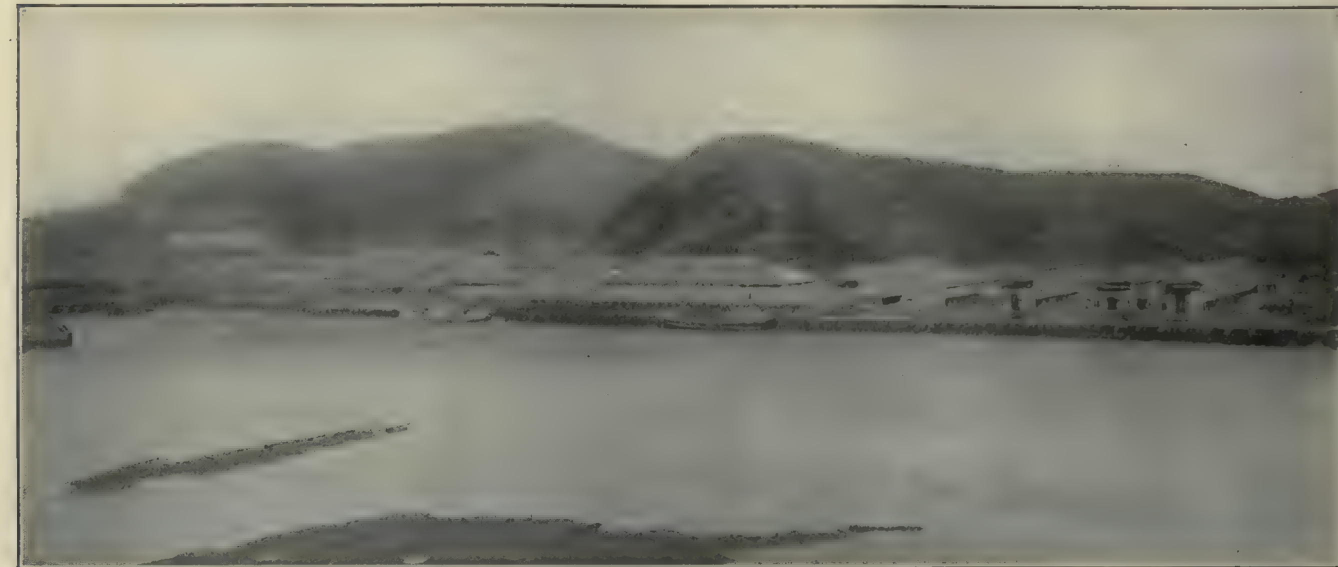


FIG. 2. VIEW OF BALBOA SHOPS FROM CANAL

The dry dock just nearing completion will admit the largest vessels afloat. The car shop and the section of the machine shop devoted to railroad work take care of the entire equipment of the Panama R.R. The machine and tool equipment is of such a varied character that any part, such as the heaviest member of a dredge or any part required on a marine job can be handled with facility; large or small electrical apparatus can be overhauled; typewriters and the like can be inspected and repaired; and still further, instruments of all kinds for ship or shore service, and clocks and even watches can be taken care of.

FIG. 3. VIEW OF BALBOA SHOPS AND DRY DOCK FROM SOSA HILL

A greater variety of work in respect to both size and character could not be found in any plant. It is doubtful if any approach to the diversity of operations here seen is carried on in any other establishment. It is rare indeed to find, for example, marine and railroad-repair operations under the same roof, at least in anything like the magnitude of the undertakings here. In respect to this feature possibly the closest and only approach in this country is represented by the great Southern Pacific repair shops at Sacramento, Calif., where regular locomotive overhauling and marine-engine repairs are always under way, this plant taking care of the equipment of river steamers and ferryboats so familiar to travelers about the bay at San Francisco.

Unless one has actually visited the Canal Zone and spent some time in Balboa, he can have little conception of the town here laid out for employees and officials. Photographic views fail to convey a satisfactory idea of

the park-like effect throughout the section occupied by the dwelling houses or of the attractive features of the buildings themselves, including the thoroughly uptodate apartment houses, detached homes, commissary or stores for employees, administration building, railway station and so on. The view in Fig. 1, however, may give some impression of the neat and attractive appearance of one of the main avenues, that leading down from the front of the administration building. At the far end of this avenue is shown the Y. M. C. A. building, and at the right of this the general commissary for gold and silver employees—that is, for white and colored workmen.

The Balboa shops lie to the right of this view, and their appearance as seen from the canal is well illustrated in Fig. 2. Fig. 3 is reproduced from a photograph taken from the opposite side of the plant, showing the main buildings, with No. 1 dry dock immediately in the foreground. The enormous proportions of this dry dock are better understood from Fig. 4, which shows the end of the shop buildings, near the right-hand wall, and the coal-handling equipment, at the left-hand side. This dock, it may be stated, measures over 1100 ft. in length, has a width at floor of 113 ft. and a width at coping of 143 ft.

FIG. 4. THE GREAT DRY DOCK NO. 1 AT BALBOA

A general layout of the Balboa shops and yards is given in Fig. 5. Inspection of this drawing will show that the big buildings consist of the machine-erecting and tool shop, the forge shop, the steel-storage shed, the boiler and shipfitters' shop, the planing mill, the general storehouse, the lumber and equipment shed, the foundry, the car shop, the paint shop and the general office building for the shop plant. The other buildings included in the group are all clearly designated.

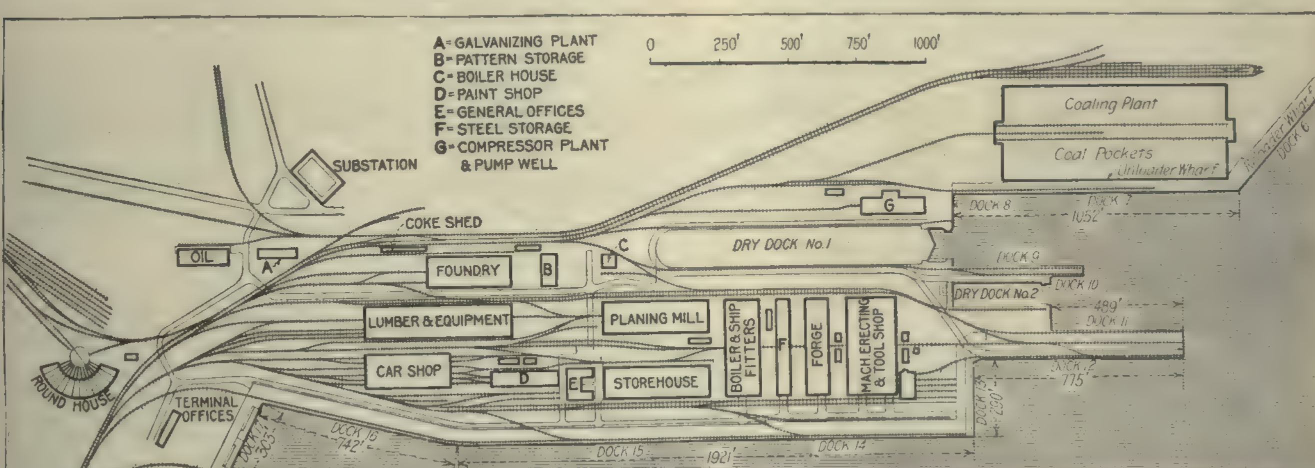



FIG. 5. GENERAL ARRANGEMENT OF SHOPS, BUILDINGS, DOCKS AND YARDS

The main buildings lie between the dry docks and wharves, the four buildings first referred to in the previous paragraph being located at the western end of the yard, with the longitudinal axis running approximately north and south. It will be noticed that these buildings are all conveniently located in relation to docks and repair wharves. Their crane runways project from the ends of the buildings, so that material and work can be handled

in and out of the shops with the greatest facility, whether the work is in connection with vessels in dock or at wharves or whether it is to be loaded on or taken off cars on the railway tracks that extend throughout the plant.

The area on which these buildings are erected is about 36 acres in extent and was originally of low-lying, swampy character. In preparing the foundations a great many piles were driven, and many caissons were required. Over 5000 piles were used in the preparatory work before the erection of the buildings. Under the machine shop, in particular, it was necessary to resort for foundations at certain points to the use of steel caissons 4 ft. in diameter. These are supported by steel rails extending down to rock, the cylinders being filled with concrete to form a solid pier. In certain cases further support is provided by reinforced-concrete beams tying the top of the piers together. Eight such caissons were employed for foundations to support the extension of the crane runways referred to above.

As seen from the drawing, Fig. 5, building No. 1—that is, the machine-erecting and tool shop—and the three other buildings lying parallel to it are 360 ft. in length. The machine shop has a width of 190 ft., the boiler shop a width of 90 ft., the steel-storage shed a width of 50 ft. and the boiler shop a width of 130 ft. The foundry is approximately 318 ft. long and 119 ft. wide. The floor areas of the principal buildings are as follows: Machine shop, 67,788 sq.ft.; forge shop, 32,400 sq.ft.; boiler and shipfitters' shop, 46,458 sq.ft.; foundry, 34,508 sq.ft.; planing mill and carpenter shop, 48,580 sq.ft.; car shop, 38,790 sq.ft.; steel storage, 18,090 sq.ft.

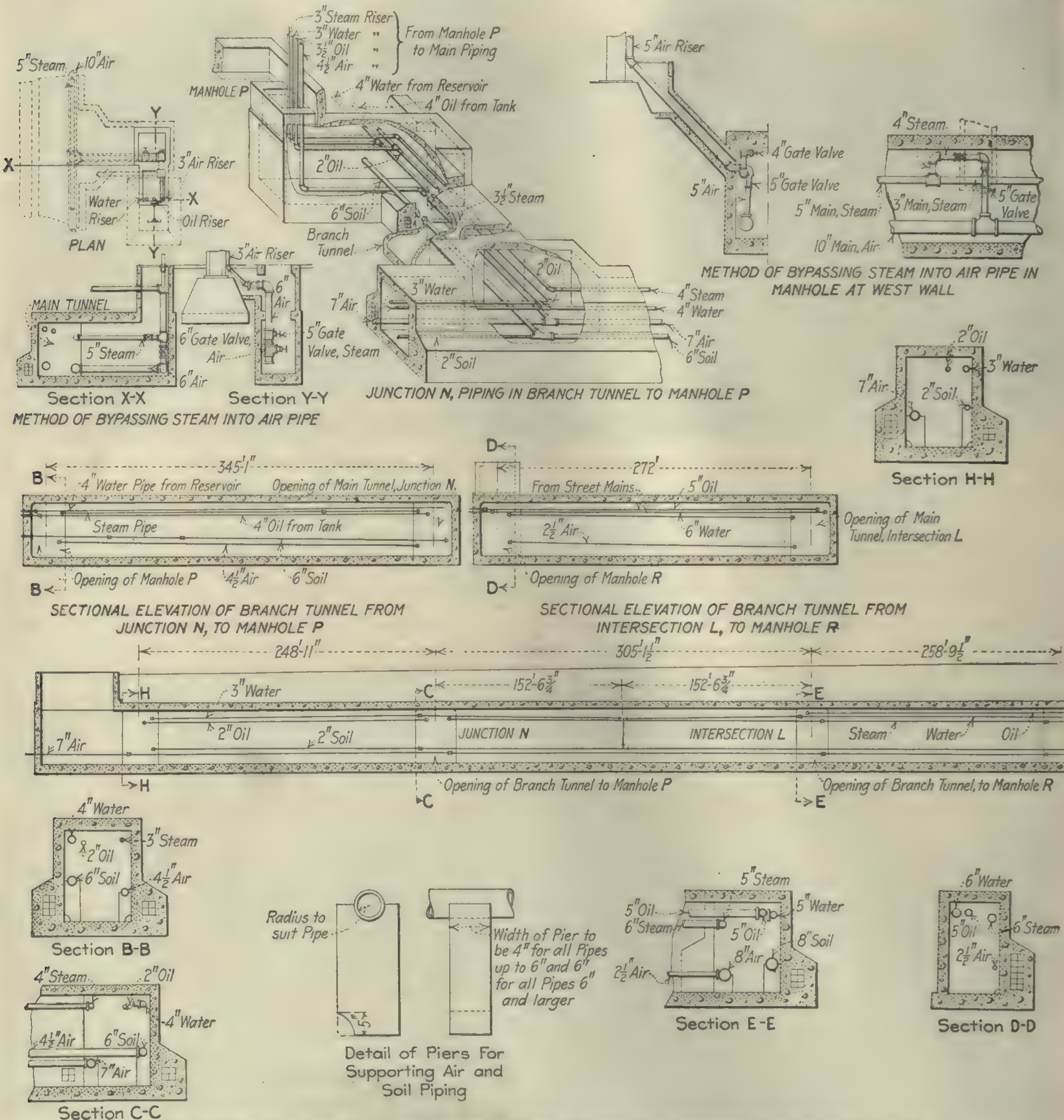


FIG. 6. ELEVATIONS AND SECTIONS OF PIPE TUNNEL CONNECTING THE BUILDINGS

Under this series of shops there is a tunnel system consisting of main passageway and laterals leading into different buildings to carry the mains for air, water, light and power, steam, oil, etc. Longitudinal sections, elevations and sections of the tunnel system are given in Fig. 6. As will be noticed, the main tunnel is dimensioned 6 ft. in height by 4 ft. 6 in. in width. The arrangements of piping for all purposes are clearly shown in the different views in this drawing. There is of course in each building a branch outlet or manhole for the various lines that are extended through to suit the requirements in that particular part of the plant.

Precision Grinding

By J. B. Murphy

In the various illustrations herewith, I have endeavored to embody a few suggestions on toolroom grinding of the highest order—gages, dies, jig parts, etc.

I have tried to make the drawings and descriptions as clear and brief as possible, and yet give information that the experienced grinder-hand will have no difficulty in following.

It will be noticed that the dial indicator plays an important part in this article, and while the drawings call for two styles, the one shown in Fig. 2 may, if desired, be dispensed with and the one shown in Fig. 4 used exclusively.

The first thing I wish to refer to is the machine itself, which in the present case is a No. 2 Brown & Sharpe surface grinder. This machine is chosen for several reasons: Because it is so generally used in the best shops; because in spite of its wide use, it is not so well understood as it should be, and because of my familiarity with this machine and its work.

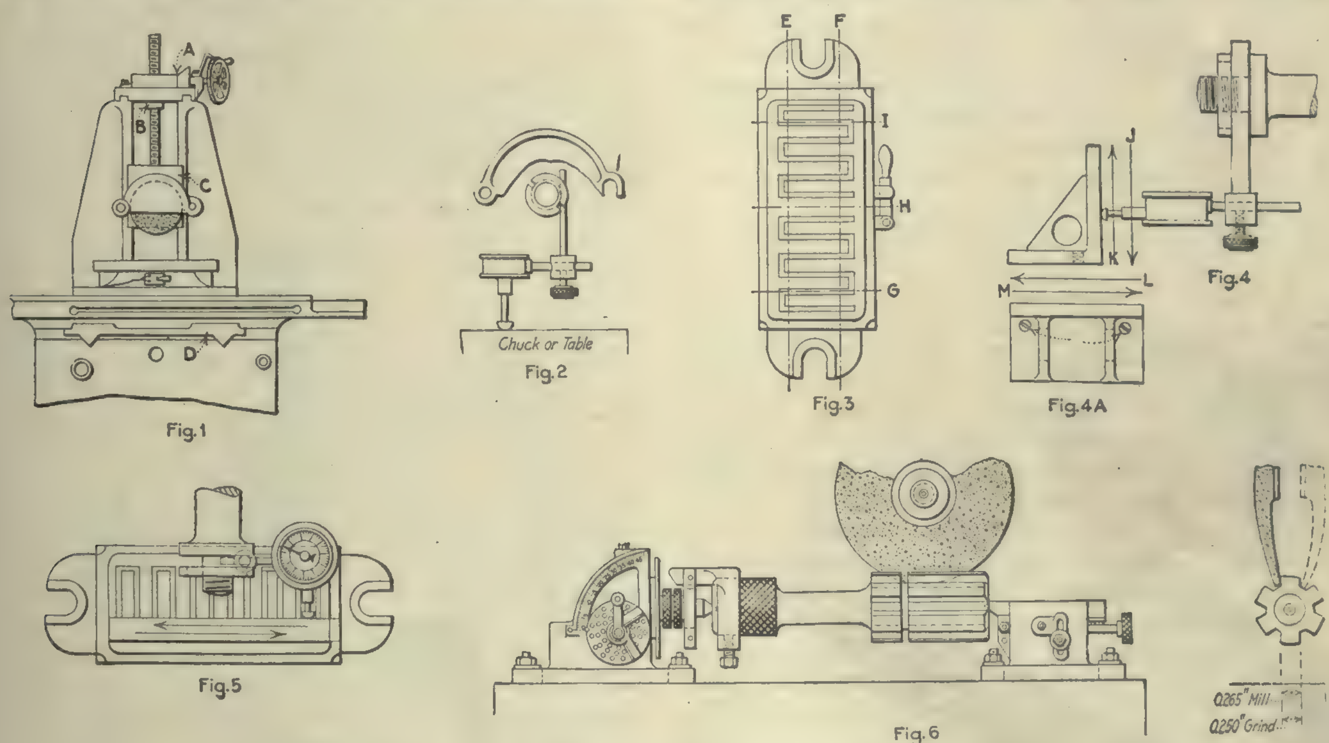
While nothing is perfect, the operator will do better and faster work, and will present the boss with fewer excuses and apologies, if he knows just where to look for trouble and knows what that trouble amounts to in quarters of thousandths of an inch.

Considering Fig. 1, error should be watched for on the reversal of the stroke in the table traverse; in the cross-feed *D* at its point of reversal; in the nut *B* when lowering the head or when setting the head for a cut, according to the graduations on the hand wheel. The gears *A* should also be tried often and if found loose should be tightened at once. Superfluous advice, it would seem, but upon several occasions I have noticed operators running grinders that were badly in need of attention; and quality and quantity of output cannot be expected under any such conditions.

Another thing to be watched for is the head becoming "cocked" on the gibs when being lowered. In this case the machine may seem to work all right for a time, until a slight jar on the machine or on the floor will cause the head to drop, and possibly spoil an expensive piece of work.

Even assuming the spindle bearings to be properly adjusted and the machine otherwise in first-class condition, it is not to be assumed that if the hand wheel is lowered 0.001 in. the grinding wheel will take an additional cut of precisely 0.001 in. For if the machine has been in use even a few weeks, there may be some lost motion or other error at any of the points shown in Fig. 1; and while the grain, size and shape of wheel must all be considered, we must also take into account the width, length and material of the surface being ground.

While I have no intention of digressing in this article to discuss wheels and materials, I will say that while a coarse wheel will wear away quickly it will not "chatter" so readily as will a fine-grain wheel; on the other hand, a coarse wheel, if operating upon a wide surface, will produce an inclined surface that will require several



FIGS. 1 TO 6. TESTS FOR THE PRECISION GRINDER

finishing cuts to bring it true. At the same time a fine-grain wheel will glaze readily and produce chatter; and, speaking of tool steel, will injure the metal, producing a peculiar surface appearing slightly burned, so well known to all grindermen who have tried to spare the diamond or have started a wide cut with a wheel of too fine a grain.

Referring again to Fig. 1, when the spindle bearings have been properly adjusted and all apparent play in the other working parts of the machine has been eliminated, the machine should then be subjected to the real test, so that minute errors and variations, if they cannot be corrected, will at least be known and may be allowed for in the work.

The Table and the Gibs

It will hardly be worth while to try the table with a straight-edge nor need we square the gibs with the table surface, since Brown & Sharpe are pretty good at that; and it may be assumed the machine is correct at these points even if the machine is an old one.

However, it is often advisable to run a light cut over the surface of a magnetic chuck after it has been carefully set and clamped.

Let us assume we are using a magnetic chuck. It has been carefully set and clamped and a light surfacing cut taken over it, to give a true working surface. The wheel is removed from the spindle and between the shoulder and the nut the indicator stem is clamped, as shown in Fig. 2. If the crossfeed is moved out and the indicator point allowed to travel back and forth along the line *E*, Fig. 3, any error in the table reversal will be shown.

This operation should be repeated along the lines *F*, *G*, *H*, and *I*, to search out any low places or inequalities in the surface of the chuck. If the surface of the chuck is satisfactory, the table traverse should be stopped and the hand wheel, lowering the head, moved down, say 0.005 in.; the indicator should then record a similar amount, the indicator point, of course, still being in contact with the chuck surface.

The reading of the indicator should be noted and the chuck moved clear of the indicator, by moving the table back by hand; then the head should be lowered, say 0.050 in. or so, and then raised to its original position, whereupon the chuck should run under the indicator again and a second reading be taken; this last indicator should, of course, correspond to the first reading. This test is to detect any error due to raising and lowering the head, and it will show what may be expected when starting a cut on a job that must be right.

Error in the Crossfeed

In Fig. 3 the movement of the indicator along the lines *G*, *H* and *I* will show any error in the crossfeed at its reversal. I have found errors as high as 0.003 in. at this point, while in raising and lowering the head I have found, in one case, 0.0005 in. error and in another case, 0.008 in variation. These things cannot always be corrected, but unless they are known really first-class work cannot be expected.

In Figs. 4 and 4A is shown a method of testing the truth of an angle plate when it is desired to clamp the work to it and grind in this way. Of course, if the machine has been accurately adjusted and its errors discovered by the foregoing tests, it simply becomes a matter of testing the angle plate itself. This can readily be done by moving the indicator along the lines *J*, *K*, and *L*, *M*, as indicated in Fig. 4, by merely moving the table by hand and raising and lowering the head.

In Fig. 5 a parallel block is being set, the test lines being plainly shown by the arrows. Fig. 6 shows the surface grinder grinding a special plug gage through the employment of the index centers; when one side of the spline is ground all around and left 0.002 in. full for finishing, the grinding wheel is turned around and the opposite side of the spline is ground and finished; then the wheel is placed in the first position and the side first ground is finished; the wheel used is a No. 3 Cincinnati, and its positions are shown in full line and dotted line.

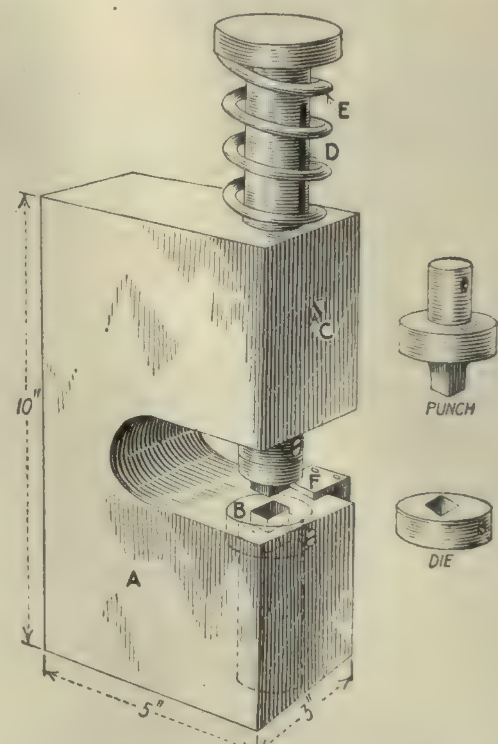
In conclusion I might say I have found the surface grinder convenient for many things besides grinding plain, flat surfaces and bevels. Fig. 6 is a suggestion that might be worth while, if it will start a line of thought that will make the surface grinder a better known and more clearly understood machine.

Subpress for the Arbor Press

By Thomas B. Bracey

As we did not have a punch press, we constructed the subpress shown, to make a number of odd-shaped pieces required for experimental work.

The body *A* is of cast iron; *B* is the die, which is held in by a cone-pointed headless screw. The punch is held



SUBPRESS, DIE AND PUNCH

in the same way by the headless screw. The screw *C* fits in the keyway *D*, which keeps the punch and die in register. The spring *E* pulls the plunger back to position. The stripper is shown at *F*. This subpress was used under the ram of an arbor press.

American Industrial Progress as Revealed by War Orders

By Earle Buckingham

SYNOPSIS—The author contrasts American and European manufacturing development and then briefly states the principles underlying interchangeable production. He remarks that little interchangeable work has ever been turned out in the United States and lists mistakes made by our manufacturers in executing munition contracts. His conclusion is that we must profit by these errors and make radical changes in our shop practice if we are to do a world-wide business.

Industrial preparedness at the present time is occupying an important place in the minds of those comprising our business world. This preparedness is even more necessary in the works of peace than in providing for the needs of war. The immense orders for the various manufactured goods that have been placed here, as a result of the war now in progress, have definitely shown us that we are far from being prepared to hold our own in the march of mechanical progress.

Already several steps have been taken to aid in arriving at a satisfactory state of industrial preparedness, and many more are under consideration; yet from all that I have been able to gather, these appear to have been chiefly in the direction of organizing and mobilizing the various industries—of course a most necessary movement and the one that should be first considered. But does the public in general realize that this is an exceedingly small part of the necessary whole?

Shortly after the beginning of the war, I took up some work in connection with the first order for 3-in. field-gun ammunition placed in this country. It was necessary for me to make periodical visits to over fifty representative manufacturing plants, both large and small, in all parts of the country. For nearly ten years previous to this time, my work had been along similar lines of interchangeable manufacturing in several prominent plants in the East. This munition work afforded me a unique opportunity of becoming acquainted with the manufacturing practices in different plants producing a wide variety of articles. As my work in itself involved many of the details of production, it gave me an intimate knowledge of the condition of these plants, and the conviction was forced upon me that we need to give far more attention to solving the details of our manufacturing problems. I take up this subject from the point of view of one of the workmen.

An army may be collected and arms and equipment of the very best be given to it, but it will only be an "armed mob" until months of constant and severe drilling and instruction have worked it into shape as a whole. A good comparison can be drawn between the military organization and the industrial. Where the rank and file in a military organization may possibly be brought to a state of fair efficiency in eight to ten months of intensive training, it would take from five to ten years to develop the corresponding degree of efficiency in an industrial organization. The reason for this is that in the military organization the different positions that require training and skill may be numbered by tens, while in the industrial they are numbered by hundreds; also that the necessary degree of skill in military duties may be acquired in much less time than the necessary skill in mechanical work, which is far more detailed and exacting.

Under present industrial conditions the work of creating even the simplest products consists of an almost infinite number of small, even petty, details. Each detailed question must be answered and every trivial problem solved, and all fitted together properly to develop a smoothly running and capable organization. The difficulties are many, both mechanical and human. The human difficulty is the greater. The more we study this question, the more we come to realize that there is no such thing as unskilled labor; that is, there is no work so elementary in itself but some measure of skill in the laborer will produce far better and more economical results than can be attained by workmen entirely unfamiliar with the requirements. The greater the degree of skill in the workman, the more satisfactory in every way will be the final results.

The many "war orders" placed here during the past two years put this country into direct competition, or rather comparison, with the European countries.

Difference Between American and European Manufacturing Development

For the past fifty or sixty years there has been a great difference between the development of manufacturing methods in Europe and in America. Europe has been more thickly settled than has this country, and the growth there has been along intensive lines. Waste products have been made into useful articles of commerce. Competition has been keen, and the successful competitor has been obliged to produce goods of superior merit.

In America conditions were entirely different. The country was growing fast in population, and the demand for the many manufactured products was greater than the supply. The problem here became one of production with an insufficient supply of labor. Production came first. Quality and accuracy were less important factors.

Abroad, with a more nearly fixed demand, the production was more nearly constant, and the labor supply was more than sufficient; so that quality and accuracy were considered more and developed accordingly. Situations were held for longer periods at a time, and thus each workman was able to acquire much skill at his particular branch of work.

In this country the growing demand for manufactured goods and the instability of labor and the insufficient supply of workmen were great spurs to invention, and many labor-saving methods and machines were devised. These, in time, were adapted to some extent by European manufacturers to suit their own needs and requirements. The reputation that this country has acquired as a great industrial nation rests entirely on two factors—large production, which also involves a type of organization

peculiarly its own, and ingenuity or invention. I have found that in discussing the industrial situation with Europeans these facts must be kept in mind and defined, or else each side will be basing its arguments on different premises and no logical conclusion can be reached.

With us, industrial progress means the speeding up of production and the creation of new devices. Abroad, it means the refinement of existing mechanisms and improvement in accuracy and quality.

The Opportunity for Close Comparison of the Two Systems

After more than fifty years of development along divergent lines, with each group adopting some of the good points of the other, the manufacturing methods of Europe and America have now been brought into close comparison on identical manufactured articles—munitions of war.

The specifications for this work were drawn up to suit the best European practice. The construction of the individual parts was fairly simple mechanically. The quantities required were stupendous. The European manufacturers had to expand their productive facilities far beyond anything they had ever dreamed of. The American producers had to adapt their methods to suit the European requirements. At the outset it seemed as if this country, with its great productive organizations, would most conclusively prove the superiority of its manufacturing methods. A glance at the records of the Wall Street markets as these orders were placed will show how great that expectation was.

Work was started with a rush. New plants were built and equipped almost overnight. Then the technical representatives of the various foreign governments arrived to supervise and inspect the work. Soon it became apparent that everything was not going so smoothly as it should. Months passed, and few if any shipments were made. Many plants had not even started to deliver their goods when the contracted time for completion had arrived. German sympathizers were accused of all sorts of preposterous plots to interfere with the work. The foreign inspectors were charged with being incapable, arbitrary and ignorant, thus holding back the contracts. The manager of a large factory engaged in this business told me in all seriousness that he was firmly convinced that the foreign inspectors were determined not to return to their own country until the war was over, and were deliberately holding back the work so as to make it possible for them to stay in this country. A thousand and one excuses were given, all equally wide of the mark, as to why the work was not produced.

Elementary Principles of Manufacturing

In order to understand the situation a clear conception of the elementary principles of manufacturing must be had. There are two general methods of production. The first method is to construct the component parts, neglecting the variations that occur until the mechanism is assembled, and then fit one part to another until the whole is completed. This method is generally followed when the output is small, or when individual special machines are being built. If any repairs should be needed later, the new part, of course, must be fitted to the machine. It would be impossible to incorporate parts from one machine in another without the extra work. The second method is known as interchangeable manufacturing. This consists of so making the various component parts that they may always be assembled without any fitting. The amount of variation allowable is fixed, and this deviation is so arranged that all parts made within these tolerances may be interchanged. For example, a certain pin is to enter a certain hole in another piece. The nominal size of both the pin and the hole is 0.100 in. in diameter. It is impossible to manufacture either of these pieces to the exact size. No matter what care is taken, a variation of, say 0.001 in., will appear. In order that these parts may go together under all conditions, the hole is allowed to vary from 0.101 to 0.100 in. in diameter, while the pin is allowed to vary from 0.100 to 0.099 in. These are fixed limits and cannot be exceeded in either direction. All the important dimensions of the component parts are treated in a like manner.

Finish and quality of work are factors that enter into both methods of manufacturing. If one part slides against another, the surfaces that contact should be smooth: for if they are rough, excessive wear and friction will develop. Some parts may stand clear from the rest of the machine. If these parts should be rough, it would not ordinarily affect the operation of the mechanism, though in projectiles, where the air itself is a vital half of the mechanism in action, even this cannot be conceded. Yet, in any event, it is good practice to hold the quality of all work as high as possible, because the character of the work that is invisible is usually judged by the quality of the work that is visible. Also because it is almost impossible to teach the workman to slight some part of his task and yet to give due attention to those operations that must not be slighted.

Some parts may be soft and still perform their functions satisfactorily, others must be hard. The physical characteristics of the material for those parts that have a low factor of safety must be accurately determined and the results strictly adhered to. This involves a series of tests to prove that both the composition of the metal and its condition meet the specified requirements.

Classes of Interchangeable Manufacture

Interchangeable manufacturing itself may be graded into many classes. As the requirements of the finished article become more severe, every detailed process entering into its production becomes more exacting in its nature. The production of the better class of interchangeable work creates conditions with which those employed in the less exacting class are entirely unfamiliar. Only the fundamentals remain the same.

The foundation of the whole structure of interchangeable manufacturing is uniformity. Opposed to this is the fact that no matter what care is exercised, variations of some sort will develop in every process used and in every determination made. This must always be kept in mind, and only those methods that will reduce variation to a minimum should be used.

The most accurate method of securing uniformity in dimensions with the facilities ordinarily available is by means of comparative, rather than direct measurements. For example, two different men making a direct determination of the size of the same object, using the same instruments, will seldom obtain exactly the same results.

The more skillful these men may be in regard to the particular work, the closer the results will be. But a slight difference at the least will always be probable. Two men determining the size of the same object, using a model piece as a standard to measure against, and thus making a comparative measurement, will usually obtain the same result. In order to eliminate as far as possible the variation due to this difference in direct measurements a physical standard should be established. For example, the measurement of one yard is legally determined in Great Britain as the distance, at 62 deg. F., between two transverse lines on two gold plugs in a certain bronze bar kept at Westminster. This physical standard makes possible the definite decision of any question that may arise in regard to the length of a yard. The most satisfactory standard for mechanical use is a model. This model, once established, becomes the standard for all dimensions and the court of last appeal. All tools and equipment must be made or adjusted so as to reproduce this model as closely as possible.

Determining Allowable Variations

As it is out of the question to reproduce this model exactly in large quantities, the amount of variation that is allowable should next be determined. The amount of these tolerances is controlled by two factors. First, the requirements of the finished product; second, the accuracy of the manufacturing facilities available. The smaller these limits are kept the more severe the manufacturing conditions become.

In order to maintain these tolerances gages are used, commonly made of steel, hardened and accurately ground to size. For example, a hole in a certain piece is to be made between the sizes of 0.101 and 0.100 in. in diameter. The gages employed to verify this dimension would consist of two cylinders of steel, one cylinder corresponding in size to the largest allowable diameter of the hole, the other to the smallest. The holes must be so made that the smaller cylinder will always enter it, while the larger will not. If the hole meets this requirement, it proves that it is made within the allowable variation. If it does not pass this test, it should be corrected or discarded. For example, if both cylinders enter, it is too large; while if neither enters, it is too small. This is sufficient to indicate the general nature of limits and gages. As it is impossible to use the model as a standard for the allowable variations, because it is the standard for the exact sizes desired, it is good practice to establish a set of master gages to serve this purpose. These master gages should be duplicates in form of the working gages and should only be used to verify, by comparative measurements, all gages used in the course of the work.

The dimensions of the parts are not always the only factors that must be uniform in order to obtain the desired results in the finished mechanism. Sometimes it is necessary to use a certain composition of material. Frequently it is required that certain parts be of a specified strength or that they perform some unusual function. Some details may need to be handled in a special manner. All such information should be embodied in written specifications, to guard against the many possibilities of overlooking some vital factor. The specifications will probably be revised from time to time, because it is impossible to foresee all the contingencies that may arise.

In order to duplicate the various parts accurately and inexpensively, many special tools, jigs and fixtures are needed. A jig or a fixture is a device for holding the material in its proper position while some operation is performed upon it. Each individual operation requires a separate fixture. This equipment must be so made as to reproduce the model within the prescribed variations. The type of appliance that may give satisfactory results on some grades of interchangeable work is often entirely unsuited for the production of the better grades. Here, as in all the other processes, the more severe the requirements of the finished product the greater the skill and the closer the attention needed for the construction of the equipment. The same is also true of all the machinery that these fixtures are to be used upon.

The actual production of the work consists in placing the raw materials successively in the various machines and other facilities provided, and there performing upon them the required operations. It is most important that the persons who do the physical work of operating the machines understand thoroughly their duties, otherwise the most careful planning and workmanship that may have gone before will be nullified. An untrained man working at almost any of the operations will not only be the most expensive in the long run, but he can never produce entirely satisfactory results. The workman must be familiar not only with the mechanical operation of his machine, but also with the requirements of the work in hand. You cannot take a man from one class of work with which he is familiar and obtain satisfactory results from him on another class of work with which he is unfamiliar, even though he should operate the same type of machine in both cases.

The Inspection Service and Assembling

In order to insure the satisfactory completion of the many parts an inspection service must be maintained. The inspectors are furnished with suitable gages and it is their duty to see that all work, before it passes to the succeeding operation, has been correctly completed. If the inspection service is to be efficient, it must be composed of persons of good judgment and well trained in the handling of the gages. They must also be thoroughly acquainted with the requirements of the product. The gages are usually expensive and comparatively delicate instruments, and if they should be abused, they would soon be rendered useless. Here, more than anywhere else, untrained service is absolutely valueless—not merely valueless, but in fact a wanton destruction of expensive instruments. The wear on gages even when properly used is considerable, much greater than is generally realized; and if the inspection service is to be efficiently maintained, provision for the periodical verification of the gages must be made.

The assembling department furnishes complete and definite proof as to whether or not the necessary attention has been paid to the details of all the foregoing factors. If the component parts may be assembled without fitting, and the completed mechanism operates correctly, it is most conclusive evidence that the many details have been taken care of. On the other hand, if fitting is necessary, or if the finished product fails to perform its functions, it is equally conclusive proof that some one has neglected his duties, or that some vital factor has been overlooked; and an investigation should be made at once to locate the faults and correct them at their source.

I have given here only the briefest outline of the fundamental requirements of interchangeable manufacturing. It would take a much longer paper than this to even sketch the elementary principles of any one of the main heads, which may be named as follows—the model, the tolerances, the gages, the specifications, the manufacturing equipment, the actual production, the inspection and the assembling. All the work preliminary to the actual production requires the services of highly skilled men and the expenditure of much time and thought. It would take, at the least, five years of strict training to educate a workman to be capable of performing any part of this preliminary work in a satisfactory manner. There is no short cut that will develop the necessary skill in a shorter time. It takes from three months to three years of careful instruction to train a man to perform any of the many productive operations. No accurate estimate can be given for the time it would take to build up a smoothly running organization composed of these many types of skilled men. There is so much of that uncertain element, human nature, involved in this process.

Very Little Interchangeable Work Turned Out in United States

This brief summary will indicate the nature and the requirements of interchangeable manufacturing of the best grade. Very little of this class of work is produced in the United States. Only a few plants establish a model. Their gages are their standards of measurement. Many places do not even keep apart a set of master gages for standards. The various measuring instruments and the personal skill of the mechanics making or inspecting the working gages form these standards. Complete specifications are a great rarity in American practice. The memories of their older employees serve this purpose. Some organizations do not even have a distinct inspection department. The machine operator is furnished with gages, or is supposed to have measuring tools of his own, and gives the product all the inspection that it receives. In some cases where the desired standards are not high it is possible to combine some of these various functions and obtain passable results, but at the best it is a doubtful economy.

The production of small arms and of ammunition for field artillery is the most exacting type of interchangeable manufacturing. The allowable limits of error in both the dimensions and the functioning of the finished product are very small. To facilitate the rapid production of the ammunition in particular, in many cases the orders for the several different parts of the round were divided among a large number of establishments. In some instances several of these units were to be assembled at the loading plant before they would be shipped to the front. In other cases the units would not be assembled into the completed round until the shell was needed in the gun on the firing line. As far as possible all parts containing any detonating charges were kept separate from those containing the explosive charges, for the sake of safety in transportation.

All parts that are to be assembled on the field must be absolutely interchangeable. Tools for making corrections in size or for fitting one part to another are seldom available on the firing line. Neither is the loading plant equipped with tools for fitting together the component parts that are received from a large number of separate factories.

The individual parts of the small arms must be absolutely interchangeable if they are to meet the requirements of military service. Although they are shipped as assembled units, repairs must often be made on the field. This makes it necessary that the arm may be disassembled, a new part inserted, and the arm reassembled without the aid of tools. Otherwise every piece of equipment that gets out of order must be shipped back to the arsenal or manufacturer for repairs; a procedure that would keep at least 20 per cent. of the equipment constantly out of action.

A Serious Mistake at the Outset

At the very outset of this work an extremely serious mistake was made. The American manufacturers either assumed that the requisite degree of quality and accuracy was not high, or else they were led to this belief by those who placed the contracts. At all events this belief was universal among the contractors, and they at once made their plans for a huge production, paying little attention to either the accuracy or the quality of the product. In almost no case did they attempt to improve upon these points, any more than they usually did on their own regular work; while in most cases they considered it as rough work, "just to be fired out of a cannon," and did not give these factors even as much consideration as they gave their own product. This was done, too, in spite of the fact that the specifications that formed a part of the contracts stated very definitely what was required. They must have believed that the needs of the countries placing these orders were so pressing that they would take what they could get, and the more of it the better. This is a truly American attitude. Evidently we are not aware of the fact that things military have advanced much beyond the days of cast-iron cannon balls and short ranges, when friction in the air did not make the difference between striking the enemy, your own troops, or vacancy. And the proper functioning of these products was not a matter of dollars and cents, but of life and death for those purchasing them.

As far as I am aware, not a single plant engaged in the manufacture of the field-gun ammunition attempted to develop a model to be used as a standard. Very likely, if one had been furnished, it would have ornamented the directors' room as a souvenir. The manufacturers of the small arms were usually furnished with models, but in few cases were they so used as to derive the maximum benefit.

The tolerances were already established and most of the plants understood them. I know of one remarkable exception, however. The largest and smallest permissible sizes for each dimension were given on the drawings that were furnished to contractors. This exceptional manufacturer inquired which sizes were wanted, as the men in his plant were trained to produce work of the exact size. In this plant I found that the men were ordinarily engaged in the production of heavy machinery that was not even interchangeable. It may be of interest to know that the first shipment from this plant was made over a year late.

The matter of gages is most essential to any type of interchangeable manufacturing; any laxity in regard to it will affect every stage of the production. A model

may be dispensed with in some cases, but this makes it even more important to establish standards in the form of master gages. To my surprise, I found that not only the subject of master gages, but also of gages in general was a closed book to the majority of the plants I visited. After I had been holding forth at some length on this subject to the superintendent of a large plant, he said to me, "This war work has certainly developed the gage end of our business to a point never even dreamed of before in any country." And practically all that I was trying to persuade him to do had been the general practice for many years in a factory where I had worked some seven or eight years before. This was typical of the point of view of the various manufacturers.

Only a small percentage of the factories I visited had the proper facilities for making their own gages. In fact, very few places realized the true situation. The authorities of one large plant, which was built purposely to manufacture these goods, deliberately canceled a requisition for the machinery to make gages, on the grounds that they could purchase from outside sources all the gages they would need. When it became apparent that they could not do this, it was too late to get the necessary machinery. In some cases master gages were furnished to the contractors as standards, and they invariably used these gages in the shop, thus destroying their value as standards from speedy wear and misusage—many workmen actually hammered the gages to make them fit the wrong-sized work—and took no steps to replace them.

Disregard of Specifications

Complete specifications were furnished to the contractors, but little attention seems to have been given to them. These specifications were the results of long experience; properly used, they would have proved invaluable aids in the production. Time after time I was asked about different matters that were fully explained in the specifications. As an example of what this neglect led to, I know of one contractor who had over a million finished parts rejected because they failed to pass the firing test. Upon investigation, it was found that the specifications for the raw material had been entirely disregarded. I know of another case where a plant had fifty thousand shells rejected because the instructions in regard to the heat treatment of these parts were not followed. The manufacturers were continually arguing that this requirement and that were not essential, that they would not affect the operation of the finished product; and yet when they disregarded these factors, the parts invariably failed to meet the prescribed firing test. The American manufacturers felt badly used because they were required to live up to the specifications. This is the greatest complaint that they can make against the actions of the European inspectors.

Having misjudged the character of the work at the outset, it is not surprising that the facilities provided for producing these goods proved, in many instances, to be entirely inadequate. The required accuracy and quality could not be attained. Another factor, also, worked to their disadvantage. This rush of war work led to a great demand for additional machine equipment, not only in this country but also abroad. The regular producers of these commodities could not supply the demand. A large number of plants went into the business of building this machinery. The regular producers increased their factories to the utmost. The outcome was that most of it was built by untrained men, and the results were what might have been expected. I visited one shop where forty or fifty new machines had to be rebuilt before they were usable. I saw a dozen lathes that had been ordered for a toolroom with the centers at least $\frac{1}{32}$ in. out of line. At other places I saw new machinery that had to be discarded entirely because it was not built well enough to produce the quality of work required.

It is only just to say here that great credit is due a few of the old established companies, who refused to hurry or slight their work, or to lower in the slightest degree their standards of accuracy and quality, despite the fact that large bonuses were offered for earlier deliveries. These companies were all too few.

The majority of the tools and fixtures provided were designed for production only. Little attention was paid to the peculiar requirements of many of the pieces. For example, tools that had been used successfully upon bronze failed entirely when set at work upon the softer aluminum, which tore like wood and demanded a sharper cutting angle and a keener and smoother cutting edge. This is typical of the prevailing conditions throughout.

Result of Slighting Preliminary Work

With all this most essential preliminary work slighted or disregarded entirely, it was only natural that the goods were not produced. It takes time to properly prepare for this type of work, and time was the thing most lacking. We should have started over ten years ago if we were to handle this job successfully. After many unsuccessful attempts, the request was made to allow this work to be done in accordance with American practice. The only method in manufacturing that is universal enough in this country to have any claim to that title is the policy of altering the product to suit the equipment provided, rather than making equipment to suit the requirements of the product. One of the foreign representatives remarked to me, "It appears to me that the policy of the manufacturers here is to put the cart before the horse." This is hardly more than the logical development of the practice of the past fifty years.

On the whole the foreign inspectors were quite lenient at the beginning of this work, soon realizing that this class of manufacturing was entirely new to the majority of the plants engaged on it. They accepted work that did not meet the specifications, carefully calling attention to the points in question with the request that they be rectified at once. The American manufacturer assumed from this that the quality of his product was good enough, although the improvements might be desirable, and started to produce parts in large quantities, making few, if any, attempts to improve or correct the work. The inspector would find on his next visit that little or nothing had been done to meet his objections, and usually rejected the lot submitted. The president of one plant protested to the inspector: "I am turning out better work than the B— Co.," he said. "You are accepting their product and not mine. Why?" The representative answered: "You have better equipment and better trained men; therefore, you should produce better goods. At the B— Co. they are doing the best they can. When the men there are better trained they must produce better work."

Those plants that did not attempt to hold even to their usual standards on this work deserve no sympathy for the troubles they were involved in. Even if their ideas in regard to the requirements of this work had been right, what were they thinking of when they planned to do work of a much lower quality than their own? It was such folly. Here is a factory, for instance, which has spent thirty or forty years in building up an organization and in training men to be capable of producing goods of a high quality. How do they dare to let this organization do work of a lower quality, and hope to swing it back to their own class of work at the end of a year or so? Is their reputation only a matter of dollars and cents to them? It is incredible to me that these men should deliberately take the chance of allowing their organization to slip downhill, after the struggle it has been to bring it to the point where it stood.

During a discussion with the president of a large and well-known concern about some of these matters, he said to me, "That is very well, but this munition work is not watch work." He was right in a measure. The requirements in many respects are far more exacting than in watch work. If a watch should fail to run correctly, a train might be missed or an appointment be tardily kept; but if these munitions did not function, many lives would be needlessly thrown away. Watch work is small and delicate and requires a special line of sensitive and delicate machinery to produce it. Otherwise it offers no great mechanical difficulties. It is far more difficult to manufacture small arms and some parts of the field-gun ammunition properly than it is to produce good watch work.

For example, the limit of time allowed for the functioning of the fuses for the European shrapnel is usually less than $\frac{1}{10}$ sec. It may readily be seen that the slightest variation in the sizes or smoothness of the operating parts might easily cause a variation in the timing of much more than this. In this respect it is interesting to compare the requirements of the American fuse with the European. Our fuse is allowed a variation of $\frac{5}{10}$ sec. against a variation of $\frac{1}{10}$ sec. for the foreign fuse. This may be taken as a relative comparison of the effectiveness of American manufacturing methods and European.

Here is a concrete example of what this means. At a range of about 4½ mi., the Europeans can keep their line of fire within 50 yd. of their men. We must leave our men uncovered for at least 200 yd. Thus, neglect of the necessary manufacturing refinements would sacrifice many lives and might lose a bloody battle.

The Handicap of Unskilled Employees

The lack of proper equipment, however, was not the greatest of the difficulties. If all the facilities provided had been the best, and if the intentions of the management had been to manufacture the goods in accordance with the specifications in every particular, the desired results could not have been attained. Indeed, as time went on and the requirements became more thoroughly understood, most of the factories did everything in their power to honestly fulfill them, but were unable to do so. The reason for this is that it was impossible to get enough trained operators to handle the equipment, because our country does not contain them. Many men were employed who had never even seen the inside of a factory before. In other cases where established factories were involved the proportion of unskilled men was so great that the morale of the plant was destroyed. No man can do his best work when he sees the results of his labors destroyed by the ignorance or carelessness of some one else who performs a later operation. Everything was sacrificed to production, and one of the assets sacrificed was the careful and painstaking habits of many good workmen.

The handling of the product told the story as nothing else could. Time after time I was obliged to insist that the parts be carefully kept on wooden trays, to prevent nicking and other injuries. After trays had been supplied in one factory, I saw a man pitching the pieces into a box as he completed them and later picking them out and placing them on the tray—an exact duplication of the burlesque acts of old pantomime clowns. The protest that followed against this practice was considered as the act of a crank by the foreman of that department.

At another plant I saw a man carefully file off the burrs and scratches from some parts and throw the work into a large box nearly full of similar pieces, thus carelessly destroying the results of his labor. He did not know any better and nobody took pains to tell him. These incidents are typical of what I saw in nearly every factory I visited.

The whole fact of the matter is that we lack a sufficient number of trained and skilled men to properly handle any great amount of this work. We need them in our own lines, too. We cannot go on forever as we have been doing. Every point in which we have failed in the production of munitions must be corrected in the manufacture of our own goods, if we are ever to hold great markets. We failed in this work not so much because of the severity of the specifications, as because of the fact that we have been satisfied heretofore with so little of craftsmanship. When our results are "good enough," our standard of achievement has been attained.

It has been characteristic of most American plants to feel that their own methods are a little better than the "ordinary commercial practice." This is proved by the fact that almost everybody regarded the munition work as "ordinary commercial practice," and then, considering this same practice as something not quite so exacting as their usual methods, neglected many of their everyday precautions with most disastrous results.

Inspection Was Considered a Necessary Evil

The whole inspection situation was a nightmare. This most vital part of interchangeable manufacturing was considered a necessary evil, and little intelligent planning was done to prepare for it. Generally it was the last factor to be considered. Every effort was put forth to provide some facilities for production, while the matter of providing gages and planning for the inspection service took second place—that is, when the subject was considered at all. The result was that when the machines were ready to produce there were no means at hand to verify the results. Many firms started without them, which merely resulted in the production of scrapped pieces.

Most of the shop inspectors were untrained men—many entirely ignorant of mechanical work—as their duties were considered elementary. "All they had to do was to put the work through the gages." This seems to have been the conception of both the manufacturers

and the inspectors. They proceeded on that basis, with the result that thousands of dollars' worth of gages were destroyed and hundreds of thousands of dollars' worth of parts were made, only to be rejected because of inaccuracies.

The gages wore out rapidly and no steps had been taken to replace them. Time after time I have seen the production stopped entirely because of the lack of gages. Few plants maintained an efficient method of verifying these most necessary aids to production and so the whole situation was always one of uncertainty and doubt.

I was at one plant where only two thread gages had been provided, one of them inaccurate, to verify the most essential dimension on the product they were making. The average number of pieces that a thread gage can measure before it is worn out is about five thousand. After fifty thousand parts had been completed I visited the plant again. The same two gages were being used. This company was very indignant when it discovered that it had to correct the entire lot before any would be accepted. All these pieces had been measured with the gage.

The Rush for Gages and Need of Gage Makers

When it finally became apparent that this subject could not be neglected, there was a great demand for gages. There are only three or four plants in the United States that have the men and the equipment to make these articles accurately in large quantities. These gage makers soon had more business than they could handle and nearly every small machine shop in the country went into this line of work. The companies ordering the gages had only a hazy notion of what was required and many of the men who were trying to make them knew even less. The chief draftsman of a large corporation engaged in munition work admitted to me, "I don't know anything about gages. I never saw one until we started this work." The resulting gages in many cases were worse than none at all.

When we consider the great amount of manufacturing done in this country and then count the number of men we have who are skilled in the making of gages, we need no other evidence to convince ourselves that interchangeable work of good quality is almost unknown here. The president of one of the largest manufacturing companies in the country recently said publicly that the number of skilled gage makers in the United States was not over 3000. This is a liberal estimate. We need 50,000 of these men to carry on our own work as we should.

The infallible test of the degree of success obtained is the assembling. In order to complete the work it was necessary in many instances to equip the loading plant with machinery and tools before the parts received from the several factories could be assembled. This caused many delays and great expense, all entirely unnecessary. Practically none of the plants manufacturing the small arms was able to assemble the component parts without fitting them to one another. This made them no longer interchangeable and destroyed half their value as a military weapon. At one plant the foreign inspector, before accepting a large lot of rifles, disassembled some half dozen guns, mixed the parts together, and then tried to reassemble them. He could not do it. It was necessary to pick out the parts that had been fitted to one another before it was possible to do this. The whole lot was returned for correction, much to the chagrin of the manufacturer.

One of the Russian engineers remarked to me: "It is the strangest thing to me that when I started to come to this great industrial nation I expected to learn many things. But to my surprise I find that I must act as instructor in every plant I visit."

"American Practice" Must Undergo Radical Changes

The representatives and the inspectors who have been sent here by the several foreign governments will undoubtedly be considered as authorities on American manufacture on their return to their own countries. The reports they will carry home will unfortunately be far from complimentary. If this country is to have any chance of competition with the European industries in their own markets, it will be necessary for us to meet their conditions. In order to meet their conditions "American practice" must undergo some radical changes.

With the cruder types of manufacture, such as automobile trucks, locomotives, motorcycles, railroad cars, agricultural machinery, etc., the American plants have done far better. But where the work required any great degree of accuracy, uniformity and quality, our record has been a flat failure.

The American objective is to produce goods; produce them in quantities and produce them cheaply. Every other consideration is subordinated to production. Craftsmen are few and far between here because we have no place for them in our scheme of production.

A craftsman, to my idea, is a man who takes pride in the work and skill of his hands and head; who feels that each result of his labor is a monument to himself; a man whose enthusiasm and consciousness of power prevent him from doing any work but his very best. No man can do justice to his own capabilities unless he is interested in, and proud of, the results of his labor. And the manufacturer must realize that he should have a vital interest in the proper training of every one of his workmen, and should use every means in his power to foster true craftsmanship in every branch of his establishment. Those problems that have mastered us in the production of munitions have mastered us in the manufacture of our own products, although we may not yet entirely recognize the fact.

The way is long and the time is short. If we do not profit by our mistakes, those "world markets" now glittering so dazzingly before our eyes will be ours only so long as nobody else is in a position to supply them—and no longer.

Vertical-Attachment Kink

By D. E. Mapes

In taking off the vertical milling attachment on a standard make of miller I experienced considerable trouble with the four-part ring dropping out of the head holder when the latter was tipped too much.

To overcome this annoyance, I took four ½-in. gas-pipe spacers ⅞ in. long and slipped them over the four holding bolts and brought the nuts down firmly with my fingers. In this way the ring is held in place while the head holder is being put on or taken off, and accidental breakage of the rings by dropping is prevented.

Raising the Harmony Tone in the Shop

By A. Towler

Perkins & Johnston were just as busy as possible. Men were at a premium, orders were coming in every day, and the filling of them was not up to schedule. Carl Janeson, one of the handy boys in the shop, had just quit work. Mr. Perkins sent for Carl and the foreman to come into this office. "Why did you quit, Carl?" said Mr. Perkins. "Why," said Carl, "Jim, the foreman, told me my work was a kid's job, and the boys in the shop laughed at me; so I quit, as I thought I ought to be doing a man's work."

The result was that a man left a job which, though it might be considered a boy's task, was nevertheless important. The trouble with some foremen and supers is that they imagine they carry all "the eggs in their basket." In other words, all the important work is being done by them. But, as a matter of fact, every operation performed in the shop is important. If the boy who chips the castings does a poor job, it means that the operations that follow will become more difficult; so his work is important. If the fellow who planes the pieces for the toolmaker does a good job, he makes it easier for the operations that follow.

When a man is given work that is not the most important in the shop, he should not be given the impression that any kind of result will do. He should be shown the importance of his task. This can be done without the workman's getting such a swollen cranium that it will be necessary for him to use a shoe horn to get his hat on.

This all reminds me of a story I heard when a shaver. The chief engineer was showing a visitor around his plant and took great care to impress on the latter the great responsibility that rested on his shoulders. The personal pronoun "I" was ever apparent. Jim, who fired the boilers, suggested that perhaps it ought to be "We" who kept the engines running so successfully. The engineer replied, "No, you only put the coal on the fires." Now Jim, though possessing an abundance of muscle, was considered to be rather short of gray matter.

Soon the engines started to slow down and they almost stopped. The chief ran down to the boiler room and said, "Jim, the steam is down; what's the matter with the boilers?" "Oh," said Jim, "perhaps *we* can remedy that." The chief saw the point and acknowledged that united, harmonious coöperation would produce the best results.

We might take a tip from these two incidents and keep the Carls and Jims happy and contented at their work.

Shipping to Latin America

The following excerpt is from a paper by A. Eugene Bolles, read at the recently held Foreign Trade Convention:

According to Commissioner Chamberlain of the Bureau of Navigation, ship space available for carrying freight to South America has increased 50 per cent. during 1916 over 1914. The total tonnage of ships cleared during the first 10 months of 1914 amounted to 1,700,527 net tons and during the same months of 1916 to 2,516,329 net tons. Foreign tonnage has remained about stationary, the gain being almost wholly in American ships, which in the first period amounted to 171,433 net tons and in the second period to 914,227 net tons, an increase of 433 per cent. The total tonnage of American ships cleared for Argentina during this period of 1916 was nearly 30 times that of the first 10 months of 1914; for Chile six times; for Brazil five times. The American tonnage cleared for Venezuela and Colombia doubled, while there were 66,169 net tons cleared for Uruguay against none at all in 1914.

Tonnage of ships for Mexico, Central America and the West Indies increased about 400,000 net tons during the two years, making a total tonnage to all Latin America of 7,660,192 in the first 10 months of 1914 and 8,840,866 during the same months of 1916.

The total tonnage of ships entered from Latin American ports showed a *decrease* during this period, owing to the fact that, before the war, ships from Europe carried cargoes to Latin-American ports and then proceeded in ballast to the United States, where they loaded cargoes for Europe. Since the war this triangular trade has largely disappeared. The total decrease in tonnage amounted to 890,624 net tons, but the tonnage of American ships entered from Latin-American ports *increased* 3,101,967 net tons, or 154 per cent.

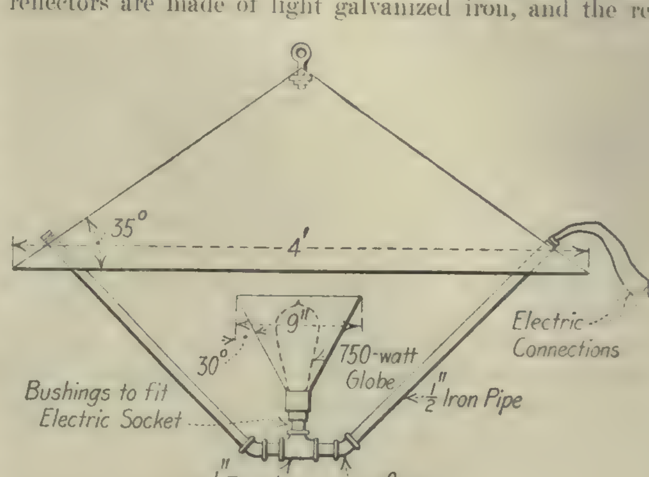
There is much in these figures to cheer the heart of the patriotic American who is hoping for the restoration of our merchant marine.

Comparing the first 10 months of 1915 with the same months of 1916, an increase of 951,632 net tons clearing for Latin America is shown, of which 933,056 tons were American ships. While the total tonnage of ships entering from Latin America increased 1,098,460, that of American ships increased 1,226,923 net tons, foreign tonnage having decreased about 200,000 net tons.

Two years ago American ships made up 25 per cent. of the tonnage cleared for Latin America. Now the Stars and Stripes wave over 58 per cent. of it.

Mill-Lighting Fixture

The homemade indirect-lighting fixture shown in the accompanying sketch is now being used to replace the Cooper-Hewitt lamps in the Tonopah-Belmont mills. The reflectors are made of light galvanized iron, and the remaining parts are of pipe fittings. The lamps were constructed by the electrician and have proven a great improvement in the lighting of the mill.—*Engineering and Mining Journal.*



A MILL-LIGHTING FIXTURE

Specifications for Electric Motor Applications—II

By A. G. Popcke*

SYNOPSIS—A discussion of the starting torque of induction motors and the reduction of voltage on motors larger than 5 hp. Single-phase motors for small powers. Mechanical considerations in motor applications, size, weight, method of driving, supports, guarding against dust and moisture. Back gearing is touched upon and good practice illustrated.

As was previously stated, the starting torque of an induction motor varies as the square of the voltage applied. At normal voltage the starting torque of a squirrel-cage induction motor is as follows:

2-, 4- and 6-pole motors	150 to 175 per cent. full-load torque
8-, 10- and 12-pole motors	125 to 150 per cent. full-load torque
14-pole motors	100 to 125 per cent. full-load torque

It is nearly universal practice to start motors up to 5 hp. at normal voltage. In large sizes, 7½ hp. and above, the motors are started at lessened voltage to reduce the amount of current consumed while starting. Provision for obtaining 50, 65 and 80 per cent. of line voltage is made on commercial starting devices; 65 per cent. is generally used. Where the starting conditions are light 50 per cent. is sufficient, and 80 per cent. must be used where the starting conditions are heavy. At these reduced voltages the starting torques are as follows:

No. of Poles	At Normal Voltage	At 80 Per Cent. Normal Voltage	At 65 Per Cent. Normal Voltage	At 50 Per Cent. Normal Voltage
2, 4, 6	150 to 175	95 to 110	63 to 74	38 to 44
8, 10, 12	125 to 150	80 to 95	53 to 63	31 to 38
14	100 to 125	64 to 80	42 to 53	25 to 31

The National Electric Light Association has recently established permissible starting currents for squirrel-cage induction motors. These values, which represent the average obtained with motors of various manufacture, are given in Fig. 5; they also indicate that for starting torques greater than 80 to 100 per cent. the squirrel-cage induction motor cannot be used, unless the starting current is limited to the values given in Fig. 5. By starting the motor at normal voltage 125 to 200 per cent. starting torque is produced, but the heavy starting current of 8 to 10 times full-load current is usually not permissible nor desirable. In addition to straining the electrical apparatus, the jolt while starting under these conditions may result in mechanical injury to the machinery driven.

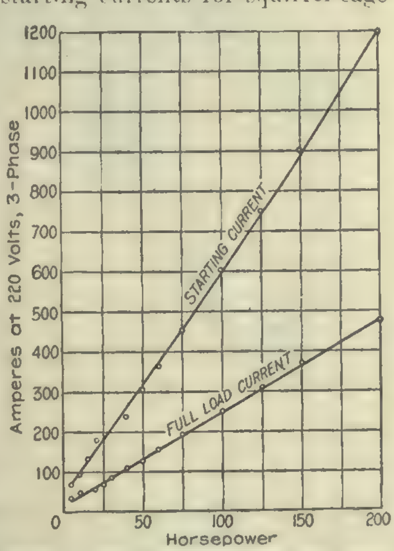


FIG. 5. CURRENT DIAGRAMS FOR SQUIRREL-CAGE MOTORS

In the case of wound rotor motors, the starting torque depends on the amount of resistance inserted in the rotor windings. Full-load starting torque can be produced with full-load current. With this type of motor it is possible to obtain a starting torque equal to the maximum torque of the motor (2 to 2.5 times full-load torque) by inserting the proper resistance in the rotor.

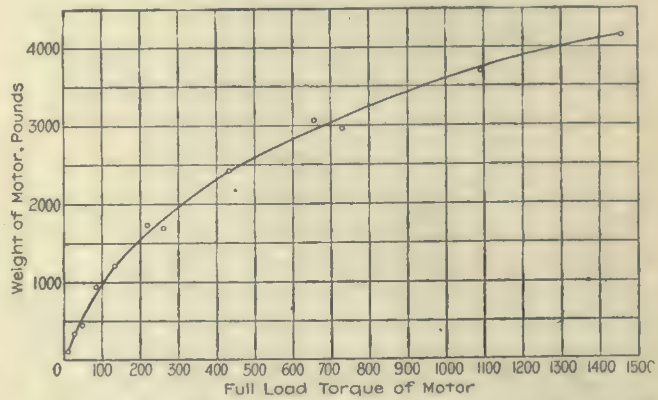


FIG. 6. RELATION OF WEIGHT AND FULL-LOAD TORQUE

For this reason wound rotor motors should be used where it is desirable to keep the starting current to a minimum, especially where starting conditions require a heavy starting torque.

For heavy starting duty, manufacturers also supply a special squirrel-cage motor. The standard squirrel-cage motor is fundamentally a constant-speed machine (speed only varies 4 to 6 per cent. from no load to full load). The proportions of its design can be modified, however, so that its operation will be similar to that of the direct-current compound-wound machines previously discussed. This modification consists of an increase of rotor resistance, having the effect of increasing the starting torque and decreasing the starting current at the expense of speed regulation. Greater slip is produced, the efficiency is lowered and heating is increased. On these motors the starting torque is 35 to 50 per cent. greater than that given for standard motors. The starting current is approximately 15 per cent. less. The maximum torque remains the same as the standard motor (2.5 to 3 times full-load torque). The slip is approximately 8 to 12 per cent., or twice that of the normal motor. The efficiency is approximately 3 to 5 per cent. lower than that for the standard motor, the power factor remaining the same. This special squirrel-cage motor should only be used where the load is intermittent. In applications where starting conditions are heavy, but the load is continuous after it has been started, a wound rotor motor should be employed as a more economical method of drive is thereby produced.

In addition to supplying wound rotor motors for continuous duty they are furnished for intermittent duty.

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They are designed to produce heavy starting torque. The starting and maximum torque obtainable on these motors is twice the rated torque, the rated torque being based on a ½-hr. intermittent rating. This type of motor is used largely on cranes and hoists. The ratings are shown

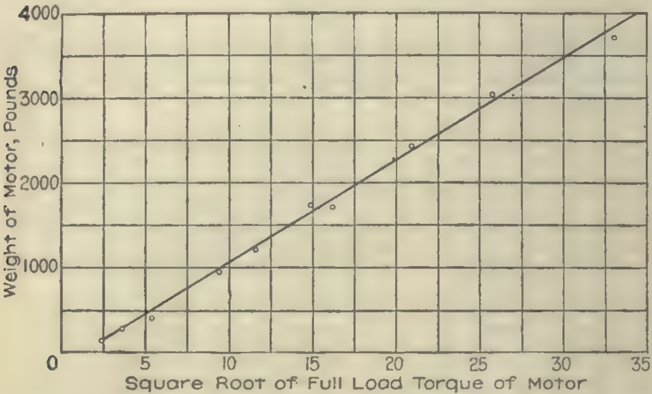


FIG. 7. RELATION OF WEIGHT AND SQUARE ROOT OF FULL-LOAD TORQUE OF MOTOR

in Table 4, which gives the values of both rated intermittent torque and maximum torque, which is the same as the maximum starting torque obtainable.

In addition to the polyphase motors described, single-phase motors are also employed in isolated districts where two- or three-phase lines are not available. They are also used where fractional horsepower is required. This type of motor usually comes in sizes up to 10 hp. Three types are marketed; they differ in the method of starting employed—split phase without clutch, split

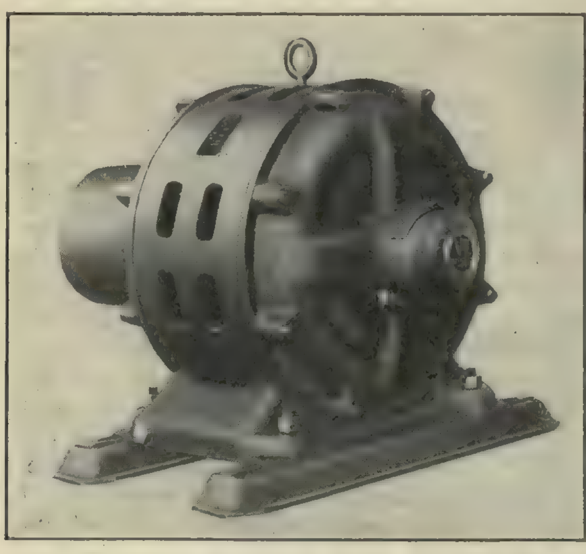


FIG. 8. MOTOR PROVIDED WITH SLIDING BASE FOR BELTED SERVICE

phase with clutch and repulsion-starting and induction-running type.

The no-clutch and clutch types are furnished in the following capacities:

	60 Cycle	25 Cycle
1/20	1,725	1,425
1/12	1,725	1,425
1/8	1,725 and 1,140	1,425
1/6	1,725 and 1,140	1,425
1/4	1,725 and 1,140	1,425
1/3	1,725 and 1,140	1,425
1/2	1,725 and 1,140	1,425
3/4	1,725 and 1,140	1,425

The repulsion-starting and induction-running type is supplied in capacities as follows:

Hp.	60 Cycle R.P.M.	60 Cycle R.P.M.	25 Cycle R.P.M.
½	1,725	1,150	1,425
¾	1,725	1,150	1,425
1	1,725	1,150	1,425
2	1,725	1,150	1,425
3	1,725	1,150	1,425
5	1,725	1,150	1,425
7½	1,725	1,150	1,425
10	1,725	1,150	1,425

In selecting the proper type of motor for a given application the following considerations are necessary:

The no-clutch motor is successfully used on all applications where a starting torque equal to or less than full-load torque is required and where, owing to the size of the motor or the allowance of the central station, the amount of starting current is not important.

The clutch motor is successfully used on all ordinary applications where liberal starting torque is required. The starting current necessary is less than with the no-clutch type, and the clutch also provides overload protection for the windings of the motor under excessive overloads for short periods of time.

The repulsion-induction type is successfully used on applications where the starting torque required is very high and the lowest possible starting current is necessary.

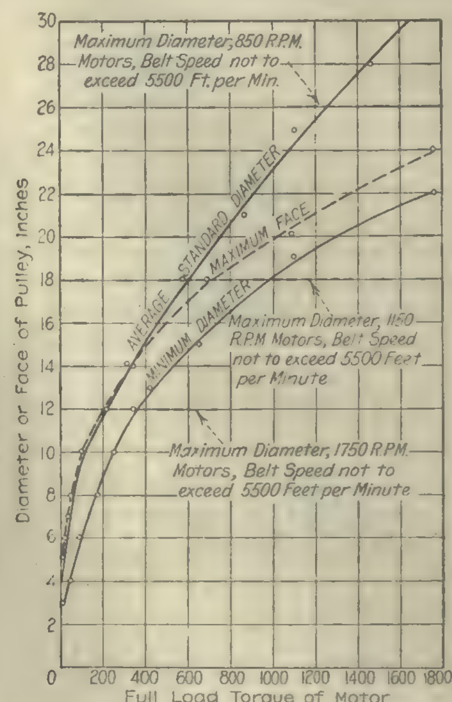


FIG. 9. RELATIONS OF MOTOR TO PULLEY DIMENSIONS

The maximum permissible starting-current values for an installation of a single-phase motor, installed and connected to its load as lined up by the N. E. L. A., which conforms to commercial motors on the market, are as follows:

½ hp. and below	220 volts, 15 amp.
½ to 1 hp.	220 volts, 20 amp.
1 to 5 hp.	220 volts, 15 amp. per hp.
Above 5 hp.	220 volts, 11 amp. per hp.

In addition to specifying the various electrical characteristics, the mechanical parts of a motor should also be given careful consideration before purchase is made.

In making mechanical comparisons of motors, the full-load torque and square root of full-load torque, which are given in Tables 1 and 3 for direct- and alternating-current motors, are frequently used. These values are determined from the formula $\frac{5250 \times \text{hp.}}{\text{r.p.m.}} =$ torque at 1-ft. radius.

The size, weight and cost of an electric motor are determined primarily by the torque. Plotting a curve between the torque and weight, for instance, results in a curve as shown in Fig. 6. This is parabolic in form. A more convenient curve for analytic purposes is obtained by plotting a curve with square root of torque and weight as ordinates. This is illustrated in Fig. 7.

The fact that over limited variations of square root of torque of ratings the relative costs or weights vary

TABLE 4. RATINGS OF INTERMITTENT WOUND ROTOR MOTORS, VALUES OF TORQUE AT RATED LOAD AND MAXIMUM TORQUE ARE GIVEN

Poles	4		6		8		10		12	
Full Load Speed	1,750		1,150		850		690		580	
Hp. on ½-Hr. Basis	Rated Torque	Max. Torque	Rated Torque	Max. Torque	Rated Torque	Max. Torque	Rated Torque	Max. Torque	Rated Torque	Max. Torque
2	....	..	8.8	18						
3	8.8	18	13.1	26						
5	14.6	29	22	44						
7½	....	..	33	66	43.8	[illegible]	54.7	110		
10	....	..	44	88	58.4	117	73	146		
15	....	..	66	132	87.5	175	110	220		
20	....	..	88	176	117	234	146	292		
25	....	..	110	220	146	292	182	364		
30	....	..	....	...	175	350	219	438	262	524
35	....	..	....	...	204	408	255	510	306	612
50	....	..	....	...	292	584	365	730	437	874
75	....	..	....	...	437	874	547	1,094	655	1,310
100	....	..	....	...	....	...	730	1,460	875	1,750
150	....	..	....	...	....	...	1,100	2,200	1,310	2,620
200	....	..	....	..	....	..	1,460	2,920	1,750	3,500

in direct proportion to the square roots of torque of the respective ratings, produces a very simple method for comparing weights or prices of different ratings. Formulas for estimating prices or weights can be estab-

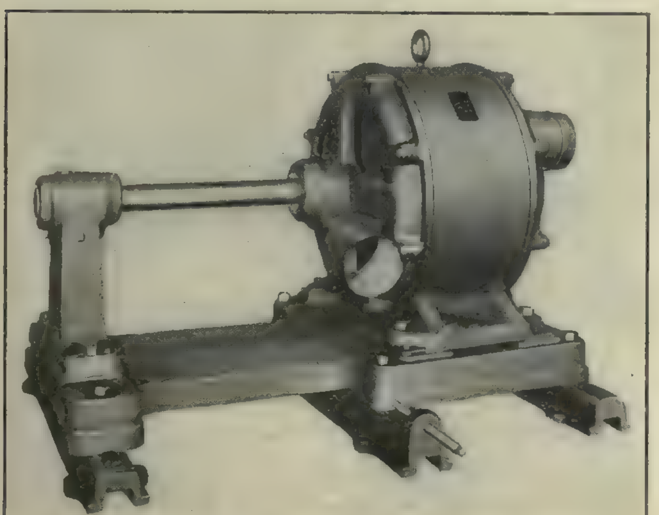


FIG. 10. THREE-BEARING MOTOR FOR BELTED SERVICE

lished. Relative costs of various types of motors can readily be compared. It gives purchasing agents or shop managers a convenient method of comparing costs, weights and other mechanical features of various proposed motor equipments.

Motors are supplied for belted, geared, chain or direct-coupled drive.

For belted drive, manufacturers supply a pulley and also a sliding base with which to adjust the belt tension (Fig. 8). Fig. 9 shows the limitations of the pulleys supplied. The curves show the relation between the average standard pulleys supplied and the rated full-load torque of the motor given in Tables 1 and 3. The maximum face is limited by the length of shaft extension. The belt pull and, hence, the bearing stress due to belt pull on the motor bearing, increases as the size of the pulley decreases. For this reason there is a minimum diameter pulley for successful operation. Moreover, as the diameter of the pulley is reduced the belt slip increases.

Fig. 9 shows the minimum pulleys recommended for various sizes of motor. An example will best illustrate the use of these curves. To determine the pulley limitations for a 50-hp. 850-r.p.m. motor, refer to Table 3. The full-load torque of a 50-hp. 850-r.p.m. motor is 292.

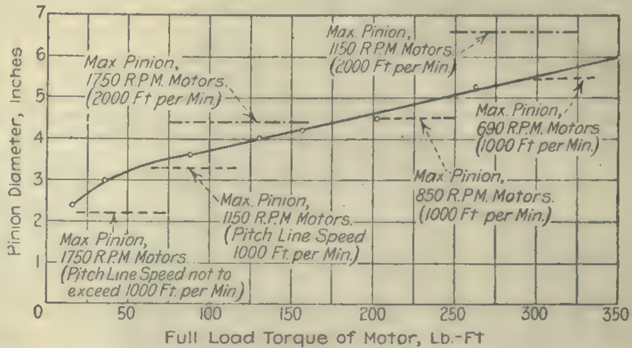


FIG. 11. RELATIONS OF FULL-LOAD TORQUE OF MOTOR AND PINION DIMENSIONS

The average diameter pulley in Fig. 9, shown on the curve, is 14 in., the minimum diameter pulley recommended is 11 in. in diameter and the maximum face is 14 in. For economical operation the belt speed should not exceed 5500 ft. per min. Fig. 9 gives the maximum pulleys for various speeds of motor to guard against exceeding the above belt speed. For example, the full-load torque of a 200-hp. 1750-r.p.m. motor is 584. The

TABLE 5. MOTOR SPEEDS RECOMMENDED TO OBTAIN DESIRED SPEEDS OF DRIVEN MACHINE

Speed of Driven Shaft, R.P.M.	Motor Speed, R.P.M.
600 to 1,500	1,750
350 to 600	1,150
250 to 350	850
150 to 250	690
100 to 200	600
80 to 100	1,150 back geared
50 to 75	850 back geared

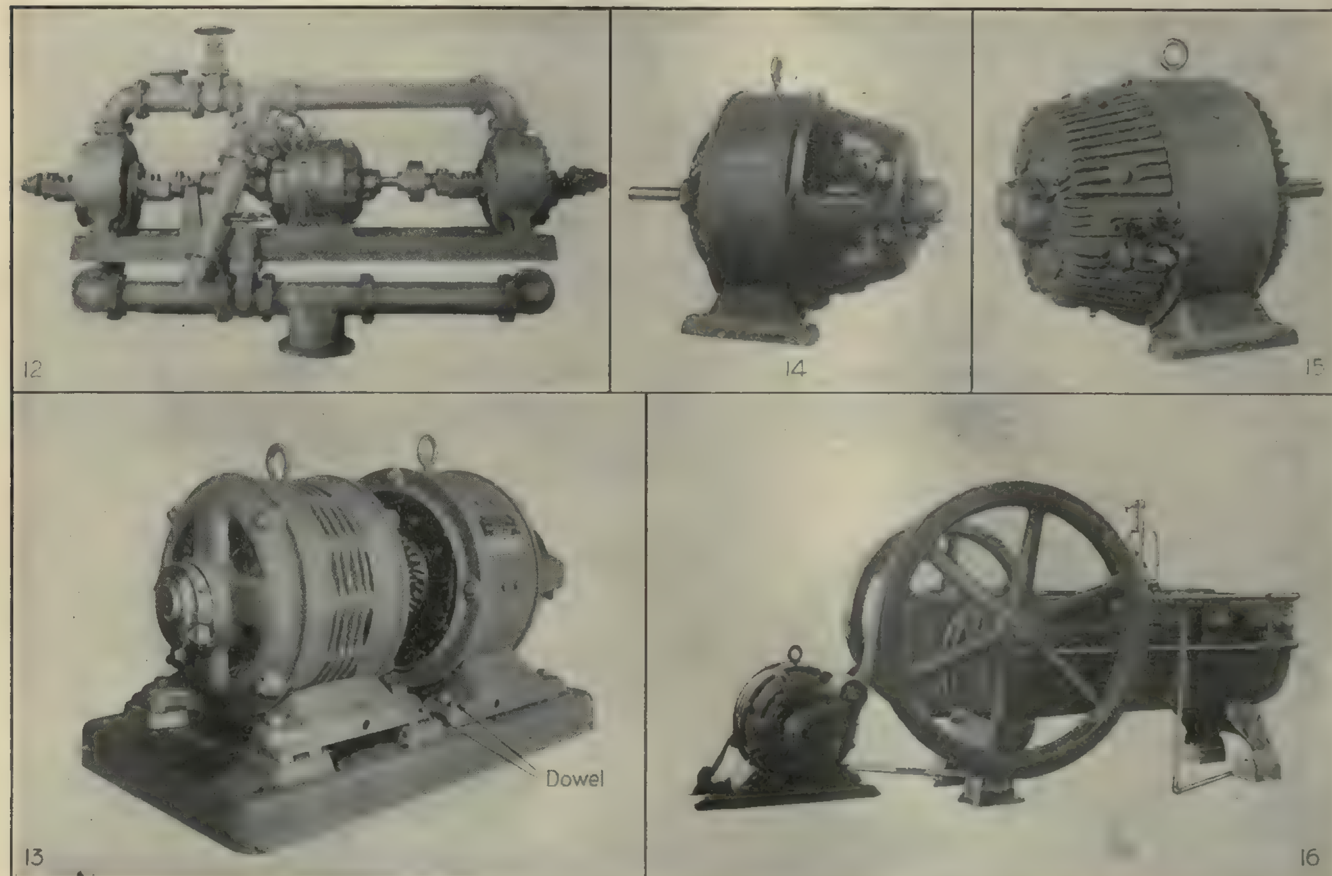
curve shows that for this torque an 18-in. pulley is usually employed. On account of the belt-speed limitation, a 12-in. pulley only can be used. Since this pulley is below the minimum recommended, in this case a motor with an outboard bearing should be used. In general, the larger high-speed motors are used for direct coupling and the question of belting does not come up. If it does, it must be handled as explained. In general, for motors up to 250 hp., 580 r.p.m., a two-bearing motor can be used. Above this capacity, however, a three-bearing motor should be used (see Fig. 10).

For geared drive, limitations similar to those given for belt drive are shown in Fig. 11. The curve indicates the relation of minimum pinion to rated full-load torque of motor. For instance, a 15-hp. 850-r.p.m. motor, full-load torque (Fig. 3), is 87.5. The minimum pinion that can be used successfully is 3.6 in. in diameter, the diametral pitch is 5. This figure also gives limitations in the diameter of pinion so as not to exceed 1000 ft. per min. and 2000 ft. per min. for the various speed motors where these gear speeds can be exceeded; 1000 ft. per min. should not be exceeded where quiet operation with steel gears is desired. Where rawhide, cloth, micarta or other special composition pinions are employed, a speed of 2000 ft. can be used. Up to 75 hp., 850-r.p.m. motors

can be geared without the use of an outboard bearing. In larger sizes, however, an outboard bearing is recommended.

The limitations given for geared drive also apply when chain drive is used, the minimum diameter of the sprocket being the same as the minimum diameter of the pinion. For coupled drive, either a flexible or a rigid coupling is used to connect the motor to the machine drive (Fig. 12).

For geared, chain or coupled drive, a motor without a sliding base should be specified; and in setting the motor in place a dowel, as shown in Fig. 13, is recommended to insure exact alignment in case the motor is taken off the base and later put back in place.



FIGS. 12 TO 16. VARIOUS MOTORS AND THEIR APPLICATIONS

Fig. 12—Motor with double extended shaft coupled to pumps. Fig. 13—Dowel pin recommended in geared or coupled drives. Fig. 14—Motor with semi-inclosing covers. These do not interfere with ventilation, but prevent dirt from entering the motor. Fig. 15—Totally inclosed motor with ribs to increase the radiating surface. Fig. 16—Motor with idler attachment

In specifying the dimensions of motors the dimension which is of greatest importance in making application is the distance from the base to the center line of the shaft. Manufacturing conditions are such that it is impossible to make this dimension exactly as specified. Hence, the following tolerance limits are specified:

On all machines up to and including those having a height of center of shaft above the base of 24 in. and less, limits of plus 0 and minus $\frac{1}{32}$ in. variation from the nominal dimension may occur. On all machines on which this distance is greater than 24 in. the variation shall not exceed plus 0 and minus $\frac{1}{16}$ in. Liners must be used to obtain the exact specified dimensions.

In addition to supplying standard horizontal open motors, electrical manufacturers market motors modified mechanically to suit special conditions. These modifications are semi-inclosed motors (Fig. 14), splash-proof motors (similar to Fig. 14, except that the upper half has a solid cover), totally inclosed motors (Fig. 15), motors with idle attachment (Fig. 16), motors with double extended shafts (Fig. 17) and vertical (Fig. 18) and back-geared motors (Fig. 19).

Semi-inclosed motors are used where small particles may fall into the motor, causing mechanical injury.

Splash-proof motors have the upper half covered with a solid cover to prevent dripping oil or water from working internal injury to vulnerable parts hidden from view.

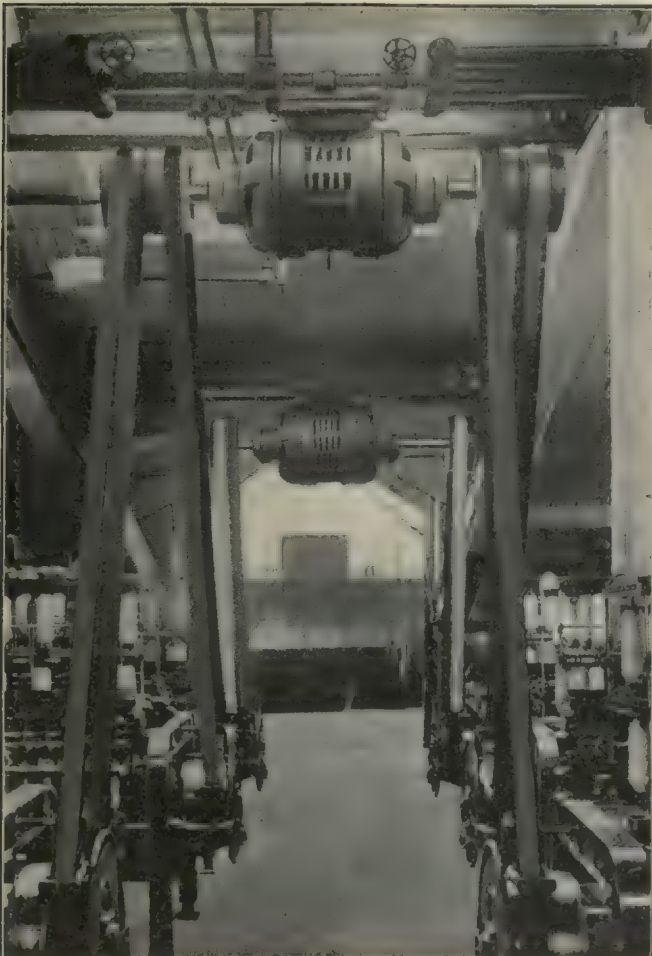
Totally inclosed motors should be specified where injurious dust or gases are present. They can be made weatherproof, but are not designed for immersion in water.

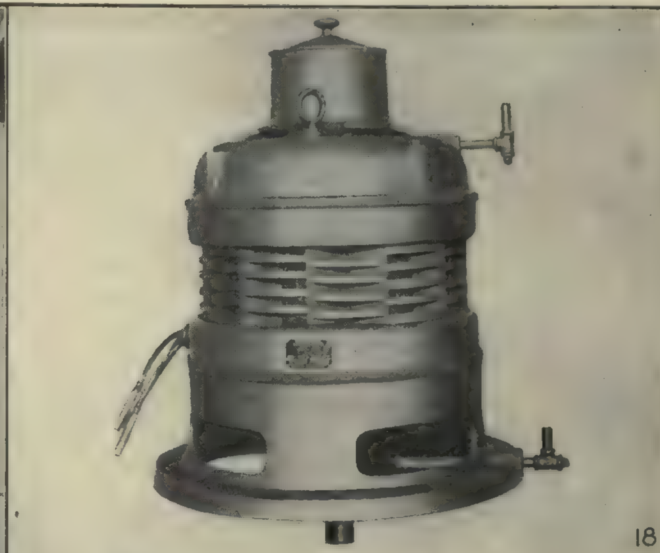
In belted application, where it is necessary to obtain a large speed reduction at small center distances, a good arc of contact on the motor pulley is obtainable by the use of an idler attachment, as shown in Fig. 16. These attachments can be furnished with motors in capacities up to 30 hp. In larger capacities this arrangement becomes bulky. If an idler is required, it can usually be mounted apart from the motor on a foundation, or base, making a far better mechanical construction than that shown in the illustration.

Motors with double extended shaft are furnished where it is desirable to belt, gear or couple off both ends of the motor (see Figs. 12 and 17).

To drive machinery that has shafts in a vertical position, vertical motors are supplied. This type of motor is usually coupled to the machine driven, the coupling being placed at the shaft extension located at the base capable of carrying an additional load, as indicated in Fig. 20.

Back-geared motors (Fig. 19) find application where it is necessary to drive machinery at low speeds and





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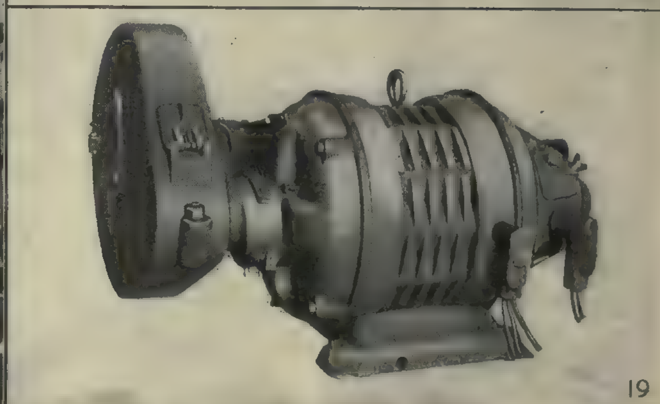

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FIGS. 17 TO 19. VARIOUS MOTOR APPLICATIONS

Fig. 17—Motor with double-extended shafts used for driving four belts. Fig. 18—A vertical motor. Fig. 19—Back-geared motor with dustproof gear housing. Conduit connections are also provided

of the motor. The smaller sizes up to 30 hp. can be belted or geared; the limitations given in Figs. 9 and 11

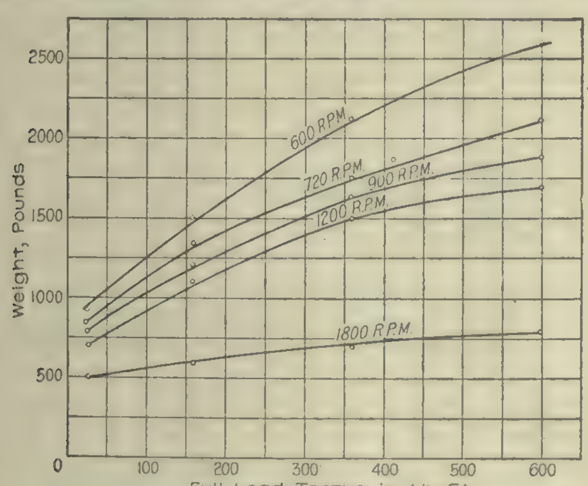


FIG. 20. PERMISSIBLE WEIGHT THAT MAY BE SUPPORTED BY VERTICAL MOTORS

apply. In belting or gearing larger sizes, an outboard bearing should be used. A ball-thrust bearing is to support the weight of the rotating part of the motor and is the use of a countershaft is not desirable or practicable. Table 5 shows for what speed reduction this type of motor can be employed to advantage. The ratio of reduction from motor speed to countershaft speed is from 4:1 to 7:1. The maximum reduction is limited by the size of the pinion and the minimum reduction is limited by the gear speeds.

Back-geared motors can be used for belted, geared, chain drive or coupled service.

Fig. 19 shows the gears of the back-geared motor totally inclosed. The motor shown also provides for making electrical connections by means of conduits. The use of conduits is being specified more and more, not only to accomplish a neater appearing installation, but also to insure maximum safety to operators.

How To Prevent Center Drills from Breaking

By James McIntyre

The cost of broken center drills is a pertinent item in the daily expense account. To overcome breaking the following method has been adopted: Grind $\frac{1}{16}$ in. off each end and draw the body to a light straw.

Engine Lathe-Turret

C. Leslie Farr

In Fig. 1 is shown an inexpensive and efficient turret. It can be made upon the lathe on which it is to be used. With it one has every advantage of the turret lathe, besides having the engine-lathe feeds and being able to cut any thread. The turret shown was made and is used on a Greaves-Klusman 16-in.-swing engine lathe. Details of the turret are given in Fig. 2. It is comparatively inexpensive to make, and for certain classes of work it has advantages that are not present in the regulation turret lathe.

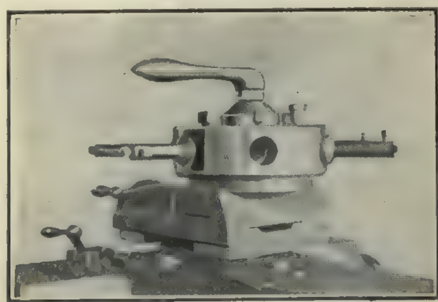


FIG. 1. LATHE TURRET

Defective Machine Tools

By R. W. Green

Two shop superintendents met recently and the conversation drifted to the condition of new tools and machines when received from the makers. Both men had installed equipment that was defective, and both had experienced trouble getting satisfaction from the sellers.

One man claimed that it was the maker's duty to furnish a tool right in every vital point and that a sensible manufacturer would welcome any word calling his attention to any defect in workmanship and be anxious to make corrections. He said that he would continue to complain when things were not right.

The other stated that in nine cases out of ten when tools installed by him have been defective, any attempt to have the maker correct them had resulted in much delay through correspondence and that eventually he had to put the equipment in shape himself. For this reason, he said, he would hereafter simply fix it and say nothing. He did not refer to minor details, but to features that are essential to the satisfactory operation of the tool or machine. Have your readers had a similar experience? We talk about going after foreign trade. Do we take proper care of our domestic trade and treat our customers right?

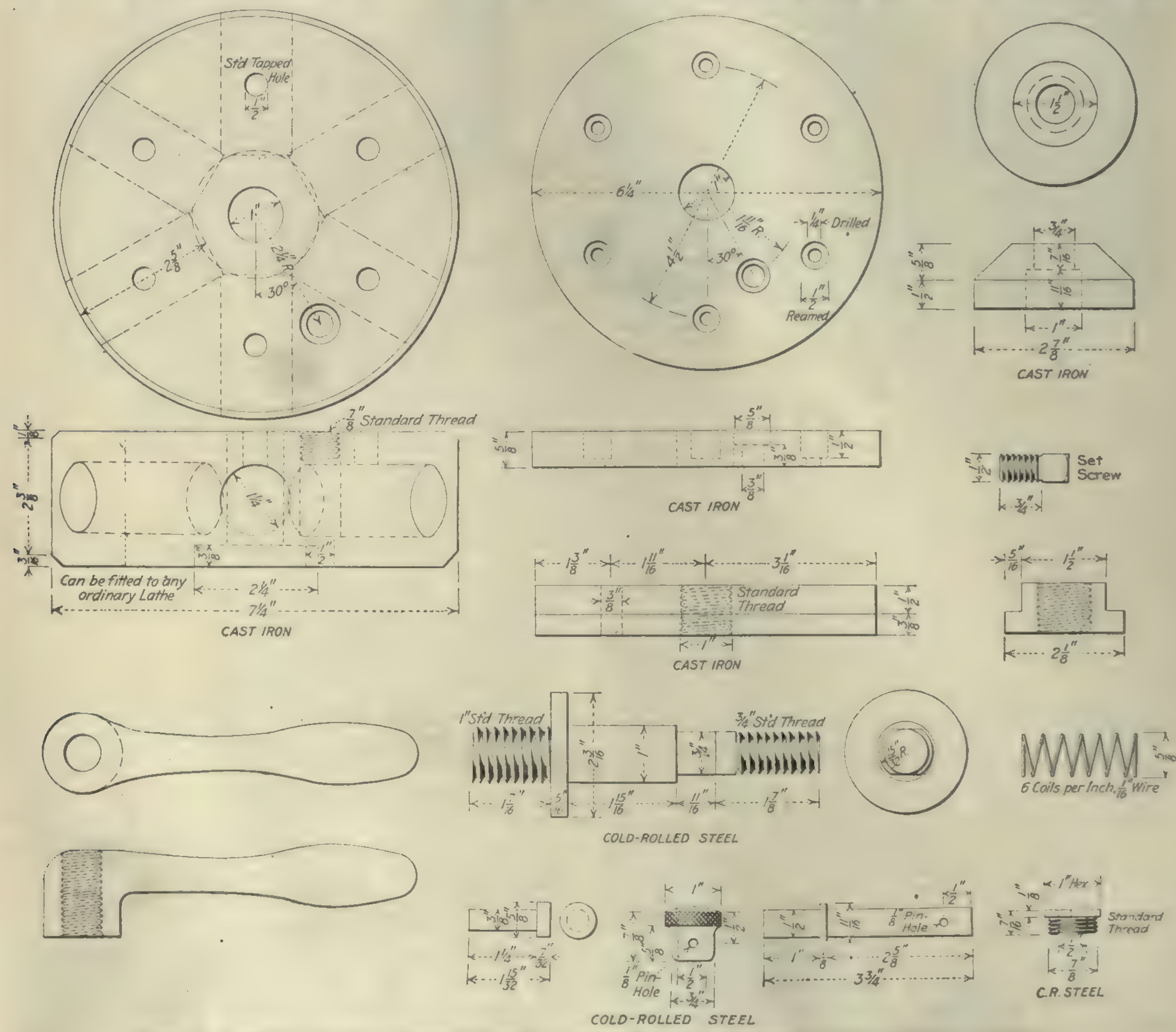


FIG. 2. DETAILS OF AN INEXPENSIVE AND EFFICIENT TURRET FOR A 16-IN. LATHE

Heat-Treatment of Wrought-Iron Chain Cable at Boston Navy Yard*

By F. G. Coburn†

Prior to July 1, 1914, all chain cables for the navy were manufactured at the Boston navy yard, by hand, after the fashion of the old English chain makers, still followed in other chain shops in this country. Experiments had been under way for several years, looking toward a steam-hammer process, and such a process had, at that time, been developed[1]—satisfactory to the extent that it effectively and cheaply welded the chain, but unsatisfactory in that the chain, apparently perfect, would not meet the breaking-strength requirements.

It became suddenly necessary, in July, 1914, to make the process work, in order to supplant hand manufacture. The process seemed to be good, but it was mystifying, indeed, to see apparently perfect chain snap off under test like cast iron. It seemed as if an addition to the process was needed, rather than a change, and heat-treatment suggested itself. There was no literature available on the heat-treatment of either iron or low-carbon steel.

It was peculiar that *hand*-welded chain was successful under test; yet we knew that it was not so thoroughly welded as the *hammer*-welded chain. The latter was very thoroughly hammered, too, and kneaded, so that it should be stiff and strong. In this very stiffness the trouble was finally found.

The distribution of stresses in a studded link under tension is such that there are maxima of bending moment at the ends of the axes of the link and maxima of shear at the quarters. It is well known that iron is weaker in shear than in tension. It was observed that the hammer-welded links always failed in the quarters; that while the hand-welded links stretched freely, the power-welded links would not stretch much prior to breaking.

The following hypothesis was then formulated by the writer, to explain the above phenomena: That the hammer-welded link was so stiff that the shearing stress could build up in the quarters to such a degree that the link would fail by shearing, whereas the hand-welded link was soft and ductile enough to deform under the shearing stress, failure occurring later due to a combination of shear and tension when a higher applied tensile load was reached.

There was no pyrometric equipment available, so in the first experiments, which were necessarily crude, the writer gaged temperatures by eye. Test doublets[2] were heated to a temperature believed to be above the upper critical point, cooled in air and pulled, giving satisfactory results as regards stretch, character of fracture and ultimate tensile strength. Heat-treatment was plainly the answer to the problem.

The writer, therefore, proceeded to equip a laboratory and to equip the shop for temperature measurement. After some experimenting a method of heat-treatment was evolved which gave fairly good results. But these results were not always consistent; and while the plant was put on a manufacturing basis, there were still very puzzling questions arising. It was considered very desirable, indeed, to find out really why heat-treatment was required for power-forged chain and not for hand-welded chain, what the very best heat-treatment should be, how much heat-treatment wrought iron would respond to and, in general, to develop working standards for shop practice.

Properties of Stock Material

At present the iron used for the most important sizes of chain is made by the Burden Iron Co., of Troy, N. Y. In the manufacture of this iron, common gray-iron pig is puddled until the carbon, phosphorus and sulphur contents are correct. Puddle balls weighing 200 or 300 lb. each are then extracted and rolled roughly into muck bars. These are cut into 2- or 3-ft. lengths, piled five or six together, heated to welding temperature and rolled again to give grade B iron. Grade A iron is further refined. It is made by cutting up grade B bars into short lengths of 2 or 3 ft., making these pieces up into piles about 7 in. square, heating to welding heat and passing successively through straight, hexagonal and round rolls down to the required diameters. The outside is formed by slabs 6x1 in., with a 1-in. round bar at the center.

The Government specifications for wrought iron for chain making are in substance as follows:

Grade A must be of best-quality American refined iron, puddled from all-ore pig iron and free from admixture of steel or scrap. The specified limits of chemical analysis are: Phosphorus, not to exceed 0.10 per cent.; sulphur, not to exceed 0.015 per cent. The physical requirements are: Tensile strength, 48,000 lb. per sq.in.; yield point, not less than one-half tensile strength; elongation, 26 per cent. in 8 in.; contraction of area, 40 per cent.

Chemical analysis of Burden iron, made by the chemical laboratory of the Boston navy yard from borings taken from several stock bars, gave the following average results:

	Per Cent.
Carbon	0.10
Silicon	0.10
Phosphorus	0.085
Sulphur	0.008

The average phosphorus and sulphur contents are well within the specifications and did not exceed them in any particular case. The analysis indicates a very good grade of commercial wrought iron.

Twelve tensile specimens cut from a 3¼-in. Burden stock bar were tested and in the following table the results are summarized and compared with the specification requirements. These results, like those of the chemical analysis, indicate a good commercial iron.

	Test Results	Specification
Yield points, lb. per sq.in.	26,100	24,000
Tensile strength, lb. per sq.in.	49,000	48,000
Elongation, per cent	35.5	26
Contraction of area, per cent	50	40

In the heating curve, which is the important curve in connection with heat-treating, the indications of an upper

*An abstract of a graduation thesis prepared by W. W. Webster and E. L. Patch, assistant naval constructors, United States Navy, at the Massachusetts Institute of Technology.

†Member American Society of Mechanical Engineers; naval constructor, United States Navy.

[1]See "American Machinist," Vol. 33, Part I, page 350.

[2]Two links of a chain.

critical point are indistinct and, at first glance, apparently indeterminate (see Table 1).

But a small point shown at 915 deg. C. was duplicated in size, shape and position on all the curves taken, as were also the indications of changes shown by irregularities of the curve from about 825 deg. C. up to 915 deg. C. It may therefore be concluded that the upper critical point is not sharp, but extends over the range indicated, with a well-defined end at 915 deg. C. This phenomenon is explained by the unequal distribution of the carbon in the iron, different parts of which vary in composition from pure wrought iron to 0.2 per cent. carbon, as was determined by metallographic examination. The second and lower critical points are well defined at the temperature indicated. The fact that the actual upper and lower points are higher than those indicated in the iron-carbon equilibrium is attributed to the presence of impurities, especially manganese. In the cooling curve the upper critical range has the same character as in the heating curve, but is about 40 deg. lower.

The practical conclusion from the location of the upper end of the upper critical range on the heating curve at 915 deg. C. is that to anneal or air-quench the chain from above the critical range it should be heated to about

TABLE 1. CRITICAL POINTS FROM HEATING AND COOLING CURVES FOR BURDEN IRON

Critical Point	Burden Stock Heating, Deg. C.	Burden Stock Cooling, Deg. C.	Average of Heating and Cooling, from Equilibrium Diagram: Pure Iron, Deg. C.	0.1 Per Cent. C, Deg. C.	0.2 Per Cent. C, Deg. C.
Upper retardation	915	875	900	850	800
Lower retardation	768	768	768	768	768
Recalesence	738	700	690	690	690

950 deg. C., or about 56 milli-volts on the furnace thermocouples, instead of 52 milli-volts, or 890 deg. C., as has previously been the practice in the manufacture of chain.

Laboratory Experiments in Heat-Treatment

The preliminary study of heat-treatment made in the laboratory was for the purpose of securing an indication of the best treatment to be used in the actual manufacture of the chain cable. In this investigation the attempt was made to find the effect of the following variables: (1) Maximum temperature of annealing; (2) rate of cooling, or quenching; (3) drawing to different temperatures after heating to maximum temperatures, or after different rates of cooling; (4) time of annealing, or time material is at maximum temperature.

The list of heat-treatments developed is given in Table 2. Each charge consisted of three tensile specimens and two blocks from which four longitudinal and four transverse specimens were machined. The furnace was heated to about 750 deg. C. before the specimens were introduced. The temperature was then raised, rapidly at first and slower as the upper limit was approached, to the point where the increase was about 5 deg. in 15 min.

After the specimens had received their heat-treatments as outlined in Table 2, tests were made for yield point, breaking stress, per cent. elongation in 2 in., per cent. reduction in area from 0.20 sq.in. Impact tests determined the resistance to shock in foot-pounds per square inch of an area of about 0.0785 sq.in. in a bar 10 mm. square by 55 mm. long, with 40 mm. between supports.

Impact tests were made on the Charpy impact machine at the United States arsenal, Watertown, Mass. It was considered important to make impact tests for the reason that chain cable which fails is usually broken by the severe shocks to which it may be subjected.

In making Charpy tests of wrought iron it is important to note the great difference between the resistance of the iron to shock, depending upon the relative direction of the nick in the specimen and the "grain," or slag streaks, in the iron.

It was suspected that the length of time during which the specimens remained at maximum temperature in the furnace might have some effect on the results, so a special series G was added of heat-treatments Nos. 28 to 31, which were all heated to 970 deg. C. and maintained at that temperature for intervals of 1 min., 15 min., 30 min. and 2 hr. The results indicated that on specimens of that size the duration of the time of annealing has no appreciable effect.

TABLE 2. TABULATION OF HEAT-TREATMENTS OF BURDEN IRON STOCK, WITH RESULTS

	Tensile Results: Yield Point	Breaking Stress	Per Cent. Elongation in 2 In.	Per Cent. Reduction of Area from 0.2 Sq.In.
Series A—Rate of Cooling:				
1. Heat to 900 deg. C. and cool in furnace	23,465	23,465	38.2	56.4
2. Heat to 900 deg. C. and cool in air	32,365	51,330	34.6	45.2
3. Heat to 900 deg. C. and quench in oil	41,400	57,050	31.4	48.4
4. Heat to 900 deg. C. and quench in water	49,275	68,720	24.7	41.7
Series B—Rate of Cooling:				
5. Heat to 1,060 deg. C. and cool in furnace	26,700	47,280	36.2	50.0
6. Heat to 1,060 deg. C. and cool in air	31,330	49,700	36.0	49.0
7. Heat to 1,060 deg. C. and quench in oil	39,435	56,900	30.0	53.0
8. Heat to 1,060 deg. C. and quench in water	44,250	65,400	26.0	51.0
Series C—Rate of Cooling Before Drawing:				
9. Heat to 1,000 deg. C., cool in furnace, reheat to 900 deg., quench in oil and draw to 650 deg	32,900	50,325	39.0	58.0
10. Same as 9 but quenched in water	31,525	49,450	38.0	59.0
11. Heat to 800 deg. C. and quench in water	49,165	68,350	19.1	41.4
12. Heat to 850 deg. C. and quench in water	42,700	64,130	24.8	47.6
13. Heat to 900 deg. C. and quench in water	43,215	62,880	28.3	49.4
14 Heat to 950 deg. C. and quench in water	50,615	69,880	22.9	51.7
15. Heat to 1,000 deg. C. and quench in water	48,835	67,135	25.9	54.3
16. Heat to 1,050 deg. C. and quench in water	45,730	63.130	25.9	52.3
Series E—Temperature of Drawing:				
17. Heat to 1,000 deg. C., quench in water, draw to 550 deg	42,285	58,235	34.2	58.1
18. Heat to 1,000 deg. C., quench in water, draw to 650 deg	35,585	53,935	35.6	58.4
19. Heat to 1,000 deg. C., quench in water, draw to 750 deg	34,365	49,935	38.4	57.4
Series F—Rate of Cooling:				
20. Heat to 1,000 deg. C., quench in oil	41,750	55,185	34.6	54.5
21. Heat to 1,000 deg. C., cool in air	33,365	49,515	36.5	55.5
Series G—Time of Annealing:				
28. Heat to 970 deg., hold 1 min., cool in air	31,365	49,550	36.1	52.1
29. Heat to 970 deg., hold 15 min., cool in air	32,300	49,200	37.4	55.2
30. Heat to 970 deg., hold 30 min., cool in air	30,830	48,200	37.4	53.7
31. Heat to 970 deg., hold 120 min., cool in air	29,800	48,480	37.8	53.1

As a general conclusion from the results of the physical tests of heat-treated Burden chain iron, it may be stated that it is affected by heat-treatment in a manner very similar to low-carbon steel, giving an increase of 40 per cent. in the tensile strength and 125 per cent in the longitudinal impact strength when heated to 950 deg. C. and quenched in water. This was confirmed by microphotographs showing sorbitic and martensitic structure typical of the hardening structure of mild steel. It is therefore recommended that a further investigation be made of the effect of this heat-treatment of chain cable and the practicability of its application to the manufacture of chain cable.

Preliminary Experiments with Chain Links

Two preliminary experiments were performed with full size chain: (1) To confirm the results of the laboratory experiments as to the best temperature to which the chain should be heated for annealing by air cooling, and (2) to determine the best sequence of annealing and proofing.

The second series of preliminary tests was to determine the best order to follow in annealing and proofing. Chain may be (1) annealed before proofing, which is the regular practice, (2) annealed after proofing, or (3) annealed before and after.

When chain is proofed, it is strained well over the elastic limit of the link as a whole. For example, 3¼-in. test links are proofed to 367,000 lb., which leaves a permanent set of about ⅜ in. The ratio of proof to pulling load is 367,000 : 620,000 = 0.59, while the ratio of elastic limit to ultimate stress of the material is 27,000 : 49,000 = 0.55.

Proofing therefore strains certain parts of the link above the elastic limit and leaves it in an internally strained condition. If method (1) is used, the chain leaves the shop for service with internal strains; but if method (2) is used, the internal strains of proofing are relieved by annealing, and from this consideration alone each link should be stronger.

Because this tendency to injure the weld does exist where method (2) is used, the conclusion was reached that method (1) of annealing before proofing should be followed instead.

Effect of Heat-Treatment

From the forging examination the conclusion is reached that the stiffness of the unannealed link is largely due to the overheated distorted structure in the welded end.

The fact that the metal of the forged link does not return to its normal condition during slow cooling after forging, even if it has been "overheated" to 1350 deg. C., is probably to a large extent due to the effects of slag and other impurities. Annealing relieves this condition by the process of recrystallization, which practically wipes out all former structure and gives a finer and more normal grain size. In regard to this overheating, Rosenhein says[3]:

> We find that by "overheating" steel—that is, by exposing it to unduly high temperatures or for too long a time at any temperature above Ac_3—the growth of a very coarse iron structure results, and this, on cooling down, gives rise to a corresponding coarse ferrite-pearlite structure. Not only this, but the arrangement and forms assumed by the pearlite which is formed from such steel are characteristic; there is a strong tendency for the ferrite to take the form of straight bands with elongated and angular patches of pearlite between them, the ferrite bands frequently crossing one another, at angles of 60 deg. Such a coarse, sharply angular structure is, of course, extremely undesirable; there is a minimum of interlocking between ferrite and pearlite, and the straightness of the arrangement facilitates the propagation of slip or cleavage through the crystals. Such structures are, in fact, frequently met with in steel objects which have failed in service. Under test they generally exhibit some degree of weakness as regards shock and alternating stresses, but their tensile strength and elongation are frequently quite satisfactory. The most typical feature, however, is a decided drop in the yield point as compared with that of the same material in a more normal condition.

For heat-treating, Burden iron should be heated to about 950 deg. C. instead of 890 deg. C., which was the former practice.

There is no apparent relation between character of fracture and character of structure.

Heating to 950 deg. C. for cooling in air gives stronger and better chain than heating to lower temperatures, and heating to higher temperatures gives no improvement.

The present procedure of annealing before proofing should be continued.

[3]"Introduction to Physical Metallurgy," pp. 281-282.

Stiffness of the unannealed link compared with the annealed link is mainly caused by overheated distorted structure at the weld.

Annealing removes stiffness of the forged link by relieving overheated distorted structure. It decreases the tensile strength and yield point, and increases the ductility and resistance to shock, of the metal; but it increases the strength, as well as the ductility and resistance to shock, of the link as a whole.

The laboratory experiments indicate the following conclusions:

Rate of Cooling—Cooling in furnace reduces tensile strength from 49,000 to 47,000, reduces impact resistance from 150 to 90, increases elongation and reduction of area. Cooling in air increases tensile strength from 49,000 to 50,500, increases impact resistance from 150 to 240, reduces elongation and reduction of area. Quenching in oil increases tensile strength from 49,000 to 57,000, increases impact resistance from 150 to 340, reduces elongation from 36 to 31 per cent. Quenching in water increases strength from 49,000 to 67,000, increases impact resistance from 150 to 400, reduces elongation from 36 to 25 per cent.

Temperature from Which Cooled or Quenched—Increase of temperature above 950 deg. C. slightly decreases tensile strength, increases elongation and reduction of area and does not appreciably affect impact resistance. Temperature of 950 deg. C. gives best results.

Drawing Effect—The higher the drawing temperature the greater the decrease in tensile strength and increase in elongation. Drawing has little effect on impact resistance.

Increased Time of Annealing—Lengthening the time of annealing slightly decreases tensile strength and slightly increases elongation, reduction of area and impact resistance.

Fixture Designed for Machining Telephone-Receiver Cup

By G. H. Hamilton

The machining of the telephone-receiver cup, Fig. 1, presented an interesting subject for solution. The requirements were that the rim and base be faced to dimensions within a limit of plus or minus 0.0015 in. The cup was blanked and drawn in the punch press; the top edge was irregular and had to be trimmed off. It was also found that the required limits between the faces *A* and *B* could not be maintained in the punching because of the variations in the hardness of the material. The only way, therefore, to obtain the desired results was to machine the faces indicated after the part was formed to shape. Owing to the irregular shape of the part and the location of the points that had to be machined, difficulty was experienced in deciding on a satisfactory method of holding it. The fixture shown in Fig. 2 was finally determined upon and proved satisfactory.

The fixture decided upon was designed to be used on a No. 1 Brown & Sharpe hand screw machine and is of unusual construction. It comprises mainly a special casting *A*, which is so made as to take the place of the top part of the bearing cap on the front end of the spindle and projects out from the face of the spindle far enough to allow for the special holding device used.

This casting was machined all over, with the exception of the irregular-shaped edges, and on the lower surface it was provided with a dovetailed slide. Fitting in this is a dovetailed holder *B*, which serves to carry two of the machining tools, *C* and *D*.

The slide *B* is operated back and forth by means of the handle *E*, which passes through the operating stud *F* and into the fulcrum stud *G*, the latter being free to swivel, to compensate for the different positions of the handle. The stud *F*, as illustrated, is fastened to the slide *B* by a nut and washer and moves in an elongated slot in *A*. The slide is provided with gibs to compensate for wear and has in addition a stop screw *H*, which can be locked as shown and is used for limiting

For facing the front and rear faces of the rim, the special facing tool *M*, shown in detail in Fig. 4, is used. Referring to this latter illustration, it will be noticed that this tool is designed so that it can be sharpened without altering the width of the slot. It consists of a body *A*, which is held in the front tool post of the screw machine, and is formed on the front end to hold the two facing blades *B*, one right- and the other left-hand. These are held in place by two clamps *C*, retained in place by a through bolt and nut *D* and *E* respectively. The through bolt, although not so shown, is provided with a pin to prevent it from turning. The facing tools are sharpened by grinding on the top face, and after sharpening are adjusted so that their top face comes flush with

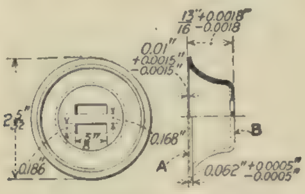
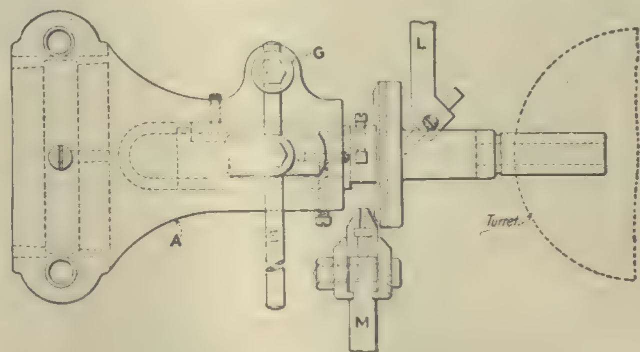


FIG. 1



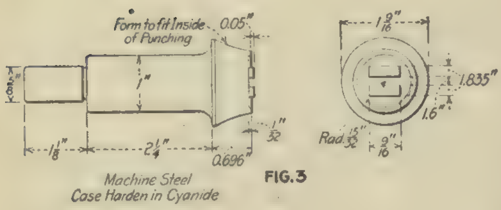


FIG. 3

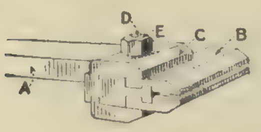


FIG. 4

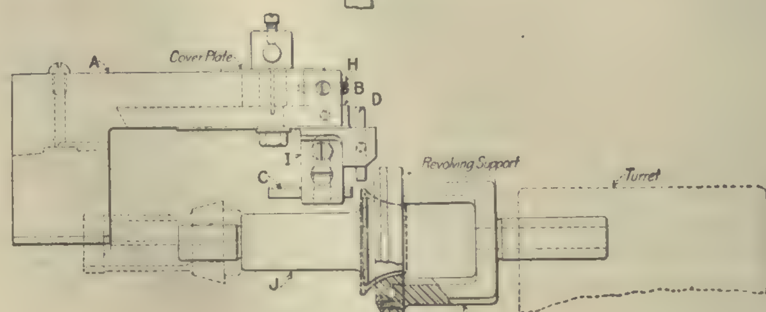


FIG. 2

FIGS. 1 TO 4. TELEPHONE-RECEIVER CUP AND TOOLS FOR MACHINING IT
Fig. 1—Telephone-receiver cup. Fig. 2—Top sliding attachment. Fig. 3—Special chuck for receiver cup Fig. 4—Two-blade cross-slide tool holder

the forward travel of the slide, governing the cut of the tool *C*. This latter is held in a tool holder *I*, which can be adjusted to locate the tool properly in relation to the shoulder on the work. The tool *D* is held in a square hole by means of a setscrew, as shown.

The special arbor for holding the work is shown at *J* and in detail in Fig. 3. This, as will be seen, is held by the shank in a regular spring collet and is shaped to suit the interior form of the work. Referring to Fig. 1, it will be noticed that the cup has two elongated slots, which, as shown in Fig. 3, furnish a suitable means of driving. The holder *J*, Fig. 2, has two corresponding projections and is recessed on the front so as to reduce the amount of surface in contact with the work. At first glance it would appear that the mandrel would have a tendency to run out; this, however, is taken care of by the special ball-bearing support *K*, Fig. 2, which is held in the turret. It should be mentioned that this support is kept in contact with the work while the machining is taking place and is only withdrawn to remove or insert the work. As shown in the plan view, Fig. 2, this revolving support is slabbed away on the sides in order to allow the facing tool *L* to get at the cup being machined.

the top face of the tool holder. When in this position the tools are made to face the rim of the work to the required thickness. The holder which was used in facing the bottom of the cup and which was held in the rear tool post is of simple design and is not important enough to need description.

Black Finish for Use on Wood Patterns

By F. C. Mason

The coating commonly used on patterns is made of shellac colored with lamp black. It takes considerable time to mix and is difficult to apply smoothly. By substituting aniline black for the lamp black one obtains an easily mixed jet black that flows as easily and smoothly as pure shellac.

The aniline is mixed with alcohol, and then white shellac is added. Orange can be used; but if an extra-fine article is desired, white should be chosen. This mixture dries with a gloss; but when rubbed slightly, it assumes a dead black and extremely smooth surface that is most desirable for a pattern finish if good castings are desired.

United States Munitions*

The Springfield Model 1903 Service Rifle

Making the Guard—II

SYNOPSIS—The installment for this week covers operations 15 to 29 inclusive on the guard, concluding the major operations on this rather intricate piece. The machining operations, which are nearly completed, involve the use of more interesting jigs and fixtures, as well as gages.

The operations here illustrated show more of the fixtures for holding the work up against a plate or plates, so as to locate by the upper edge. A good example of this is shown in Figs. 1204 and 1205, which are two views of the same fixture to show exactly how the wedging up is accomplished in this particular case. Here the lips, or top plates, *A* form the upper clamping surface, the guard the top and locates the hole in the front from the ramp, also gaging its vertical distance with relation to the top.

A different method is shown in Fig. 1209, where a cam is used directly under the magazine portion of the guard. Somewhat different is the holding device for the profiling, in Fig. 1211, although it also locates against the top of the guard. It is located endwise by a pin fitting into the front screw hole, while the tang is supported against the cut by the block shown. This operation profiles the bow, the cutters being shown in Fig. 1212.

Quite an elaborate example of the finger gage and its use is shown in Fig. 1213. Here the guard is laid on the upper face and located endwise by a stud at the front. The different fingers give both height and contour of the various surfaces. Fingers *A*, *B*, *C* and *D* measure the contour of the guard at all of the four points indicated.

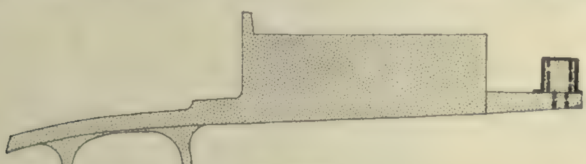


FIG. 1203

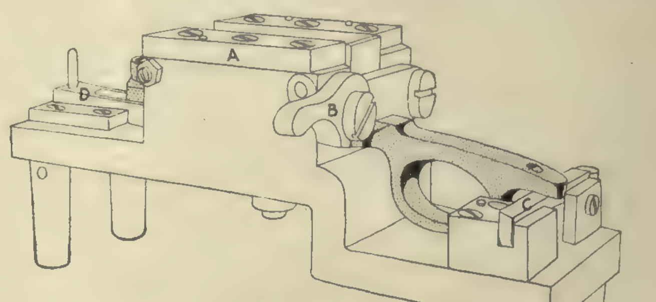


FIG. 1205

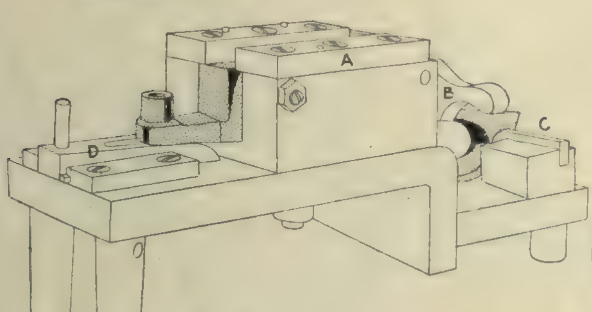


FIG. 1204

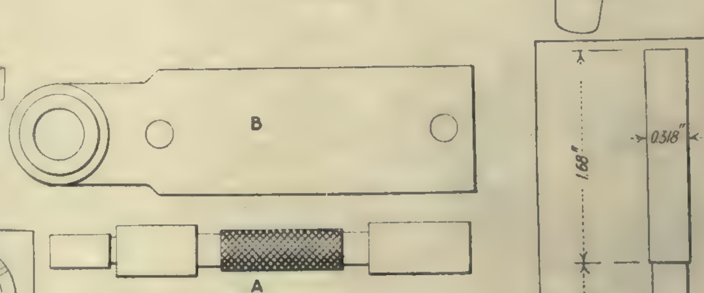


FIG. 1207

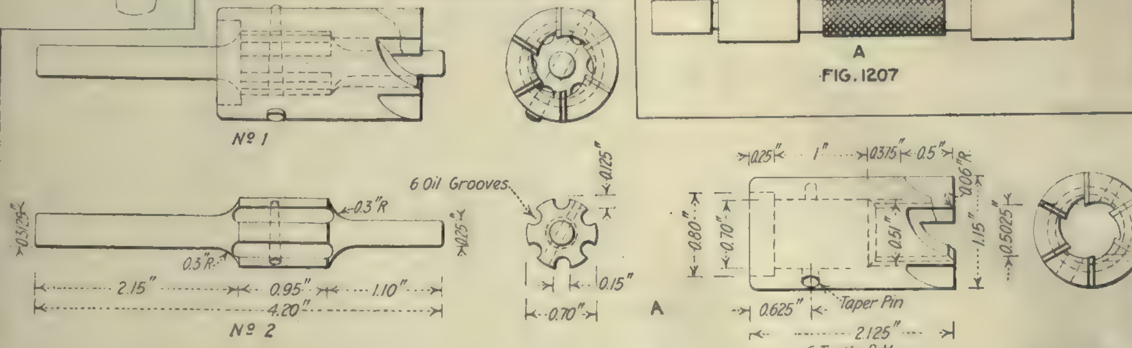


FIG. 1206

OPERATION 15

being forced up in front by the wedge *D* while the tang rests on the plate *C* at the other end. The latch *B* locates the guard endwise, holding the upper projection, or ramp, at the rear against the end of the plates *A*. This arrangement locates the guard firmly, accurately and rapidly for any work to be done on it. The gage *A* tests diameters of bore and counterbore, while *B* is a plate that fits on

OPERATION 15. HOLLOW-MILLING TO REMOVE STOCK IN REAR OF FRONT GUARD-SCREW STUD

Transformation—Fig. 1203. Machine Used—Dwight-Slate 16-in. three-spindle upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Figs. 1204 and 1205; guard is pressed up against ledges A by wedges C and D; latch B locates guard endwise. Tool-Holding Devices—Drill chuck. Cutting Tools—Fig. 1206; A, counterbore; B, facing counterbore; hollow mill for outside. Number of Cuts—Three. Cut Data—Speed of counterbore, 450 r.p.m.; speed of hollow mill, 350 r.p.m. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1207; A, diameter and depth of counterbore; B, outside and length of screw stud. Production—35 per hr.

OPERATION 16. HAND-MILLING TO REMOVE STOCK IN REAR OF FRONT GUARD-SCREW STUD

Transformation—Fig. 1208. Machine Used—Becker-Brainard large hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held upright, clamped by vise jaws, Fig. 1209; guard is located endwise by stops and held up against the top plate by the eccentric A. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, 0.84 in. diam., 0.505 in. wide, solid on shank. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—2,500 pieces. Gages—Thickness of walls beside lightening cut. Production—85 per hr.

stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1216, form of opening; also gage for thickness of trigger guard. Production—30 per hr.

OPERATION 19. MILLING LIGHTENING CUT IN TOP OF REAR TANG

Transformation—Fig. 1217. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held in fixture, Fig. 1218; clamped at top and bottom of magazine against plates A, by cam B; back end is supported by wedge C; this is mounted on elevating table, shown in Fig. 1219, which brings the guard up against the cutter. Tool-Holding Devices—Taper

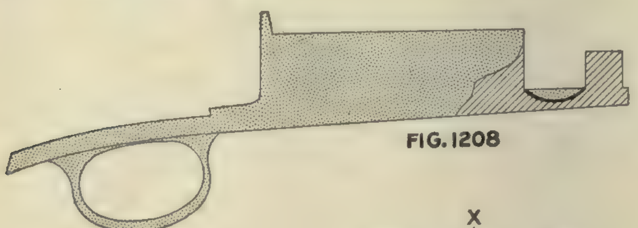


FIG. 1208

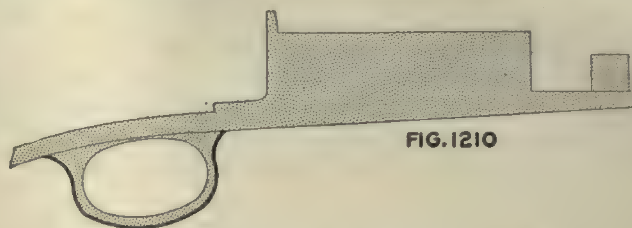


FIG. 1210

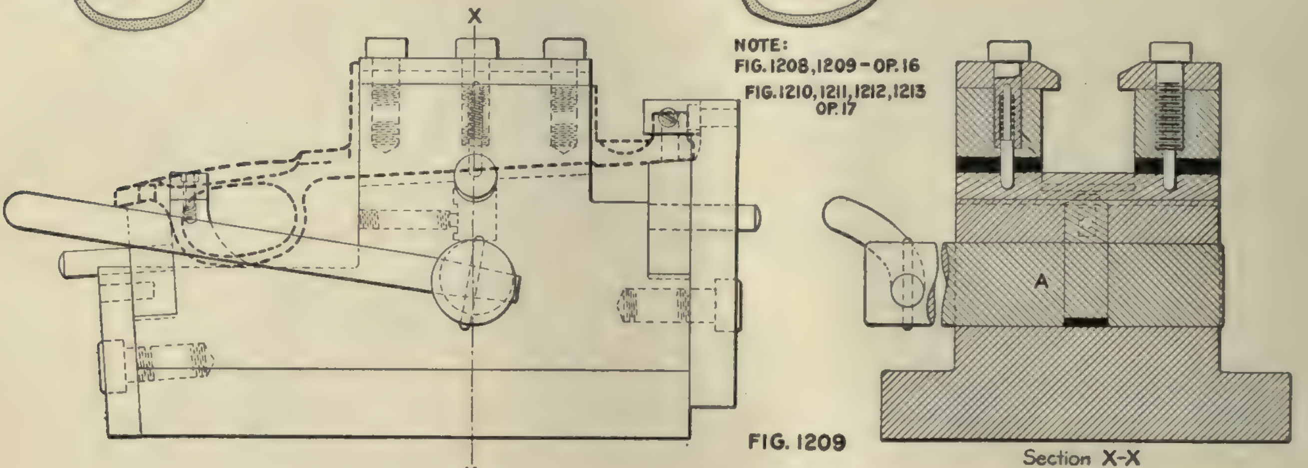


FIG. 1209

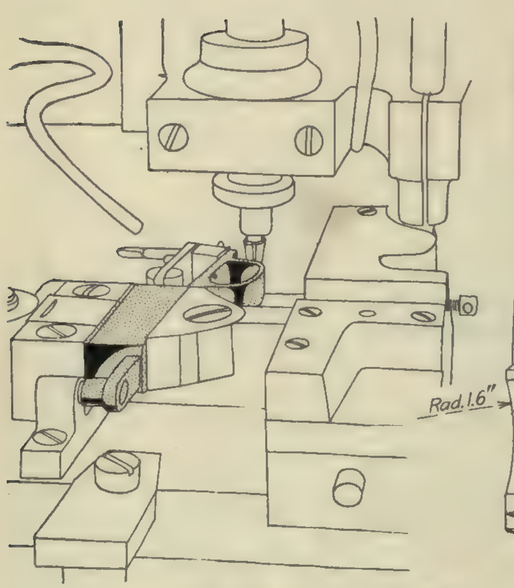


FIG. 1211

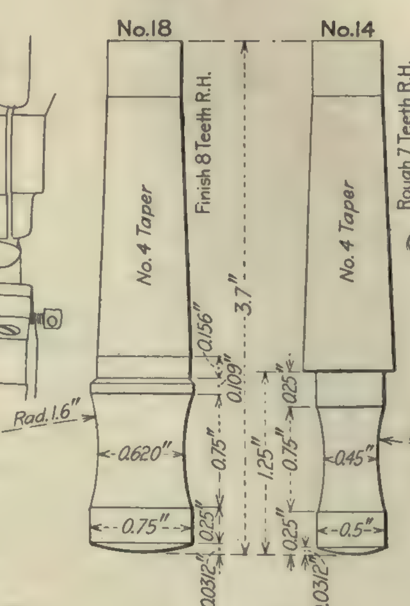


FIG. 1212

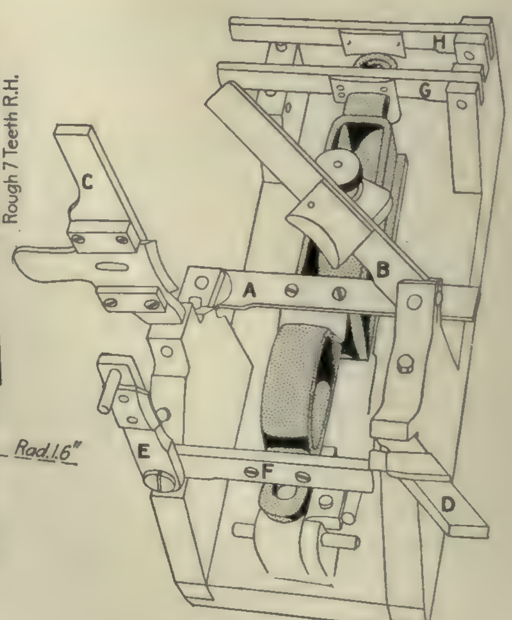


FIG. 1213

OPERATION 17. PROFILING OUTSIDE OF GUARD BOW

Transformation—Fig. 1210. Machine Used—Pratt & Whitney No. 2 profiler, Fig. 1211. Number of Operators per Machine—One. Work-Holding Devices—Clamped by vise jaws, located by pins. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter, Fig. 1212. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Form, Fig. 1213; fingers A, B, C and D swing down to stop pins; other fingers E, F, G and H gage later operations. Production—35 per hr.

OPERATION 18. PROFILING INSIDE OF GUARD BOW

Transformation—Fig. 1214. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Clamped with vise jaws; held on pin, Fig. 1215. Tool-Holding Devices—Taper shank. Cutting Tools—Similar to Fig. 1212. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in.

shank. Cutting Tools—Milling cutter, 0.90 in. diam., 0.505 in. wide, solid on shank. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—Form, Fig. 1220. Production—9 per hr. per machine.

OPERATION 21. PROFILING FLOOR-PLATE LUG SLOT AND REAR-END FLOOR-PLATE SEAT

Transformation—Fig. 1221. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on pins; clamped with jaws, Fig. 1222; work held upside down against plates A; locating points, B and C; profiling form D for finishing; arm E swings over and is used for the roughing cut. Tool-Holding Devices—Taper shank. Cutting Tools—Straight profiling cutter, 0.25 in. diam.; solid on No. 3 taper shank. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1223, form of slot. Production—40 per hr.

The profiling for the inner surface of the low, or trigger, guard is shown in Fig. 1215. The holding fixture is the same and the cutter very similar. The guide for the profiling is of course of slightly different contour; the gage is simply a flat disk of proper shape mounted on the tang, the miller table feeds it under the cutter. The gage, Fig. 1220, shows when the cut is correct.

The profiling of the next operation, represented by Fig. 1222, shows one of the little kinks developed in connection with various kinds of work. There are two cuts, a roughing and a finishing, which are controlled by the profiling form *D*. On top of this is an arm or plate *E*, which swings across the opening so as to limit the movement of the guide during the roughing cut. This plate is located, as to position, by the notch shown coming in contact with a pin that projects from the form *D*.

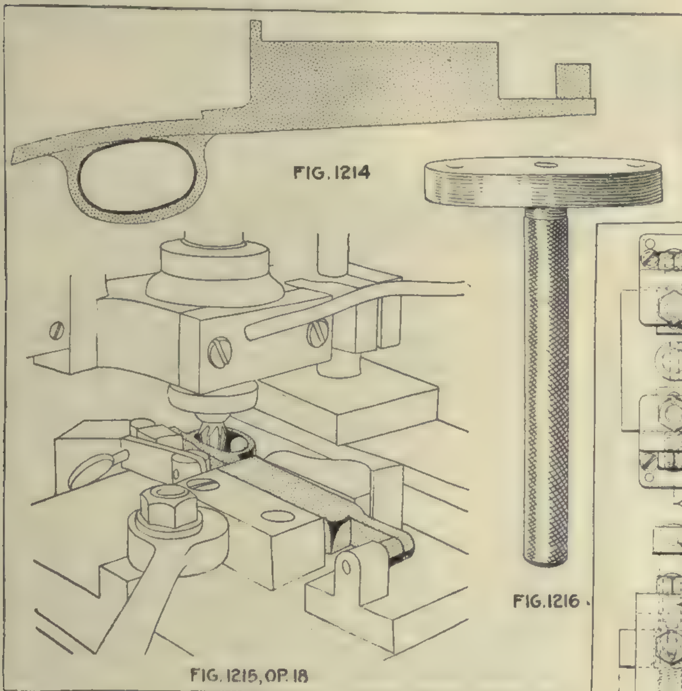


FIG. 1214

FIG. 1216

FIG. 1215, OP. 18

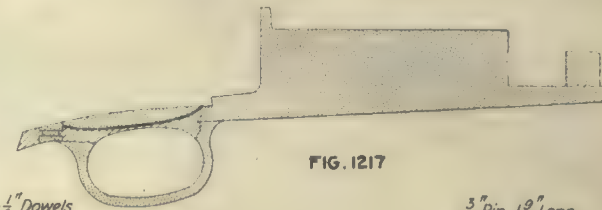


FIG. 1217

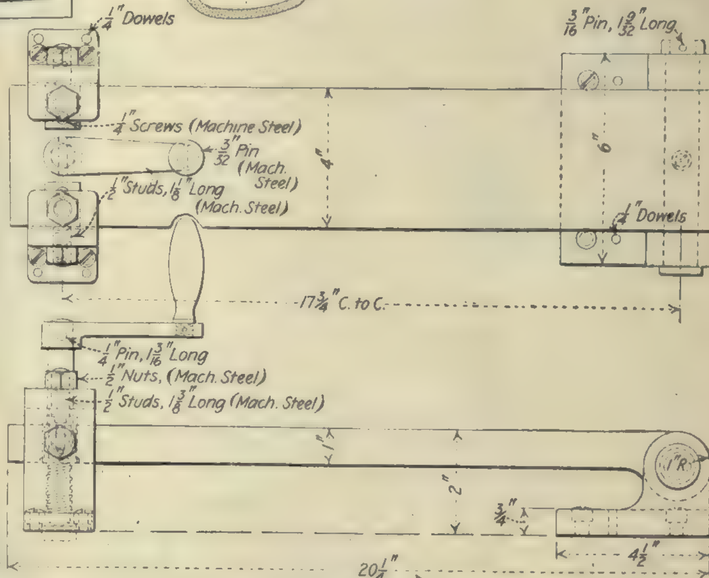


FIG. 1219

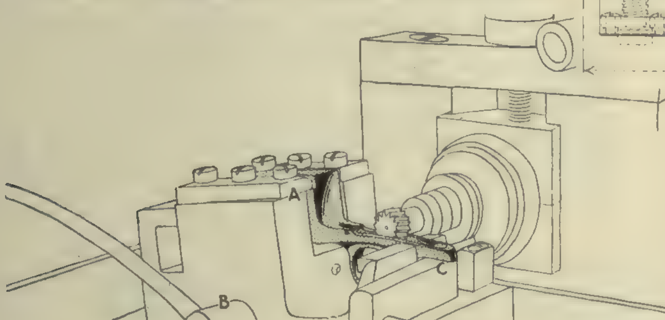


FIG. 1218

OPERATION 19

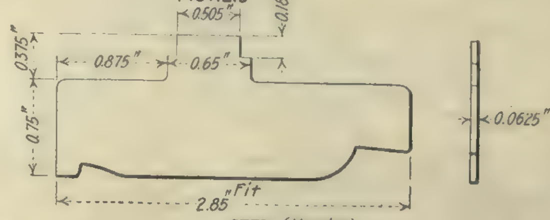


FIG. 1220

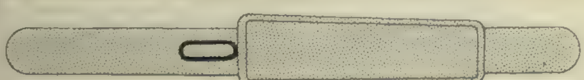


FIG. 1221

OPERATION 21

FIG. 1223

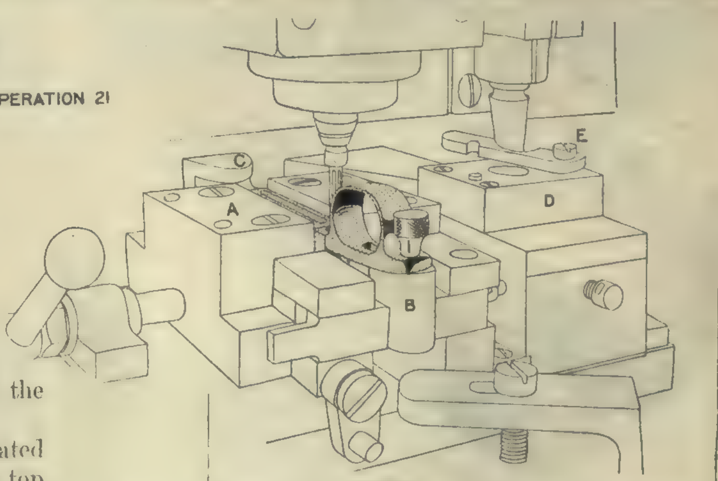


FIG. 1222

a plug for easily testing the contour of the inside of the bow.

The following operation is a lightening cut, as illustrated in Fig. 1217. The guard is again located against the top by plates *A*, Fig. 1218, by the cam *B*, while the tang is supported as at *C*. This involves the use of the elevating table, shown in Fig. 1219. The fixture is mounted on this table; and after the work is clamped in the fixture, the whole attachment is raised into contact with the cutter by raising the end of the elevating table. Then, after the cutter is sunk deep enough into the top of

OPERATION 22. HAND-MILLING SLOT RECESS FOR FLOOR-PLATE CATCH

Transformation—Fig. 1224. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin; clamped from top and bottom in fixture, Fig. 1225. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, 0.85 in. diam., 0.296 in. wide, solid on No. 4 taper shank. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, 1/16-in. stream. Average Life of Tool Between Grindings—2,500 pieces. Gages—Flat for width and depth. Production—100 per hr.

Cutting Tools—Slotting cutter, 1.75 in. diam., 0.21 in. wide, threaded for arbor. Number of Cuts—One. Cut Data—350 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 1228, locates trigger slot from rear guard-screw hole. Production—100 per hr.

OPERATION 24. MILLING BOTTOM OF GUARD FOR FLOOR-PLATE SEAT

Transformation—Fig. 1229. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pin clamped by vise jaws, Fig. 1230. Tool-Holding Devices—Standard arbor.

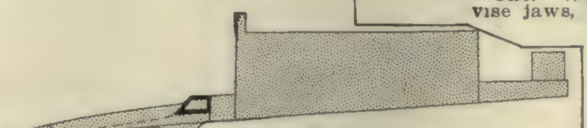


FIG. 1224

OPERATION 22

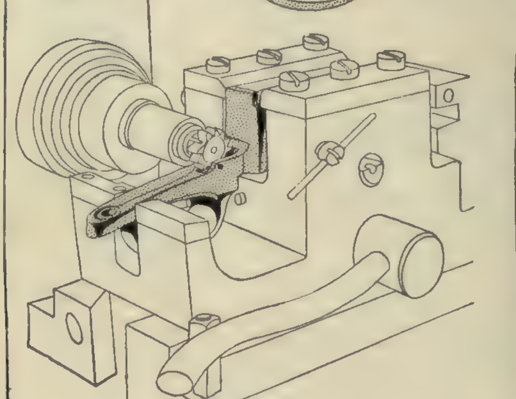


FIG. 1225

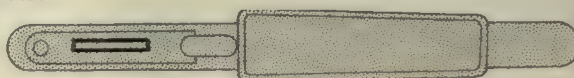


FIG. 1226

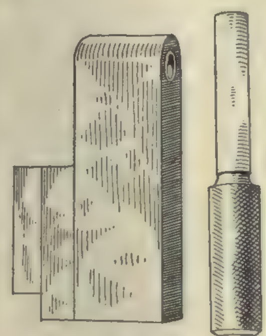


FIG. 1228

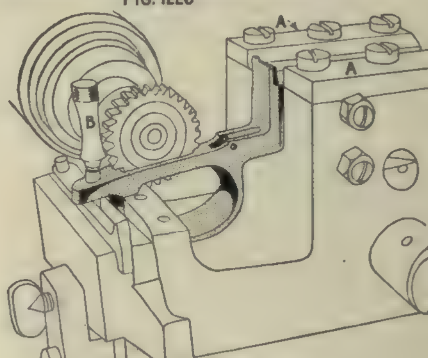


FIG. 1227

OPERATION 23


FIG. 1229

OPERATION 24

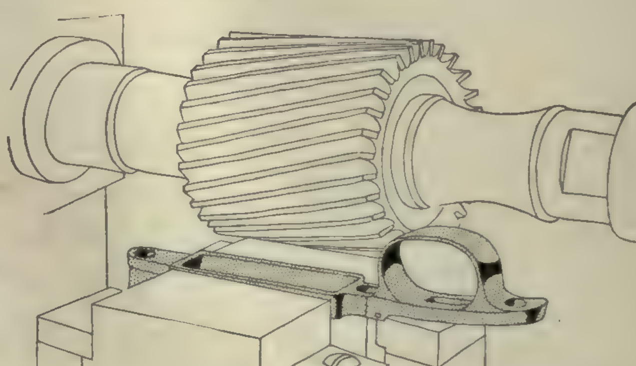


FIG. 1230

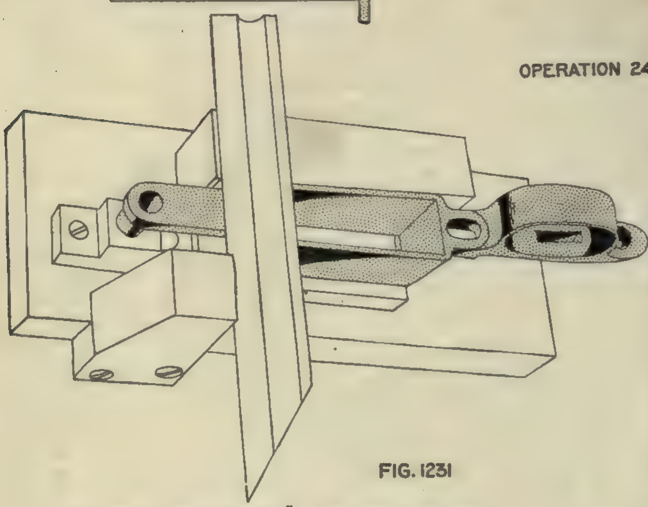
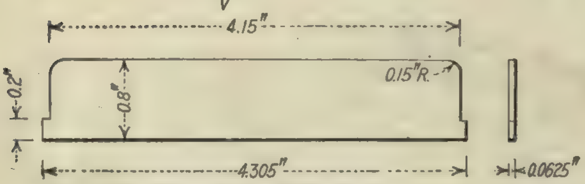


FIG. 1231



Total Lenght of Floor Plate Seat
STEEL (Harden)
FIG. 1231 A

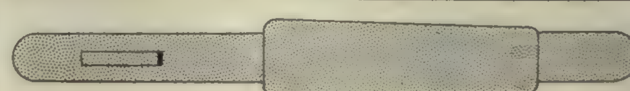


FIG. 1232

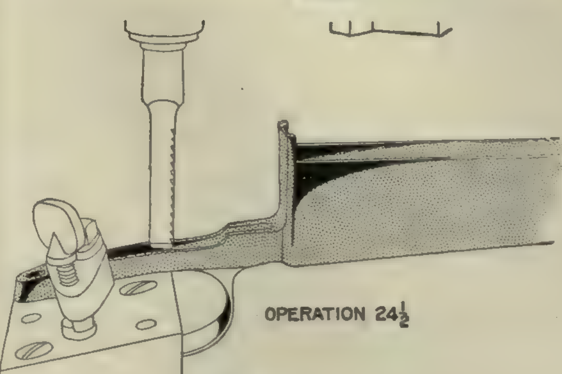

OPERATION 24½

FIG. 1233

OPERATION 23. HAND-MILLING TRIGGER SLOT

Transformation—Fig. 1226. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin A against upper plate B, Fig. 1227. Tool-Holding Devices—Taper shank, threaded arbor.

Cutting Tools—Spiral mill, 4x4 in. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1231, placed on a stand gage and straightedge used as shown; Fig. 1231-A, total length of floor-plate seat. Production—20 per hr. Note—A block is placed in the magazine hole before placing in the fixture, to prevent sides of hole from springing together.

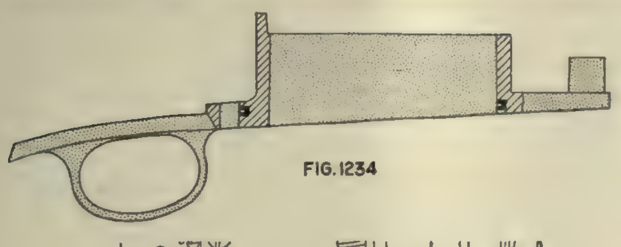


FIG. 1234

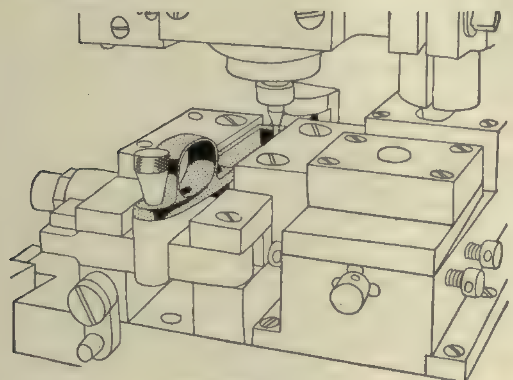


FIG. 1235

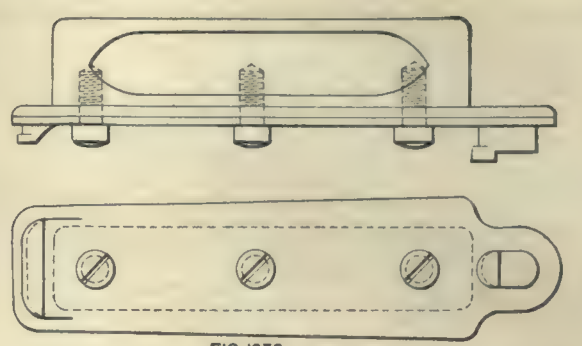
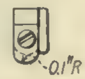


FIG. 1236



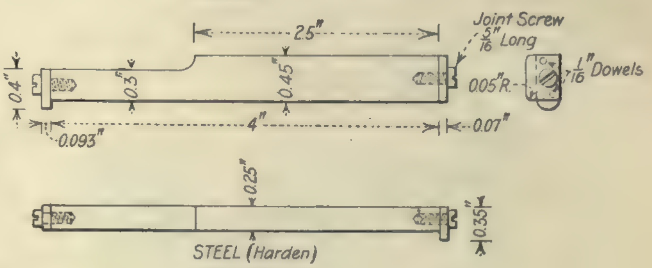


FIG. 1237

OPERATION 25 & 26

OPERATION 24½. BURRING FOR OPERATION 24 AND BROACHING OPERATION 23

Transformation—Fig. 1232. Number of Operators—One. Description of Operation—Burring and broaching forward end of trigger slot, Fig. 1233. Apparatus and Equipment Used—Ames profiler rebuilt for broaching. Gages—None. Production—125 per hr.

OPERATIONS 25 AND 26. PROFILING RECESSES FOR FLOOR-PLATE TENONS IN FRONT OF MAGAZINE OPENING AND IN FLOOR-PLATE LUG SLOT

Transformation—Fig. 1234. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—On pin clamped by vise jaws, Fig. 1235. Tool-Holding Devices—Taper shank. Cutting Tools—Two profiling cutters; No. 1, 0.285 in. diam., 0.093 in. thick; No. 2, 0.385 in. diam., 0.07 in. thick; 6 teeth; both on No. 3 taper shank. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Figs. 1236 and 1237. Production—35 per hr.

OPERATION 27. HAND STRADDLE-MILLING SIDES OF REAR MAGAZINE WALL

Transformation—Fig. 1238. Machine Used—Brainard large hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held upright; clamped by vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, 3 in. diam., 0.32 in. wide, 26 teeth. Number of Cuts—One. Cut Data—300 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—2,500 pieces. Gages—Fig. 1239; located on guard by pins A and B; point C gages width of rear wall, D and E the width of magazine walls; there is also a gage, practically a receiver, that gages outside of magazine portion. Production—100 per hr.

Operations 22 and 23, which give further examples of the type of fixture already described, are shown in Figs. 1225 and 1227. Both of these have to do with the tang, the last breaking through for the trigger. The first operation mills the recess for the floor-plate catch. In operation 23 the guard is held against end movement by the pin *B*, the lips *AA* locating the upper side of the piece. The gage locates the position of the slot from the rear screw hole in the tang.

The milling of the bottom of the guard for the floor-plate seat is illustrated in Fig. 1230, while the method of gaging by the use of a knife straight-edge is shown in Fig. 1231. The side of the gage is of the correct height, and by resting the knife-edge across this raised side the height is easily determined. Most of these straight-edges are made from bayonet blades that have been found defective in some way. They make a very good straight-edge for this and other purposes.

The final cleaning out of the trigger slot is done with a single-sided broach, as shown in Fig. 1233. The work is done in an old Ames profiler, which has been built over for this job. It is virtually a slotting job with a multiple-toothed tool.

Then comes the undercutting of the recesses for holding the floor plate, this being a profiling job and necessitating the use of rather delicate cutters. Here again a pin in the tang screw hole holds the guard against end movement. The gages are virtually duplicates of the completed floor plate.

Another interesting gaging operation is shown in Fig. 1239, after the sides of the rear magazine wall have been straddle-milled, as in Fig. 1238. This gage not only measures the width of this rear wall by the part *C*, Fig. 1239, but also gages the width of the magazine and the location of the wall from the two screw holes as well as the height of the top of the guard from both tangs. It is a simple gage and contains suggestions that can be adopted in other classes of work. The projections *D* and *E* help to locate the gage squarely on the work.

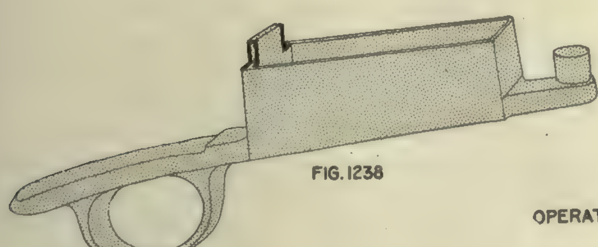


FIG. 1238

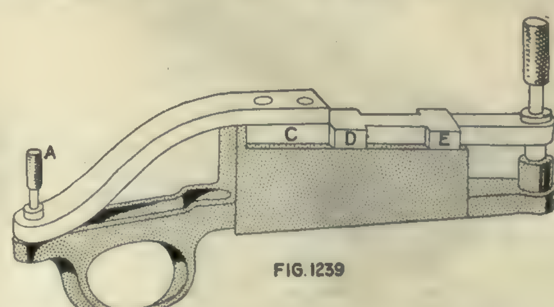


FIG. 1239

OPERATION 27

OPERATION 28. HAND-MILLING RAMP CUT IN REAR MAGAZINE WALL

Transformation—Fig. 1240. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held in fixture clamped at top and bottom, pushed to stop at back of magazine hole, Fig. 1241. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, 1.40 in. diam., 0.375 in. wide, solid on No. 4 taper shank. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1242. Production—100 per hr.

OPERATION 29. PROFILING STRADDLE-MILLING SIDES OF PROJECTING REAR MAGAZINE WALL

Transformation—Fig. 1243. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held by pin A; clamped in vise jaws BB, Fig. 1244. Tool-Holding Devices—Taper shank. Cutting Tools—Fig. 1245. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1246, gages sides and ends of guard by fingers A to H. Production—25 per hr.

OPERATION 28

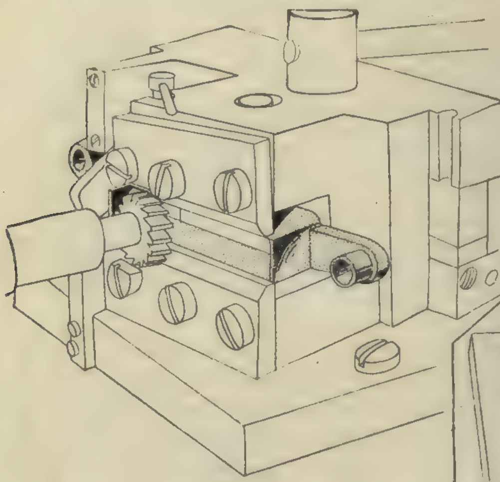


FIG. 1241

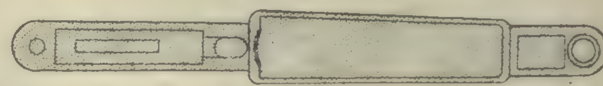
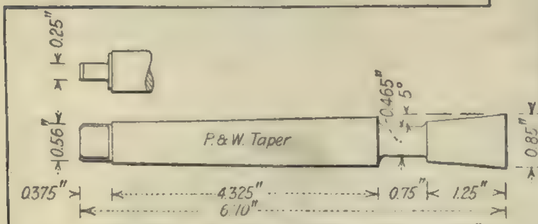


FIG. 1240

FIG. 1243

FIG. 1242



8 Teeth, Right Hand, Spiral Left Hand. 1 Turn in 10.50"
FIG. 1245

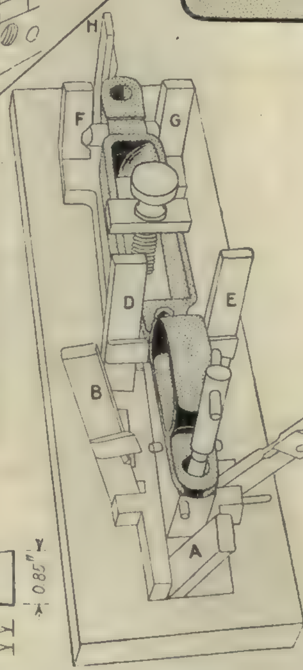


FIG. 1246

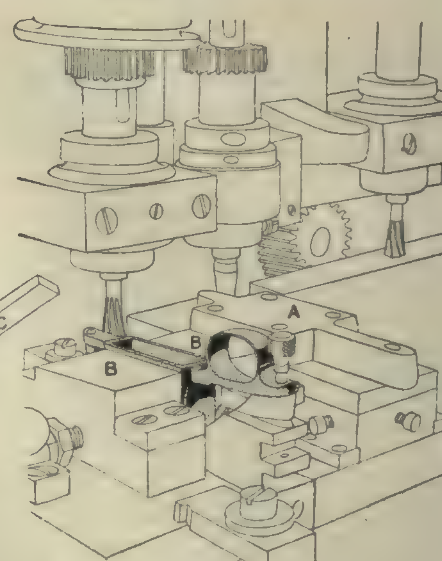


FIG. 1244

OPERATION 29

A Shop Library

By C. H. Willey

I recently paid a visit to the shop in which I served my time as apprentice. Things were booming, and I hardly dared go nosing around until noontime, so I dropped into the office. The superintendent, after a few minutes' chat, said: "You can idle your time in the shop employees' library. It is at the end of the drafting room."

This was a surprise to me, and the library was a dandy. In it were all the best books of the different branches of the trades, complete treatises on all subjects from mechanical drawings, blacksmithing, pattern making and foundry work to the actual making of finished products of the machine trade. All the first-class trade papers and journals were there, and several copies of each; also, complete sets of textbooks from the leading correspondence schools. Several drawing outfits were available. Plenty of pens, pencils, ink and paper were in evidence, and comfortable tables and chairs added to the attractiveness.

This library was for the use of the employees. One of the junior draftsmen was in charge of it. Some of the men would spend part of their noon hour and evenings there. The privilege of taking home the books or trade papers or a drawing outfit was extended for certain lengths of time in order to encourage the men.

In the library was a box into which could be dropped any question desired, which was answered by the chief draftsman. There was a blank book, 8x15 in., on the library table, where each question was written, together with its answer, thus making a practical journal of discussion, which was very interesting.

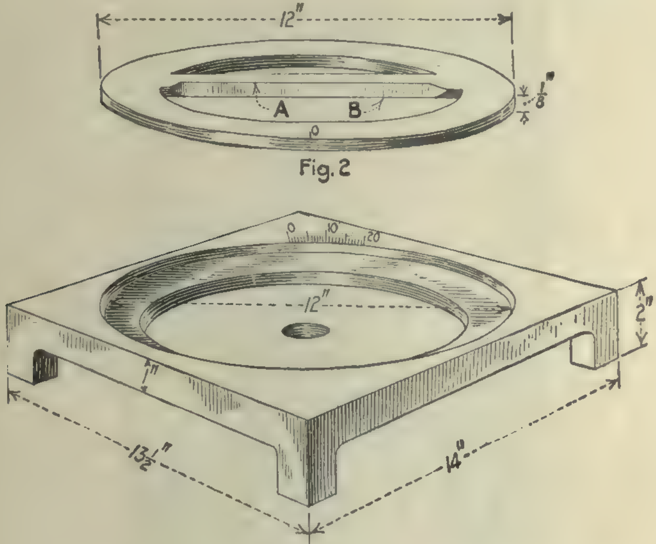
The library is open every evening until 9:30, and on Sunday afternoons. Many of the employees contribute popular magazines and books to it, and it is a pleasant place to spend a few hours.

The shop superintendent told me that it is one of the best tools that he ever induced the firm to install. That it has been a good investment has been proved by the interest shown in it by old and young alike. A better understanding of shop methods, use of machine tools, blueprints, etc., is noticeable. Perhaps the best feature is lending books, magazines and drawing tools to the employees to take home for a week for private study. To my mind, such a library ought to be a good thing for any fair-sized shop.

Letters from Practical Men

Improvement on a Protractor

Having a large number of master cams to lay out and make at different times, we made and used a plate after the idea described on page 172 of Halsey's "Handbook for Machine Designers and Draftsmen." Certain



FIGS. 1 AND 2. PROTRACTOR FOR LAYING OUT CAMS

improvements that were worked out to our satisfaction I present to the readers of the *American Machinist* for their consideration and probable use.

The cast-iron plate, Fig. 1, was first planed on the face and feet, then mounted on the faceplate of the lathe. The 1-in. center hole was bored and reamed, and the two recesses were carefully finished. It was then mounted in the miller and graduated to half-degrees.

The plate, Fig. 2, was made of 1/8-in. sheet stock and shaped to the form illustrated. It was carefully fitted to the plate, and the edge *A* was beveled, as shown. Care was taken to make the edge *B* exactly bisect the center of the plate. Made in this way, it is one of our most used tools and gives perfect satisfaction.

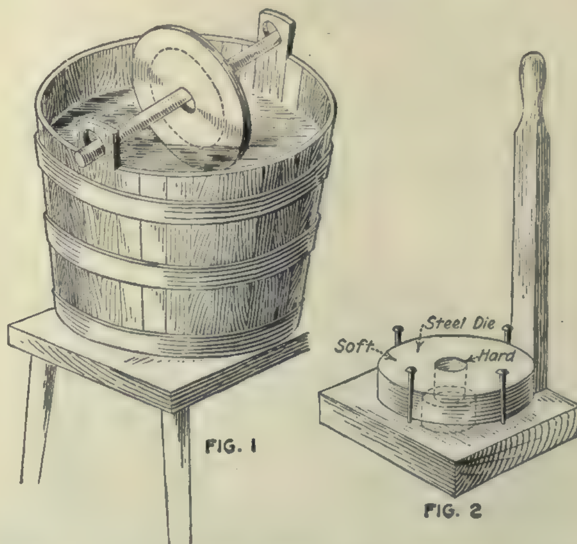
For those who desire it a vernier may be added for further refinement, but we use it as given.

Woodhaven, L. I. J. C. M.

Shrinking Rings—Local Hardening

Fig. 1 shows a ring that was bored about 0.015 in. too large. In order to save the work it was heated to something over a cherry red, but not hot enough to burn it. Then the piece was put onto a rod and dipped into cold water to about 1/2 in. from the edge, being turned so that the outside would cool off and the inside remain hot. The contraction closed the hole and saved the job. In this manner I have closed in rings about 0.025 to 0.030 in.

In Fig. 2 is shown a ring, for local-hardening a die, which consists of a wooden frame, a platform and a handle. The die is heated and placed on the wood platform, the hole in which is 1/4 in. larger than the hole in the die. Nails can be driven into the platform to center the die. While being dipped in the water or



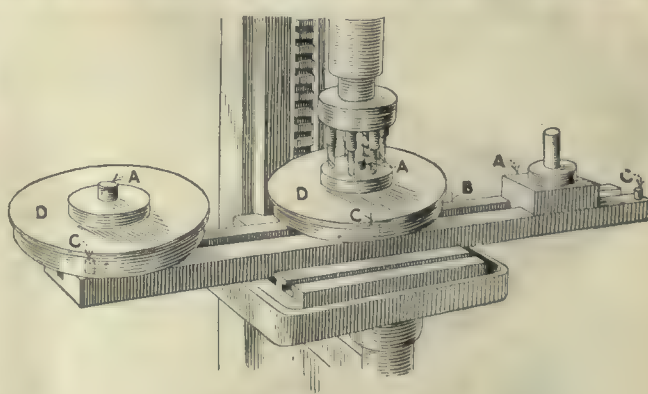
FIGS. 1 AND 2. SHRINKING A RING AND LOCAL-HARDENING A DIE

oil the die and platform are moved rapidly up and down. This leaves the center hard. The outside, however, will be soft enough to machine and will not be so liable to crack. GEORGE B. FAIRMAN.

Buffalo, N. Y.

Increasing Drilling-Machine Output

The illustration shows how I first doubled the output of a machine and then trebled it. The job was drilling



WORK, JIGS AND RAIL

six holes with a multiple head on a drilling machine, using a jig. Formerly, the jig had been fastened to the table, and two men were required on the machine. The

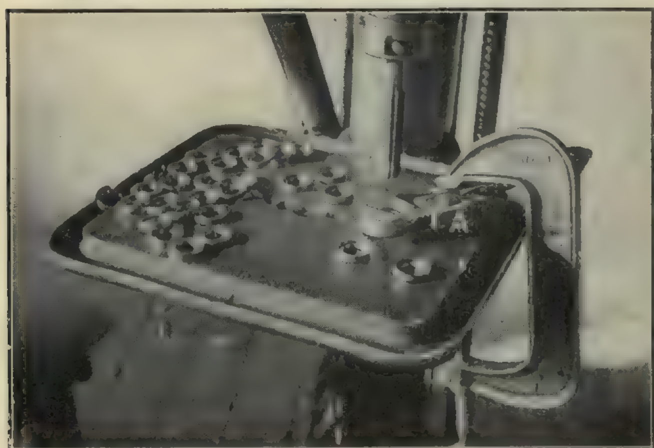
piece to be drilled weighed 60 or 70 lb., and to lift it into place between the drills and the jig was not a convenient operation for one man.

I made the new jig as illustrated. There are two jigs on one common slide. The jigs are marked *A*, the slide *B*, the stop pins *C*, and the piece to be machined *D*. To double the output, one man was assigned to each jig. He loaded his own jig, slid it under the head, drilled the holes and returned to the end of the slide. The other man alternated the process. To treble, another man was put on; two men loaded and unloaded, and one man drilled. F. C. MASON.

North Tonawanda, N. Y.

Improvised Retapping Kink

The American Water Motor Co., Columbus, Ohio, had to retap a number of spring retainers that are used on the water motors manufactured there. The improvised method shown in the illustration was employed for holding them.



RETAPPING SPRING RETAINERS

A Stillson wrench *A* was fastened to the drilling-machine table with a C-clamp, as shown. The jaws were set so that they would just hold the part to be retapped. The tap was then fed into a piece placed in the jaws. The piece was held securely during the tapping operation by virtue of the motion of the tap forcing it against the serrations on the wrench jaws. As the tap was reversed, the piece was released from the serrations. When the tap was drawn out, the operator removed the piece with one hand and with the other hand inserted another piece to be retapped. With this simple device about 400 spring retainers were retapped per hour.

New York City. A. MACGREGOR.

Using a Post Drill as a Portable One

In the process of overhauling an old motor car some $\frac{3}{8}$-in. holes were needed in the frame. I did not like to breast-drill such large holes and I had no ratchet drill. I did have a very small post drill similar to those used by blacksmith shops. This I put on the car frame with the drill table under the frame and clamped it fast. I never saw an easier way of hand-drilling such work. No more ratchets for me if I can possibly get at the job with that post drill. H. W. JOHNSON.

Poughkeepsie, N. Y.

Storing Special Small Tools in a Fireproof Vault

Provision for die and jig storage varies with the shop and the methods in vogue there—from a dark corner behind somebody's machine in the loosely run plant to the most elaborate system of protected shelving in the more progressive. The illustration herewith gives some idea of the thought bestowed upon this phase of management by one forging and stamping concern. A brick room was built large enough to care for present and probable future die needs—in this case about 20x20 ft. in extent and 12 ft. high—and then a second wall built around this one, leaving an 8-in. air space between the walls. The doorway shown is the only entrance, and the dead air space is carried across this opening by fitting two sets of close-fitting steel doors, one in each wall.

ENTRANCE TO THE TOOL VAULT

When completely closed by both these doors, the remainder of the plant could burn to the ground without disturbing the contents of the die room; and, as soon as the ashes of the old plant had cooled sufficiently, the dies and jigs could be taken to some other plant and production carried on without the usual intermission or delay caused by most fires.

The type of shelving used here varies from that usually employed. Soft pine boards are used, on the theory that it is cheaper to renew shelves than it is to replace nicked die edges—which is true—and dies are stored with a margin of space all around, to prevent damage from close packing. The fireproof vault is considered by the management to be the cheapest kind of insurance on the dies and the life of the business, while the occasional replacement of a shelf or two is a cheap premium for undamaged edges and unmarred parts.

Pittsburgh, Penn. CHARLES C. LYNDE.

Discussion of Previous Question

Wooden Mandrels

Mr. Parker's article on page 1056, Vol. 45, shows a wooden mandrel that doubtless is all right for the work for which he used it, but the method of fastening in the steel centers is not as good as it might be.

I have made a number of wooden mandrels for lathe and miller work. With steel centers fastened in as shown in the sketch they are, if dressed to size immediately before using, just as satisfactory as steel mandrels and not nearly so heavy. The reason for dressing such mandrels to size shortly before using them is that wood changes shape radially, under certain conditions, very

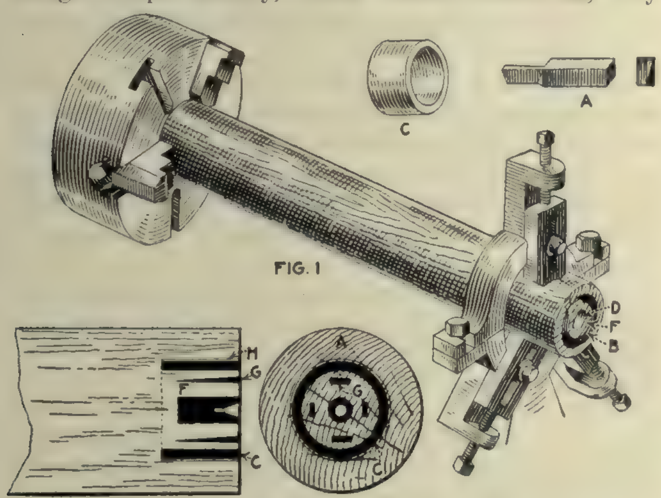


FIG. 2

FIGS. 1 AND 2. WOODEN MANDRELS WITH STEEL CENTERS

rapidly; and a plain steel plug driven into a plain hole in the end of a piece of wood, even though it be tight when first driven, is not apt to remain so for very long. This is exactly the same condition that is so familiar to us all in the ordinary ax wedge. When one of these becomes slack, we soak the ax head in a pail of water; the wood swells and grips both wedge and head.

The method of fastening shown in the illustrations herewith has been in vogue in the textile industry for many years for fastening shafts in rollers used in dye-houses and bleacheries. In this country these rollers are commonly made of hard maple and in diameters from 6 to 30 in. or even more. The rollers run as high as 12 ft. in length. Sometimes they are bored the entire length and the shaft passes entirely through them from end to end. In other cases the shafts are a foot or two in length, driven in from each end. In either case they are wedged in as shown. Where the rollers are subjected to twisting stresses, cast-iron spiders are secured to the shafts. The spiders have radial webs fitted into recesses cut in the ends of the wooden rollers.

The mandrel is first turned between centers, using a dog or clamp to drive it, the centers of the lathe entering the wood itself. In this way the whole length, or two steadyrest spots, can be turned at the ends.

The wood is then held at one end in the chuck of the lathe, and at the other end is supported in the steadyrest, as shown in Fig. 1. Then with a tool shaped like *A*, the annular recess *B* is made. Its diameter and depth depend on the size of the mandrel and the stresses to which the center will be subjected. This recess forms a seat for a piece of wrought-iron pipe, the duty of which will be apparent later. This ring of pipe is shown at *C*. The hole *D* is next bored for the reception of the steel center. This should be a tight driving fit for the steel center that is to be driven into it. Before going farther, let me say that the recess *B* should be made so that the ring *C* is a tight fit on the central wooden boss *F*, but a loose fit in the outside *H*, Fig. 2. The mandrel is then reversed in the lathe, and the other end is operated on in exactly the same manner.

Having bored both holes and recesses, the two rings *C* are driven into the ends, after which the two steel centers are driven. There is no possibility of splitting the mandrel, as the rings *C* prevent this. The work can now be returned to the lathe and mounted as shown in Fig. 1. The centers are drilled and countersunk in the steel centers.

If by chance the holes for the centers have been bored too large, this condition can easily be remedied by driving wedges *G*, Fig. 2, inside the rings *C*, between them and the centers. This method of tightening the centers can also be employed later on when the wood has warped and the centers have become slack in their holes.

Hancock, Mich. ROBERT MORRIS.

Reaming with Twist Drills

Mr. Shirley's query for information on drills and reamers has been of more than passing interest to me. After reading the inquiry on page 777, Vol. 45, I wrote out my own convictions on the points mentioned. However, upon rereading what I had written I thought, "Everybody knows that," and so I did not submit my answers.

A few days later one of the jig makers of the shop where I am employed came to me and asked how he was going to make the holes straight, round and of the proper size in a three-hole $\frac{5}{16}$-in. drill guide when there were no reamers of the proper size available and none of the drilling machines or profilers would bore a true hole. None of the millers were available, and he was "up against it right," as he expressed it.

When I asked him why he did not drill and ream the holes with twist drills, he replied that the job had to be pretty near right. I explained that I had met with good success in reaming with drills and outlined the order of procedure as follows:

Place and indicate the part to be drilled; drill a small lead hole that has a diameter about one-half that of the finished hole; follow this with a drill about 0.015 in. smaller than the finished hole is to be; then select a drill that measures at the cutting edge about 0.002 in. smaller

than the hole is to be finished; grind the drill true—that is, both cutting edges at the same angle and the same length—then break the sharp corners with the grinding wheel and finish the cutting edges with a stone.

The job was finished to the complete satisfaction of all concerned. By varying the amount of stock to be removed by the reaming drill I have met with excellent results in making holes in tool steel, machine steel and cast iron in sizes from $\frac{1}{16}$ in. to $1\frac{1}{2}$ in. in diameter. A little thoughtful practice will enable one to get the right grind on the finishing drill with slight extra time and with the accuracy that will finish a hole in a way that will make many a reamer blush with envy.

In Vol. 45, page 1094, Mr. Raught replies to the inquiry of Mr. Shirley and states that "twist drills, as a rule, are made tapering, being very nearly exact size near the shank and several thousandths over size at the point, varying of course according to size." My observations have been that standard makes of twist drills are very nearly exact at the point and taper from 0.006 in. to 0.010 in. per ft., according to size, being under size at the shank. MEYDRON DELMER.

Beloit, Wis.

Training Young Mechanics

On page 33 F. B. Jacobs tells of a machinist who put in the back gear and attempted to ream a taper hole by power with a dull reamer. When told that he should have known better than to make the attempt, he answered, "I do know better now"; and he was discharged.

Power, of course broke the reamer; but it was not on account of the power, but owing to lack of skill and knowledge on the part of the machinist. After the accident he knew better than to try it again, I suppose. The accident had taught him mighty little, and what he had learned was at the cost of the shop. Then he was discharged, with that accumulated knowledge, instead of being retained. Skill is something that even the *American Machinist* cannot teach; it can only be acquired by actual work and considerable of it. There is no inherent danger in using a taper reamer with power. It is done every day and probably every hour with perfectly satisfactory results. All it needs is the knowledge that, when used in a lathe, the reamer must be firmly held back against the tail center, and the skill "to feel" the out.

To discharge the man under the circumstances was certainly a very unwise commercial proceeding as, after teaching a man something at considerable cost and inconvenience, the knowledge gained was then given to some other shop. All foremen will bear me out when I state that the great percentage of machinists are chagrined and ashamed at spoiling a tool or a job; and I assert that the safest man to give a job to and have it come out right is the man who has previously spoiled work of the same kind.

It seems to me that the first error in this proceeding belonged to the shop itself in having its toolroom hand out a reamer that was not in proper condition. The machinist was at fault in attempting to use a dull tool. Next, there was a mistake in not showing the man the real cause of the accident and how to avoid it in the future; the final error was the man's discharge.

Mr. Jacobs asks where we are to get our all-around machine and tool makers, or rather how? Just as we always have—from the ranks of those in the machinist's trade who are mentally and physically suited for such work. Nothing on earth can prevent them from coming along. They will come to the surface as a cork does in water. I can look back a great many years, and I know mechanical work in this and many other countries. Never have I found enough first-class machinists to go around, except during one or two panics. It does of course depend upon the man himself whether he becomes "first class," but he will arrive at that end much more quickly if he is shown the cause of his mistakes and is treated fairly. W. D. FORBES.

New London, Conn.

I think that the article by J. S. Williams on page 935, Vol. 45, is interesting. The past few years show a rapid decline of apprentice learning in machine building, and we do not have to look far into the future to realize that the "old school" is an institution of the past. Although the decline of the apprentice system is inversely proportional to the advent of automatic machinery, there seems no question that we will always require skilled all-around mechanics.

The efforts of a few large corporations that manufacture specialties to institute special apprentice courses are commendable and should not be overlooked. They are, however, negligible in the solution of the problem, when the number accommodated is considered. Besides they aim to produce specialists in particular lines, rather than all-around mechanics.

It is the vocational school to which we must now look for our future skilled mechanic, and its seemingly slow development is directly due to the lack of interest and coöperation on the part of employers. There are a few such schools in this country now, which although handicapped by such lack of coöperation are nevertheless sending out young men who will soon take places as first-class mechanics. There is such an institution here in Brooklyn that has for nearly half a century been training mechanics, not engineers. I owe my machine-shop education to it. This school, one of the first of its kind in the country, founded by a practical and far-seeing American, offering this education to young men at a fraction of cost, is obliged to pay the same price for additions to its equipment as the shop owner who uses his equipment for profit. Naturally, many much-needed machines are beyond the means of such an institution, with a consequent impairment in efficiency.

In the hearty and material coöperation of employers of mechanics with the industrial school lies the solution to the problem of training young mechanics.

Brooklyn, N. Y. J. W. WUNSCH.

Magazine Feed on B. & S. Automatics

The method of obtaining independent chuck opening and closing action, for use on No. 2 B. & S. automatics for magazine work, as described by H. A. Burns, page 67, would necessitate the purchase of another sleeve *M*, Fig. 1, if the machine was converted to rod work.

The method I have followed for several years is to remove this sleeve *M* and substitute for it a plain brass sleeve of the same length and inside diameter, but $1\frac{3}{4}$ in. outside diameter, which does not depress the lever, but allows it to follow the action of the chuck-opening clutch *H* on the rear shaft *A*. It will be seen from the

gear ratio that one revolution of the clutch H will move the chuck-closing cam on the shaft L one-half revolution, leaving the chuck open, when a second dog on E, Fig. 2, will close the chuck at the proper time.

The cam N, Fig. 1, does not actuate the chuck; it feeds the stock on the No. 2 machines. The chuck-closing mechanism is on the right side of the friction pulleys on the spindle and is actuated by the cam shown (but not lettered) directly at the left of the gear on L, driven by the gear K on A, Fig. 1.

I have designed several types of magazine attachment for No. 2 machines and have used this plain sleeve I speak of, substituting the regular sleeve when rod work was necessary. The sleeve, after being milled as shown in Fig. 3, would serve for rod work, but would cause loss of time and extra wear on the chuck-operating mechanism. STEPHEN McEVOY.

Bronx, N. Y.

Truing Worn Triangles

While reading the article on truing worn triangles, by Mr. Fenaux, on page 78, I was reminded of a somewhat similar job. About three years ago I was working at the board in the drawing room of a large Michigan automobile factory. Most of my work was on large layouts, and instead of a T-square I used a traveling straight-edge, about 3½ in. wide and nearly 6 ft. long. This was made of wood, with transparent celluloid edges, and was far from being straight.

I secured the chief draftsman's permission to try my hand at truing it. One evening, when the experimental department was running overtime, I got the use of a planer for the job. I carefully secured the straight-edge against rib irons on the planer table, clamped an electric grinder to the clapper block and, using the machine as a surface grinder, proceeded to grind first one edge and then the other, of the straight-edge. This resulted in such a satisfactory job that a number of the other straight-edges in that drafting room were later trued in the same way.

I have never tried to grind triangles, but I believe it would be a simple matter to do so on an ordinary toolroom surface grinder with the aid of an angle iron and a sine bar. H. M. DARLING.

Greenfield, Mass.

Lapping Flat Steel Surfaces

Earl E. Cline's article on "Lapping," on page 59, while clearly and interestingly described is entirely too scientific, not to say protracted, for the average tool maker to grasp properly.

My experience as a gage maker has taught me that lapping, to a certain degree, requires more or less of a sixth sense, which is developed by natural born skill coupled with practical experience. This fact has deterred me from writing on the subject before, though I was frequently tempted to do so because of the large numbers of tool makers who appear to know little about lapping.

For the benefit of those whose time is limited and who find it necessary to "make time" on a job, I will herewith describe my methods in this art, which I have found satisfactory for all accurate gagework.

For flat lapping, a cast-iron block of fairly large surface, say 12x18x1½ in., is best. The block needs no seasoning, as no lapping plate will remain true very long, which Mr. Cline himself admits when he says "contrary to common belief the lap also wears." This, however, is not such a great misfortune if one will consider the fact that the work is usually much smaller in area than the lap, which means that if a plate of the above dimensions develops a hollow of 0.001 in., a job 2 in. long can only be affected 0.0001 to 0.00015 in., which can be corrected by rubbing the work along the edges of the plate to avoid the depression. With little care a lapping block can be nursed in such a way as to keep it perfectly true by simply using all of its surface instead of plowing "holes" in the center of it as is so often the case. I have made knife-edge straight-edges 5 in. long on a lap 8 in. square. It is advisable in all cases to make longitudinal grooves in the plate about ½ in. apart to hold the abrasive, moving the work to and fro along the surface in long strokes at right angles to the grooves.

The best way to charge such a lap is to sprinkle a small quantity of 4 to 6 F emery flour on it and add a little clean gasoline; cover this with a cast-iron block of about half the area of the lap and weighing about 15 to 20 lb., and move this in all directions. The abrasive is thereby evenly distributed and all the coarse particles of emery ground down. This should be continued for 30 or 40 sec., or until the surface of the lap begins to dry, when it will have an even mat appearance that will be found ideal for good work. A lap so charged will cut fast and smooth, and the older it gets the better it works. No wiping-off should be resorted to or all the abrasive will be brushed away, as you cannot "force" it into the lap without considerable pressure, which tends to destroy the true surface so essential. With the lap described all the excessive emery will lodge in the grooves, thereby eliminating accidental scratching of the work, which is inevitable with a plain lap. When recharging the lap the emery is brought to the surface again by the gasoline, a little of which is added from time to time.

When proficiency is acquired it will not be necessary to resort to this tedious and cumbersome method of charging. Just take a little wad of clean waste slightly soaked with gasoline and swab the plate lightly; this will give good results nine times out of ten.

Hold the work firmly and never rub in circles, as this is a sure way of making the lap hollow. If the work is held too lightly it will never be true. In fact I have always found it necessary to use considerable pressure in order to insure perfect contact between the lap and the work; otherwise it will surely be bell-mouthed. This is also invariably the case where wet lapping is resorted to, as the "lapping mixture" will get between the lap and the work, thereby causing imperfect contact. Local heating and curling of the work are hardly worth considering in more than a figurative sense, and I would not advise any one to worry over it.

Many tool makers grind their work carelessly, expecting the lap to correct all evils, with the general result that it only gets worse. A good job of lapping can only be preceded by a good job of grinding, and it is cheaper to regrind a piece of work that is badly bell-mouthed than to lap away on it in desperation. The less lapping, the better. Lapping is no fascinating art, but simply hard and tedious work.

The foregoing applies only to lapping in its simplest form. More real skill is required in lapping angles, re-

cesses and other awkward portions of a job where a lapping block cannot be used. In such places the finish is not so important a factor as accuracy. Take, for instance, a snap gage made from 1/8 to 1/4 in. ground stock or cold-rolled steel. A first-class job of grinding will bring this to within 0.0002 to 0.0003 in. and slightly belled on the ends. All that is necessary now is to lap down the high spots with a fine india stone, using a straight-edge and prussian blue to gage with; by the time the sides are straightened out the master, or plug, will just about fit. What if the wheel does leave a few scratches? There is no real depth to them, and the utility of the gage is in no way affected. No one wants to pay for extraordinary finishes that add only expense, as the last 0.0001 in. removed usually costs about four times as much as the first 0.001 in.

I trust that the foregoing will tend to correct some of the queer notions entertained by the average tool maker on lapping and have an enlightening influence on this difficult subject. FELIX WYNER.

Factory Manager, De Mant Tool and Machine Co.
New York City.

Lagscrews Used as Foundation Bolts

On page 31 A. L. Haas shows a foundation-bolt kink that is new to me, and perhaps the method I have used with fairly good results would be of interest to some readers.

First, drill the holes in the concrete foundation, making them considerably larger at the bottom. Next, fill the hole full of lead or soft babbitt. Drill a hole in the babbitt the size of the root of the thread of the lagscrew that is to be used. Put plenty of white lead on the lagscrews, and screw them in. The threads on the lagscrews will cut their own way into the babbitt, at the same time expanding it in the concrete. J. A. RAUGHT.

Janesville, Wis.

Formulas for Testing Gears

J. A. Potter's article, page 5, does not go far enough to be of much practical use in the majority of gear departments. He gives formulas for calculating the sizes of plugs, to be used for measuring the pitch diameter of gears and the dimension measured over the plugs, for an even number of teeth. This is not a difficult problem and is of little value unless the formula for determining the size over the plugs for an odd number of teeth is known.

Measuring the pitch diameter of gears by the use of these formulas is impractical in any shop handling in quantities gears of varying pitch and size, as even for gears of the same pitch the size of the plugs changes according to the number of teeth in the gear. For instance, a 22-tooth 8/10-pitch 20-deg. gear calls for plugs 0.2149 in. in diameter, while for a 16-tooth 8/10-pitch 20-deg. gear the diameter of the plugs would be 0.2174 in. An inspection method like this would lead to endless confusion and mistakes.

The only practical way of measuring the pitch diameter of gears by means of plugs is to select a plug size for each pitch (if the size is calculated for a 22-tooth gear, we get a good average size). Then the required dimension over the plugs can be figured out for whatever number of teeth is to be cut. Notice that I say can and not should, as the practical man would prefer to cut a pair of sample gears, to run without backlash, at the desired center distance, taking his dimension over plugs from them. If figures alone are to be relied on, do not make the mistake of cutting the gears to the exact size worked out, as an allowance of from 0.002 to 0.004 in., according to conditions, must be made to produce gears that will run at correct center distance.

Detroit, Mich. A. E. BURRELL.

Hardening High-Speed Steel

Referring to the request on page 126, concerning the hardening of high-speed-steel cutters or tools of irregular shape and great accuracy, there are nearly as many ways to treat high-speed steel as there are to treat carbon steel. Where a form cutter of substantial cross-section has a light section or projection, the best results would probably be obtained by the use of a barium furnace, adopting a muffle furnace for the preheating and the barium furnace for the high heat.

High-speed steel should be thoroughly preheated to a temperature of about 1500 to 1550 deg. F. The length of time depends entirely upon the section. After thorough preheating transfer the work quickly to the barium furnace, which is brought to a temperature of about 2200 to 2250 deg. F.

After the tool has reached the proper heat, 2200 to 2250 deg. F., it is immersed in a good quenching oil. Keep the tool moving in the oil, so that it will harden uniformly; and keep it in the oil until cool. After hardening, it is well to draw the steel; for a formed cutter I should say to a temperature of about 450 deg. F. In some cases the draw should be to about 750 or 775 deg. F.

The purpose of the draw is to relieve certain strains in the steel. It will be found that the steel will give up very little hardness. The last-named draw will leave the steel slightly harder and tougher.

In the hardening of high-speed steel considerable success is obtained with the muffle furnace; and as for the scaling of high-speed steel when heated in this type of furnace, much of this is due to poor combustion and to too much air striking the tool. Successful hardening can be done in muffle-type furnaces; but when there are light projections, as on form cutters, etc., there is a chance of considerable scaling, because the light projections will become hot so much more quickly than the heavier part of the tool.

Quenching or cooling may be done in oil or air blast; but when it is not convenient to use the air so as to apply it on all sides of a cutter, oil may be used with satisfaction. It is necessary to draw the temper of cutters, formed tools, etc., because while it does not impair the hardness, it does relieve hardening strains.

A point worth mentioning in connection with hardening high-speed steel, as well as carbon steels, is that, when quenching, the tools should be kept completely submerged until cold, and there should be an ample supply of oil for quenching. Another point to bear in mind is uniform heating. With these particulars in mind and judgment in heating, high-speed steel can be used for almost all tools made from carbon steel.

Wilkinsburg, Penn. J. THOMPSON.

Standardizing Airplane Parts

EDITORIAL CORRESPONDENCE

SYNOPSIS—The growth of the airplane industry to the point of having a convention of its engineers and those who supply parts for it marks the passage from the experimental to the manufacturing era. The standardization of parts as one of the first steps is a hopeful sign for the future.

The first meeting of the airplane engineers under the auspices of what is soon to be the Society of Automotive Engineers was held on Feb. 9. The large and enthusiastic attendance indicates very clearly that this is really a new industry, not a passing fad or fancy. In his opening remarks Chairman Henry Souther called attention to the marked similarity between the airplane industry today and that of the automobile 10 or 15 years ago. At that time men were asking the same questions as to reliability and practical use of the automobile as are now being asked in regard to the airplane. The new industry, however, has the advantage of being able to utilize the experience of the automobile engineer to a very large extent; and while the new problems differ from the old, the experience gained in making automobile motors and other standard parts can be of direct service in the new industry.

Mr. Souther called attention to some of the differences between the airplane and the automobile which have been brought out by his connection with the Army Aviation Board. To a large extent the motor must be designed for the particular type of plane in which it is to be used, both on account of power and the distribution of weight. In other words, it would not be feasible in many cases to transfer a motor from one type of airplane to another plane of a different type. He told of the practical work that is being done at the army aviation schools, about which comparatively little is known; only the accidents are published in the daily press.

Mr. Souther emphasized the need of a production organization in airplane manufacture, in order that machines may be turned out fully equipped and on time, this being practically impossible with a small shop. The duplication of parts is the basis of economical production, which means that standardization of parts and fittings is absolutely necessary. Every draftsman should have a list of standard parts, which are to be incorporated in his designs, instead of his being left to put in fillets of different radii and bolt heads of different thicknesses as his fancy dictates. Mr. Souther suggested that the data sheets of the Society of Automobile Engineers should be used as far as possible.

ALLOY-STEEL NUTS UNNECESSARY

The main paper of the session dealt with the question of standardizing airplane parts, as brought out by F. E. Diffin. This will be published soon. There was much discussion of extreme interest, and the necessity was pointed out of all designers being familiar with the standards already in general use, such as the sizes of screw slots. The designer should also know what sizes of material can be had that will answer his requirements, so as to avoid the delay of having special sizes made or the waste of having to turn off excessive stock, if commercial sizes are used.

Mr. Diffin told of over a thousand tests which his firm had made on the strength of nuts and which led to advocating the use of cold-rolled instead of nickel or other alloy steel for this purpose. In all these tests they have never had a nut break or tear out in the thread. The difficulty of tapping good threads in 3½ per cent. nickel-alloy steel, which is demanded by some airplane builders, led to these tests being made, which confirmed the belief that alloy steels are unnecessary for this purpose.

The effect of standardizing such parts as bolts and nuts, both as to material and size, will be to greatly increase production and decrease cost to the manufacturer and the consumer. It will, furthermore, reduce delay, which is often of more importance than actual cost. As an evidence of this, Mr. Diffin cited a report from the screw-machine department showing an efficiency of only 36 per cent. for the previous month, owing to difficulties of machining alloy steels and the changing of tools for different designs of the same size of bolts and nuts.

STANDARDIZATION DOES NOT HANDICAP DESIGNERS

Standard designs for pistons, connecting-rods, crankshafts, propeller hubs, strut connections, etc., were advocated by some, while others opposed attempts to standardize much beyond such parts as bolts and nuts. The same arguments were brought out that have been advanced against all kinds of standardization by the machine-tool builders and others. But the amazing growth of the automobile industry, due largely to the work of standardization of parts, proves that this practice does not hinder development, as many seem to fear. Standardization in reality works for better development, as it leaves the designer free to think about the important problems by removing all small and comparatively unimportant details from his mind.

The advent of some of the well-known automobile engineers into the field of the air motor has aided and will aid greatly in its development along practical manufacturing lines. Mr. Vincent, of the Packard Co., told how he had utilized standard-sized bolts in all his designs and used only three sizes, ¼, ⅜ and ½ in., on the whole motor. This work, in turn, is reacting on the automobile field, and he feels sure the time will come when the automobile tool kit can almost be carried in the pocket.

Mr. Vincent also brought out the point that for greatest efficiency the cross-sectional area of a bolt in tension should be as uniform in area as possible. As the weak spot in the bolt is the root of the thread, he drills all his b lts with such a size hole as will leave the area of the body the same as the root of the thread. This hole does not need to be drilled clear to the thread, but only deep enough to give a substantial length of the bolt with no excess of strength over the thread. Another method of accomplishing the same result was suggested by Mr. Brush—by turning down the body of the bolt from the thread to a distance of about one bolt diameter from the head. Still another suggestion was to use a die having a long tapered lead to the bolt, so that the reduction of

area shall be very gradual from the body toward the end.

One member, who was evidently very familiar with the difficulty in introducing the A.S.M.E. standard machine screws, pointed out that it is much easier to adopt standards than to induce people to demand them. He cited the difficulty of securing A.S.M.E. screws from stock even now, after they have been adopted about seven years; and he pointed out that the only way to secure the adoption of such things is to induce consumers to insist on ordering these sizes. If a customer will not buy anything but the standards adopted, makers will soon carry standard sizes in stock. The individual, however, can do very little in this line, as he must have his parts promptly to get out his product. It is only by coöperating with others and by all demanding the standard sizes that the desired result can be accomplished.

The standardization of airplane parts would also help the fliers, according to Captain Goodyear, who spoke of some of the experiences on the border, where it was necessary for a truck to carry material from which the various sizes of bolts and similar parts could be made as needed for repairs.

Salvaging Damaged Airplanes

Mr. Manly told of an interesting visit to the salvaging plant of the British air service. Here the damaged planes that cannot be repaired at the field base are brought for final repair or destruction. Huge bins are provided, in which the wings, tails, rudders, ailerons, motors, etc., of a certain type of machine are placed as fast as they are removed from the damaged planes. After enough have been collected to make a complete plane, they are reassembled, tested and flown back to the front for further service. This practice would be impossible without standardization of parts to a large degree, and its advantages are clear both from the point of cost and of rapid salvage.

Another paper, by John J. Rooney, of the Wright-Martin Aircraft Corporation, dealt with "Suggestions for Standard Tests of Airplanes." Mr. Rooney pointed out the advantages, if not the necessity, of having definite data as to flights of new machines. The usual distance between the factory and the flying field and the absence of the engineer from the field make actual records of changes and results exceedingly hard to secure. Mr. Rooney gave blanks listing the data desired and other suggestions for obtaining the information needed.

High-Pressure Aviation Engines

Leigh M. Griffith gave "Some Notes on High-Pressure Aviation Engines." He discussed the adaptation of automobile racing engines to airplane work and the introduction of higher compression in both two- and four-cycle engines. He also took up the questions of jacket-wall design, thermal resistance of cylinder walls, proper piston material and weight reduction with best cylinder construction. In this connection he cited a case where he had built 4⅝x7-in. cylinders of nickel and carbon steels, which weighed only 24 lb. per pair and gave 9.8 cu.in. displacement per pound of weight. They gave 116 lb. mean effective pressure. Mr. Griffith also pointed out the need for better spark plugs and the advantages of multiple valves.

Elmer A. Sperry presented an interesting paper on "Aërial Navigation Over Water," showing the difficulties brought about by drift, with nothing to go by but reference to the earth. His contention that the crests of waves can be used as lines showing the direction of the wind is not in accord with the experience of some fliers, who contend that the wave crests are not visible at the usual flying height of 2500 to 3000 ft. They assert that definite land or sea marks are the only positive guides.

An extremely interesting paper on "The Evolution of Wing Trussing" was presented by Prof. F. W. Pawlowski, of the aëronautical courses, University of Michigan. It was illustrated by 45 diagrams showing the development from the glider to the triplane, and divided them into N, K, V and X types, giving the characteristics of each.

The success of the first meeting speaks volumes for the future of this branch of the Society of Automotive Engineers.

What Constitutes Depreciation of Machinery?

By William H. Harrison

In connection with valuation work for railroads and other companies I have been asked the question, "What constitutes depreciation of machinery and what percentage of its cost should be deducted?" Some mechanical engineers take an arbitrary percentage for each year that the machines have been in use. Some have argued, "Why should not all machines be estimated at an average cost irrespective of what each individual maker charges?" In my opinion both these assumptions are wrong.

First, because individual wear on different machines varies. In a great many cases a machine that has been purchased later than another has been used harder and has depreciated more than the older machine. Each machine should be subject to depreciation separately. An instance can be cited of a railroad shop where certain lathes delivered several months before the rest—all of the same size and weight—were in a better condition than those delivered later. Another shop had a large miller that was practically new, though purchased some years before. Investigation disclosed the fact that it had not been used very much. If the railroad company at that time had wanted to dispose of it, they would have received as much as, if not more than, they paid for it. Again, one railroad had a double-end wheel lathe that from the make I knew could not be less than 40 years old. It was in use, doing good work, and upon investigation was found to be earning a percentage on its cost greater than that earned by the more improved high-priced wheel lathes also in use. It would, however, be difficult to value these old lathes from the viewpoint of a customer, as the market value of the lathes would not be considered as great as that of the newer though less efficient ones.

Second, it is impossible to average any cost price on machinery. At the time the foregoing valuations were made, for example, you could go into the market and purchase 16-in. swing lathes for from $350 to $1500, depending upon make, type and attachments supplied. Yet mechanical engineers, possibly without selling experience, argued against valuation based on facts as above set forth. Possibly some of those in the employ of the Interstate Commerce Commission have been considering the matter, and this may lead to a discussion.

Editorials

Our Unsubmarined Foreign Trade

In a special bulletin on foreign-trade conditions the National Association of Manufacturers counsels coolheadedness on the part of anyone who is doing an export business. It is pointed out that for many months submarine activity on the part of the Central Powers has brought about the destruction of many merchant vessels; nevertheless, the import trade of the countries most directly affected has notably increased, while the value of the exports has tended to increase rather than decrease.

In support of this encouraging statement the following figures showing our exports to France, Italy and the United Kingdom during eleven months ended November, 1915, and for the same period of 1916 are given:

VALUE OF AMERICAN EXPORTS FOR ELEVEN MONTHS

Country of Destination	1915	1916
France	$452,576,134	$802,132,401
Italy	247,411,431	265,537,270
United Kingdom	1,072,887,384	1,702,906,305

Furthermore, our imports from those countries have shown an increase during this same period despite submarine warfare. The following figures illustrate this fact:

VALUE OF AMERICAN IMPORTS FOR ELEVEN MONTHS

Country of Origin	1915	1916
France	$67,935,357	$98,404,909
Italy	47,105,500	55,445,970
United Kingdom	231,192,517	279,727,143

The apparent failure of the submarine campaign as a means of blockading the ports of Great Britain, France and Italy is shown by a comparison of the trade of the United States with those countries for the last month for which statistics are available—namely, November, 1916. These statistics compare with those of the same month for the year 1915 as follows:

AMERICAN EXPORTS FOR THE MONTHS OF NOVEMBER, 1915, AND NOVEMBER, 1916

Country of Destination	1915	1916
France	$49,950,576	$91,732,089
Italy	26,150,026	35,584,578
United Kingdom	104,632,785	145,684,875

These totals are significant and should strengthen the response of American manufacturers to the duty of continuing to cultivate export trade with the same energy and degree of optimism that have characterized the business dealings of most of them during the two and one-half years of war that have already passed.

Educational Orders for Rifles

In accordance with the plan to give out small educational orders for various munition materials, there will probably be orders for Springfield rifles as well as for shells and other supplies. The order is understood to amount to 30,000 or 35,000 rifles to each shop, hardly enough to secure economical results or to interest some of the rifle plants in properly equipping for the making of a new gun.

The Army appropriation act of last summer (HR 17,498), however, provides that $200,000 of the appropriation of $5,000,000 for arms may be used to procure gages, dies, jigs, tools, fixtures and other special aids and appliances, including specifications and detailed drawings necessary to the manufacture of arms by private manufacturers. The purchase of arms for the purpose of completing the necessary quota need not be competitive, up to contracts for $50,000.

This provision recognizes the necessity of providing jigs and fixtures on small orders, but the amount is inadequate. The manufacture of rifles in even a few plants requires a vastly larger expenditure for jigs, fixtures, tools and gages. And these are essential both for rapid manufacture and for reasonable interchangeability of parts.

Another feature that must be considered carefully is the life of gages constantly used in this work. The cost of gages—that is, the necessary replacement due to wear—is variously estimated at from fifty cents to a dollar per rifle, a cost which must be taken care of and which counts up even on a contract for 30,000 rifles.

If rifles are required rapidly, several sets of these "aids and appliances" must be made at once and by different manufacturers. The designs used at the Springfield armory and so fully illustrated in our articles on rifle manufacture will serve as a guide, as they have been proved out in actual practice. They can probably be modified to advantage to suit the machine equipment of the different shops, but they should be sufficiently standardized to enable them to be used in many shops. Also they should be owned by the Government and stored in suitable locations when not in use.

The size of the orders should be sufficient to secure a fair economy of manufacture, so that should the necessity arise a large and constant output can be secured at short notice.

Difficulties of the Past Two Years

It is being said that American manufacturers are losing the good name that they have heretofore had abroad. The charges against them include the sending of poorly built machinery, failure to ship when and as promised, disregard for many of the important provisions of their contracts and an attempt to obtain every possible financial advantage from foreign transactions.

Without doubt there is some justification for each one of these charges. But "one swallow does not make a summer." It is unfair to judge all American businessmen by the acts of a few. It is doubly unjust to judge all by the acts of pirates who have been able to carry on their detestable methods because of the unusual stress and strain of business conditions.

From every viewpoint of fairness the *American Machinist* asks that all the facts be taken into consideration before American manufacturers are condemned in wholesale fashion for the unfortunate happenings of the past two years.

Since the outbreak of the European War the manufacturers of the United States have had a tremendous

burden thrown upon their producing facilities. This load they were but ill prepared to handle. The more conservative realized this fact and established a policy that has carried them along without serious mishaps. But the glittering prospect of enormous profits in manufacturing attracted many who knew nothing of its principles or practice and gave rise to mushroom concerns founded and managed by irresponsible men who rushed headlong into the taking of orders and the attempt to fill them. The result has been disaster to themselves, disgust on the part of their customers and the raising of a cloud over the name of American businessmen in general.

But the many should not be condemned for the acts of these few.

It is not likely that anyone who has not actually been engaged in manufacturing during the last two years realizes the tremendous difficulties encountered by established firms. First, came the sudden demand to double or perhaps even treble production. A tremendous task in itself under even normal conditions! Second, machinery was almost impossible to obtain short of months' or even a year's delivery. In many cases the time was even longer. Third, skilled help could not be obtained—it simply did not exist unemployed. The time and trouble required to take unskilled men and make them into efficient producers in machine shops have been pointed out time and time again. Fourth, materials not only increased enormously in price with a lengthening of the time of delivery, but likewise decreased in quality. It has been a day-and-night fight to obtain material when wanted. Fifth, inspection to uphold the quality of the product turned out was enormously increased in difficulty, because of the added responsibility to watch out for the results coming from unskilled labor and possibly improper material. It is no exaggeration to say that in many plants inspection has trebled in cost per unit of output. Sixth, labor troubles have affected some communities to a degree that has seriously hampered production. Seventh, there has been some difficulty in financing foreign business.

These seven items are the most important of the difficulties that manufacturers have faced, though by no means has the list been exhausted. They are all due to the stress of business conditions. They could not have been foreseen nor guarded against. In the face of them the American manufacturer has been compelled to do the best he could.

So we make the plea to measure results alongside of demands, to consider failure beside difficulty and in a spirit of fairness to "give the devil his due."

Buying Shells by Results Rather Than by Specification

There is one phase of the recent bid for projectiles that must not be overlooked. These shells are not purchased by any specification except that they must be of steel and must be in a condition to explode after passing through an armor plate as thick as their diameter. In other words, the Government buys results rather than a specified article, and this makes even the specification as to metal seem superfluous.

This means that the maker can use any grade of steel that can be so treated as to meet the requirements. There is no question as to whether high- or low-carbon steel be used; whether it be crucible, openhearth or bessemer, with or without alloy. If three out of every hundred shells go through an armor plate as thick as the diameter of the shell in a condition to explode, the Government asks no questions as to how they were made. Furthermore, all shells that crack from internal stresses, within three months, must be replaced.

Under these conditions, which make the manufacture of armor-piercing shells somewhat of a speculation, high prices are to be expected. But the submission of almost identical bids by all the makers points to either some sort of a gentleman's agreement or to an unheard-of accuracy in estimating costs.

Whether this be the best method of buying shells is open to question. It seemingly assures the Government of shells that will perform the desired function, but it is certainly not desirable to have the Government officers ignorant of the material of which the shells are made or the way in which they were manufactured.

Practical Preparedness Against Fire

The value of training and constant preparation for fighting fire in industrial plants is shown by a recent report of the Pennsylvania R.R., more than $14,000,000 worth of company property having been saved during the year 1916. This included the extinguishing of 385 fires before the arrival of the fire companies. The total loss was only $16,437.42, while the property endangered was valued at $14,536,430, the average loss being a trifle more than one tenth of one per cent.

Water casks and pails, chemical fire extinguishers and locomotive fire apparatus were all utilized with gratifying results. The number of fires was also considerably reduced, which seems to indicate greater care.

While fire drills are perhaps uncalled for in many shops, no shop is too small to have a little instruction and suggestion as to what to do in cases of emergency. Every employee should know how to telephone fire headquarters, and suggestions as to what to do first in case of fire will prevent much loss and may aid in saving life.

Our "Ministry of Munitions"

On Feb. 13 the Advisory Commission of the Council of National Defense organized its work by establishing seven committees, each headed by a member of the commission. The one that will deal with machinery building and machine shops is the one on "Munitions." Its chairman is Howard E. Coffin. It is a source of satisfaction that Mr. Coffin has been selected for this important post. The responsibility and opportunity come to him in true American fashion. He has made good. As chairman of the Preparedness Committee of the former Naval Consulting Board he carried through to successful completion a stupendous task, when during last year he surveyed some 27,000 manufacturing plants.

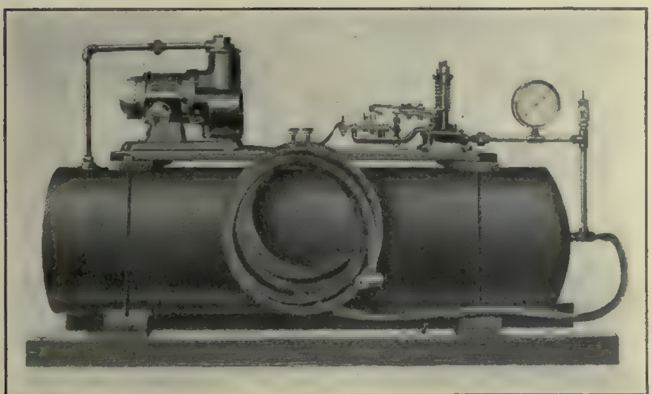
His Munitions Committee is to have charge of the manufacture of munitions throughout the United States, including the work of standardization for manufacture, control of the industrial relations between private plants and the Government and oversight of the inter-relations between private plants.

Mr. Coffin's task is a huge one. The *American Machinist* wishes him a full measure of success.

Shop Equipment News

Compressed-Air Tank Outfit

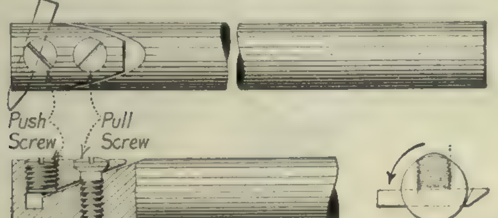
The compressed-air tank outfit illustrated is one of the recent productions of the Black & Decker Manufacturing Co., of Baltimore, Md. While it is primarily intended for service in garages, it should be equally useful in machine shops where a small compressed-air outfit is desired. The electric motor for driving the pump is equipped with universal windings, which allow the use of either direct or alternating current. An automatic switch shuts down the motor when a pressure of 150 lb. per sq.in. is reached and starts it again when the pressure drops to 120 lb. All moving and electrical parts are inclosed to protect them from injury or dirt. The storage tank is equipped with a safety valve and a cock for draining condensation.



COMPRESSED-AIR OUTFIT

Boring Bar for Lathe Work

The tool illustrated herewith is one that has recently made its appearance on the market, being known as the improved lever-clamp boring bar. Its feature is the utilization of the principle of the lever in clamping the tool in the bar. The method of clamping the tool is as follows: Both the push and pull screws are loosened, and the tool is inserted in the bar. The push screw is then tightened down on the tool. If the pull screw is now tightened, the push screw is forced against the tool with a considerably greater pressure than is put upon the pull screw, due to the mechanical advantage gained by means of the lever involved.



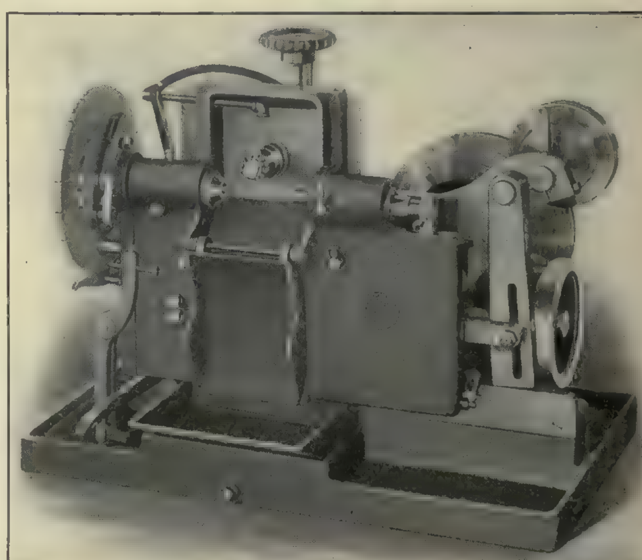
IMPROVED BORING BAR

The boring bar is being marketed by the Rigid Tool Holder Co., Washington, D. C.

Gear-Cutting Machine

The Waltham Machine Works, Waltham, Mass., have recently placed on the market a 4-in. gear-cutting machine, shown in the accompanying illustration. The machine is intended especially for cutting watch, clock or other similar gears with pitch not coarser than 16. The operations of feeding and indexing are automatic and continue until the completion of the last cut, when the machine stops. The index wheel is 10 in. in diameter. The cutter slide is lifted during the return stroke of the work, so that the indexing may be accomplished more quickly. The alignment of the cutter to the center of the work is secured by rotating the cutter spindle bearing.

The machine is provided with a lubricant reservoir and pump, and parts are protected against chips. The work slide is driven from the camshaft by a worm and gear. With a standard cam the stroke is adjustable between 2 and 3 in., but shorter cams are furnished when needed. The location of the work slide with relation to the cutter is adjusted by turning the pinion shaft, and the depth of the cut is controlled by a graduated handwheel. The machine is equipped for two speeds and four feeds. The base measurement is 28x18 in., and the weight is about 500 lb.

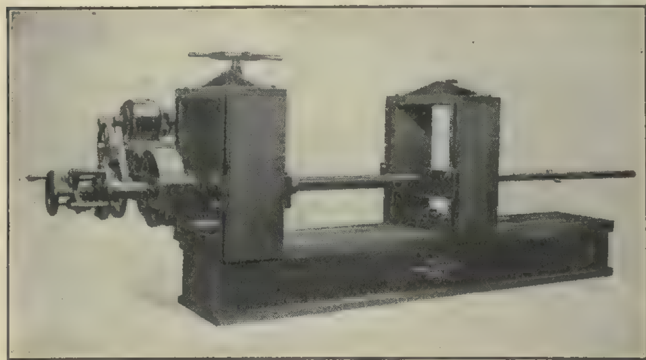


GEAR-CUTTING MACHINE FOR USE IN WATCH- AND CLOCK-MAKING WORK

Horizontal Boring Machine

The Pedrick Tool and Machine Co., Philadelphia, Penn., has recently placed on the market a new horizontal boring machine intended particularly for boring and drilling miscellaneous work. The machine consists of a bed, with T-slots on the upper surface at each side, equipped with two movable housings that support the boring bar at suitable heights above the bed. The main

bearing for the bar consists of a quill with crossheads at each end that are bolted to the two sides of the front housing. The handwheel shown on the front housing operates



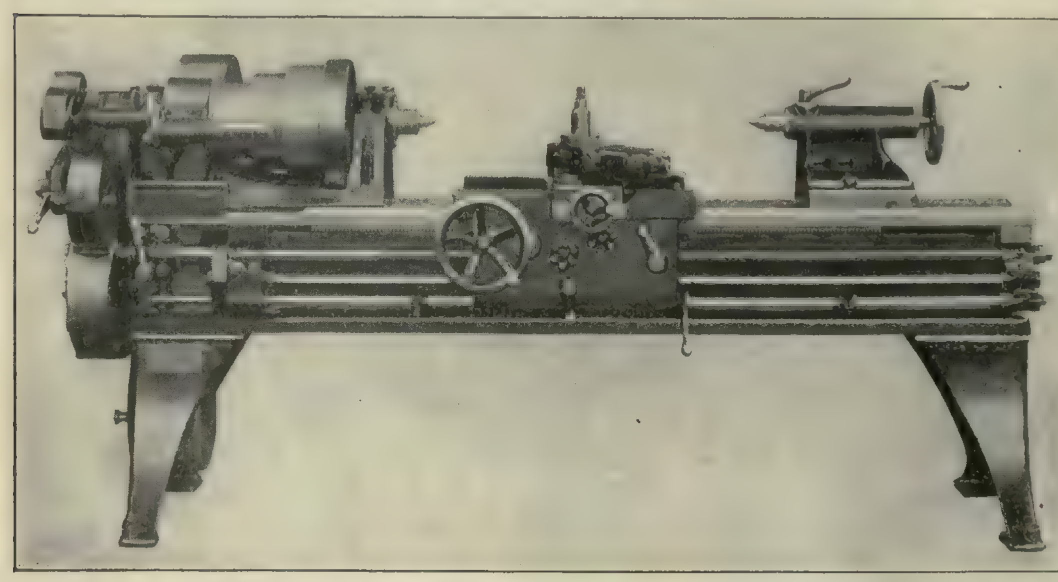
HORIZONTAL BORING MACHINE

the elevating screw for adjusting the height of the bar. A ball thrust bearing is provided.

In order to secure a smooth drive the main driving gear is divided, the teeth in one half coming opposite the spaces in the other. Various speeds are provided for by means of gearing. The feed is reversible and has three changes, the feed screw being located in a recess on one side of the boring bar. Quick return is secured by removing the half feed nut and sliding the bar through the bearing. The machine may be used with a traveling bar or with a fixed bar and traveling cutterhead. Holes up to 16 in. in diameter may be bored on a machine with a 3-in. bar. If the hole to be bored is smaller than the main bar, an auxiliary bar supported at one end only is pushed through the work.

Lathe with Relieving Attachment

This lathe is built by the Springfield Machine Tool Co., of Springfield, Ohio, and is along lines similar to its regular Ideal class. However, a three-step cone is employed, a cutter-relieving attachment added, and it is made especially to cut metric threads. The method of gear changing, which has previously been described in our columns, is the same as for ordinary threads. Some slight modifications have been made in the apron-operating knobs and levers, but otherwise the machine is practically the same as the company's regular 18-in. Ideal lathe.

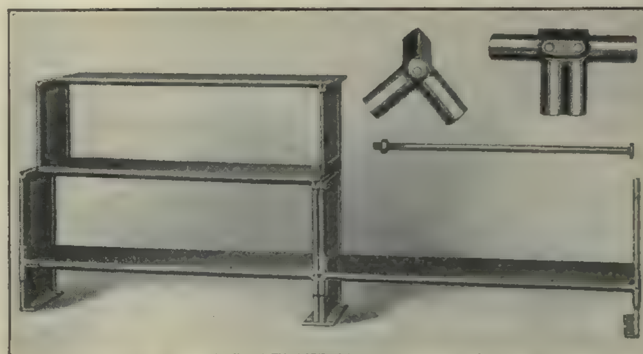


LATHE WITH RELIEVING ATTACHMENT

Swing over bed, 19 in.; over carriage, 13 in.; length of carriage, 24⅞ in.; hole through spindle, 1 9/16 in.; diameter of nose of spindle, 2¾ in.; has double back gears and relieving attachment; cuts metric threads; shipping weight, 8-ft. bed crated, approximately 3200 lb.; dimensions boxed, about 110x40x34 in.; or 86 cu.ft.

Sectional Steel Shelving

The National Scale Co., of Chicopee Falls, Mass., is marketing the sectional steel shelving illustrated, which is known as the Multi-Unit type. It is intended especially for factory or other use where considerable rough handling is expected, and is built of sheet steel. It can be



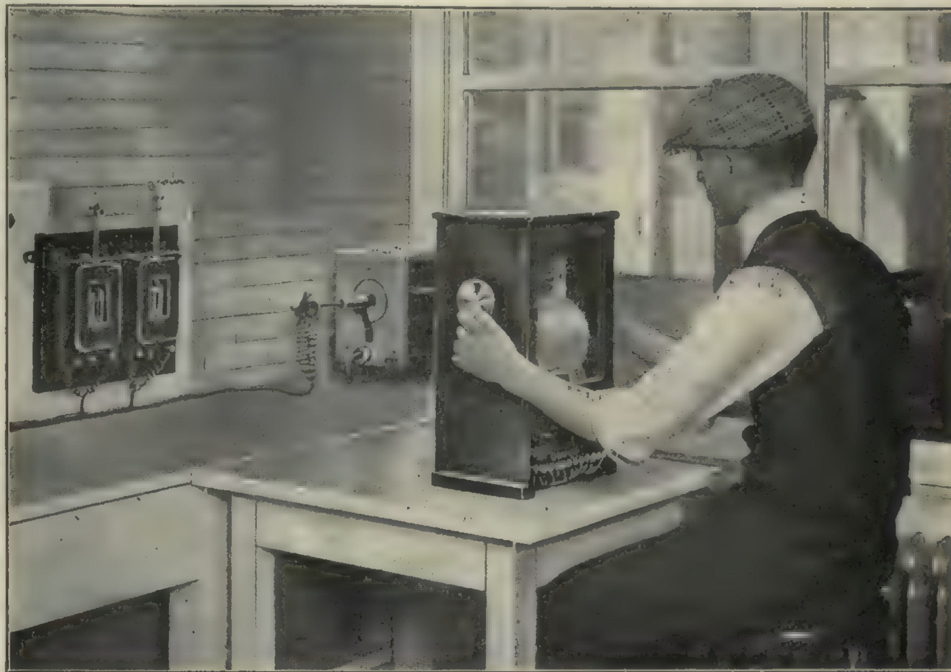
SECTIONAL STEEL SHELVING FOR FACTORY USE

built up in any number of sections desired, all units being interlocked. All parts are interchangeable. At present the units are supplied only in the standard size, 36 in. long, 12 in. high and 12 in. wide, but a variety of sizes is soon to be added. It may be procured in plain steel, black or olive-green enamel.

Apparatus for the Location of Thermal Transformation Points

In answer to a demand for some sort of apparatus by means of which the critical or transformation points of steel being heat-treated could be accurately located, the Leeds & Northrup Co., Philadelphia, Penn., has recently brought out the apparatus shown. The method employed is as follows: The sample under test and a body that will heat at a uniform rate—that is, a body having no transformation points—are heated in close contact one with the other. Two thermocouples are employed, one measuring the temperature of the sample and the other the temperature difference between the sample under test and the second body, termed the sample holder. Temperatures are plotted as one

ordinate and the corresponding temperature differences as the other. As long as both sample and sample holder heat uniformly, there will be no change in the temperature-difference ordinate; when, however, the temperature of the sample remains stationary or lags behind the temperature of the sample holder, due to a transformation in the steel, the temperature-difference ordinate, formerly approximately zero, undergoes a large percentage change, even though the actual change in temperature difference is small. The means used for detecting the difference between sample temperature and neutral-body temperature is a thermocouple composed of two pieces of platinum joined by a short piece of platinum-iridium alloy. The changes in the electromotive force due to changes in temperature are indicated by a reflecting galvanometer. In order to eliminate the labor and the possibilities of error involved in reading off the temperatures and temperature differences simultaneously from two different instruments, the transformation-point indicator, which constructs its own graphical chart, has been designed. The paper upon which the chart is to be made is mounted upon a drum, which also carries the potentiometer slide wire. Bearing upon this drum is a pen. As the drum is revolved to keep the potentiometer in balance, the pen automatically records the corresponding electromotive forces, or temperature, upon the paper. The pen, together with a semi-transparent target, is mounted upon a carriage, and this carriage can be made to travel parallel to the axis of the drum by rotating a wormshaft. The operator making the curve moves this carriage in such a way as to keep the spot-light from the galvanometer connected to the difference couple on the semi-transparent target. By so doing the pen is caused to move back or forth across the record whenever the difference in temperature between sample and neutral body changes, thus indicating when a transformation point is reached.

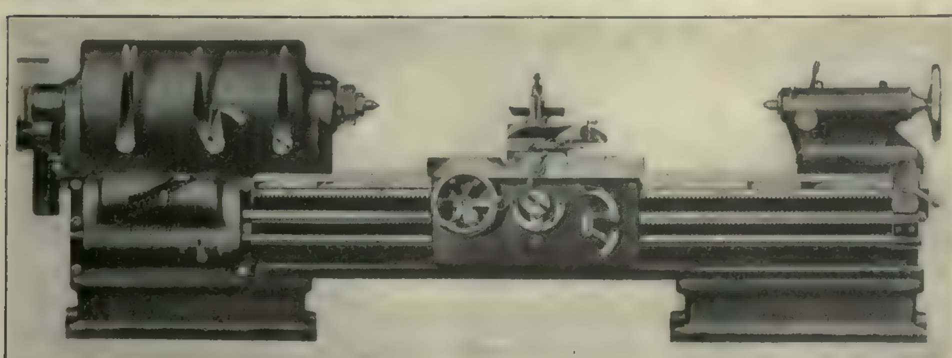


TRANSFORMATION POINT APPARATUS IN USE

The charts are about 20 in. long and 5 in. wide and cover temperatures ranging from 500 to 1800 deg. F.

Heavy-Duty Engine Lathe

The 26-in. heavy-duty engine lathe shown herewith is one that has recently been placed upon the market by the Oliver Machinery Co., of Grand Rapids, Mich. The machine is of the all-geared type, with a single pulley drive. The spindle speeds, twelve in number, range from 8 to 300 r.p.m. All gears are inclosed and run in oil; bearings are of the two-piece type, of bronze. The spindle is hollow, the hole being of such size as to permit the passage of a 3-in. bar. The spindle is lubricated by means of felt wipers connecting with oil chambers. The tail spindle is 4 in. in diameter and is provided with a clamp acting on two sides. The tailstock is moved along the bed by means of a crank and gear. The cross and toolpost slides are provided with taper gibs, allowing for adjustment in case of wear. The hand carriage movement is accomplished either by the regular handwheel or rapid-movement crank placed on the extended end of the intermediate gearshaft. Oil-bearing felt wipers are provided at both ends of the carriage, to lubricate the ways and clear off dirt or chips. Both longitudinal and crossfeed are by means of friction drive. A taper-turning attachment is attached to the rear of the bed.



ENGINE LATHE WITH ALL-GEAR DRIVE

Swing over bed, 28½ in.; swing over carriage, 17 in.; length between centers, 72 in.; spindle speeds, twelve, 8 to 300 r.p.m.; cuts threads, 1 to 16; feeds per revolution, 0.021 to 0.333 in.; front spindle bearing, 6½x10 in.; rear, 4½x7 in.; spindle nose, 8 in. in diameter, four threads per in.; hole through spindle, approximately 3 1/16 in.; centers, Morse taper No. 6; angular travel compound rest, 10 in.; cross-slide travel, 12 in.; tail-spindle movement, 12 in.; lead screw, 2¼ in. in diameter; threads, two per inch; driving pulley, 18x7½ in.; speed, 280 r.p.m.; weight crated, 12,600 lb.

Location of Time Clocks

By A. E. Holaday

In a great many factories time clocks are located in the business office, which in some cases is quite distant from some of the mechanical departments. This is disadvantageous to the manufacturer, for when so placed an employee can ring in, go and read the morning paper or make a visit, and after the whistle blows start for his department, where he arrives anywhere from one to five minutes later, while his time card shows that he was on time.

It is natural for a man to want to get out as soon as possible, especially at lunch time, so the men leave their departments a minute or two early and arrive at the time clock with a grand rush when the whistle blows.

Some factories have a time-card rack in each department. There is little advantage in this method, as the card only shows the time stamped on it. This is not conclusive evidence that he was or was not on time. Where there are several clocks they are apt to vary, and if late a man will ring up on the slow clock. I have seen cases where nine-tenths of the employees rung in on a clock that was not running.

A time clock, to be of any use, should be located in each department, under the foreman's supervision, and controlled by a master clock.

This would assure the employee being in his department on time, and would prevent his leaving before time. Some foremen would also be made more efficient by such a system. I would like to hear from others on this question.

New Publications

The Mechanical World Pocket Diary and Yearbook—Thirtieth year of publication. Three hundred and thirty 4x6-in. pages; illustrated; indexed; cloth bound. Published by The Norman Remington Co., Baltimore, Md. Price, 35c.

In this, the thirtieth annual issue of this book, several new features have been introduced. The section on steam and the steam engine has been largely rewritten. New tables have been introduced giving dimensions of piston rings and governors; notes on lubrication and antifriction bearings are included.

A new section on the heat treatment of steel has been introduced that includes notes on annealing, hardening and tempering.

Tables giving the dimensions of flanged couplings and for calculating of springs have also been inserted. Many new illustrations have been introduced and the book revised in order to bring it up to date.

Elementary Course in Lagrange's Equations—By N. W. Akimoff. One hundred and ninety-five 6x9-in. pages; 58 illustrations; cloth bound. Published by the Philadelphia Book Co., Philadelphia, Penn. Price, $2. Reviewed by S. E. Slocum.*

Although this work professes to be an elementary treatise, and is in fact a simple exposition of Lagrange's method, the reader should be equipped with what the average engineer would consider a sound knowledge of the fundamental principles of mechanics.

In view of the difficulties that are constantly met as new and practical applications of the dynamics of rotation and the theory of vibrations arise, which cannot be handled by ordinary methods, the value of a sound general method that will afford a rigorous solution of as simple a nature as compatible with the conditions of the problem is apparent. As Lagrange's method is the most powerful device in mechanics, a work of this kind by a practicing engineer is a valuable addition to technical engineering literature.

The introductory chapter is a brief synopsis of certain principles of dynamics. Beginning with the idea of constraints and the principle of virtual work, the author derives the fundamental equation of mechanics, also known as the general expression of d'Alembert's Principle, and then proceeds to show that if a force function exists, the change in kinetic energy is equal to the difference between the force functions in the initial and final configurations of the system, better known to most engineers as the special case in which the change in kinetic energy is equal to the work done. This is followed by a discussion of degrees of freedom and a review of certain general theorems on moments of inertia, including the properties of principal axes of inertia and the momental ellipsoid. This preparatory work leads up to the important features of the chapter, which include the derivation of Euler's equations connecting the linear components of velocity with the components of instantaneous rotation, the determination of motion relative to moving axes of reference, the use of generalized coördinates and the calculation of the so-called Euler's angles.

The remainder of the book is devoted to a discussion of Lagrange's equations of motion in generalized coördinates for a particle and for a system of particles, and to the relative motion of a system. A number of typical applications of the method are given, intended chiefly to explain the method under discussion, although some are of practical application; such, for example, as that relating to the vibration of auto springs. The extent of the field covered is indicated by the fact that the author includes in his discussion the theory of small vibrations, the precession and nutation of axes of rotation and the principles of gyroscopic motion.

As the book is intended to make Lagrange's powerful method available to engineers in practice who would otherwise find neither time nor inclination to familiarize themselves with its application and use, it will undoubtedly prove useful in supplementing the limited treatment characteristic of most elementary textbooks on mechanics.

*Professor of Applied Mechanics, University of Cincinnati.

Leather Belting—By Robert Thurston Kent. One hundred and fourteen 5¼x8-in pages; 31 illustrations; indexed; cloth bound. Published by John Wiley & Sons, Inc., New York City. Price, $1.25 net.

Much of the information made public through papers presented before the American Society of Mechanical Engineers finally finds its way into general use through engineering handbooks or special works devoted to particular engineering subjects. This volume is a proof of this fact. The works of Taylor, Barth, Lewis and Bird are found recorded in the transactions of the American Society of Mechanical Engineers, together with discussions and contributions from others who have studied the subject of leather belting.

From these professional papers and somewhat from articles appearing in technical journals Mr. Kent has drawn the matter in the book under review. His purpose has been to put this information in usable shape in order to lead to better belting practice in the shops of the country.

The first chapter takes up the general considerations affecting the transmission of power by leather belting, and on page 7 compares by means of a chart the formulas of Barth, Nagle and two others. The conclusion of this chapter points out that the practical results from the application of the works of Taylor and Barth are ample proof of the soundness of their practice. The second chapter is devoted to Taylor's investigations on belting, with a statement of his 11 rules and some comments upon them. Chapter 3 is devoted to a discussion of the horsepower transmitted by leather belting. This is based on the mathematical work of Barth. Chapter 4 is based on information from the same source and deals with the theory of transmitting power by belting.

The fifth chapter takes up belt maintenance, shows the Taylor belt bench, a system of belt symbols, tells how to maintain tension in belts and shows a simple system of belt fixer's orders. The sixth chapter deals with methods of fastening belts, showing the common forms of fastenings, and gives helpful hints in regard to their use. The seventh chapter is devoted to miscellaneous comments on the use of belting, including specifications, dressing, the uses of old belts and the like. The final chapter deals with some of the more uncommon arrangements of pulleys for difficult drives.

Perhaps the most useful part of the book follows, occupying the portion from page 91 to page 110. This section is entirely made up of tables, of which the headings follow: Table 1, "Horsepower and Tensions of Belts"; Table 2, "Arc of Contact of Belts on Smaller Pulleys, Degrees"; Table 3, "Velocity of Belt, Feet per Minute, for Different Pulley Diameters and Revolutions per Minute"; Table 4, "Cross-Sectional Area of Belts, Square Inches"; Table 5, "Diameter, Circumference and Rim Velocity of Pulleys"; Table 6, "Width of Pulley To Be Used with a Given Width of Belt."

This book is commended as gathering together in one place and in permanent and easily usable form the best of our knowledge in regard to practice in using leather belting.

Obituary

Philip C. Fosdick, 59 years old, president of the Cincinnati Gear Co. and former director of Public Service, died on Jan. 22 in Miami, Fla., of uræmic poisoning. He is survived by his wife, two daughters and a son. Mr. Fosdick was born in Louisville, Ky., where he lived the first five years of his life. At this time he moved to Cincinnati, where he has since resided. He was educated in the Cincinnati schools and graduated from the Hughes High School. His first business venture was as shipping clerk for the C. M. Holloway Salt Co. Later he became connected with the Lodge & Davis Machine Tool Co., and his associations with this company led to the organization of the Fosdick-Plucker Machine Tool Co. In 1887 the Fosdick Machine Tool Co. was organized, but Mr. Fosdick disposed of his interests in this concern 10 years later to become associated with the Kern Machine Tool Co., retiring from this company when it moved its plant to Hamilton, Ohio. Soon afterward he was elected president of the Cincinnati Gear Co.

Mr. Fosdick always took a keen interest in public affairs, having been president of the Board of Control, representative in the Seventy-Second General Assembly of Ohio and director of Public Service. He was very widely known as the author of the law requiring women to remove their hats in theaters and other public places. He was a member of the Business Men's Club, Chamber of Commerce, Queen City Club, Country Club, Automobile Club, Cincinnati Whist Club, Blaine Club, and the Shrine.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1735 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22

The United States 3-in. common shrapnel, familiarly known as a 15-pounder, carries a charge of 238 hexagon-shaped lead balls, 0.5 in. at their largest diameter and 0.45 in. at the flats. Back of the balls is a charge of 1180 grains of shrapnel powder. Screwed into the front end of the projectile is a combination fuse communicating with the powder chamber through a small tube, the shrapnel powder being held in place by means of a small plug of dry guncotton. This guncotton also acts as an aid to ignition. The fuse may be set for time explosion, or it will explode on impact.

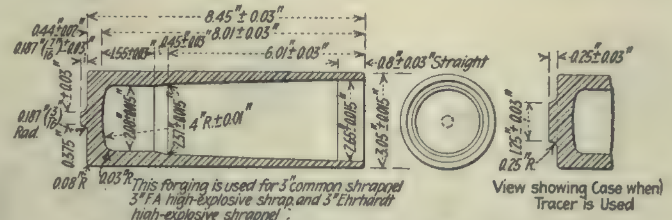


FIG. 1. DIMENSIONED FORGING FOR 3-IN. COMMON SHRAPNEL

The dimensions of the case forging are given in Fig. 1. These forgings must be thoroughly annealed and pass the following physical tests: Elastic limit, 60,000 lb.; tensile strength, 95,000 lb.; elongation, not less than 15 per cent.; contraction not less than 30 per cent. The only requirement as to chemical composition is that neither the sulphur nor phosphorus content shall exceed 0.045 per cent.

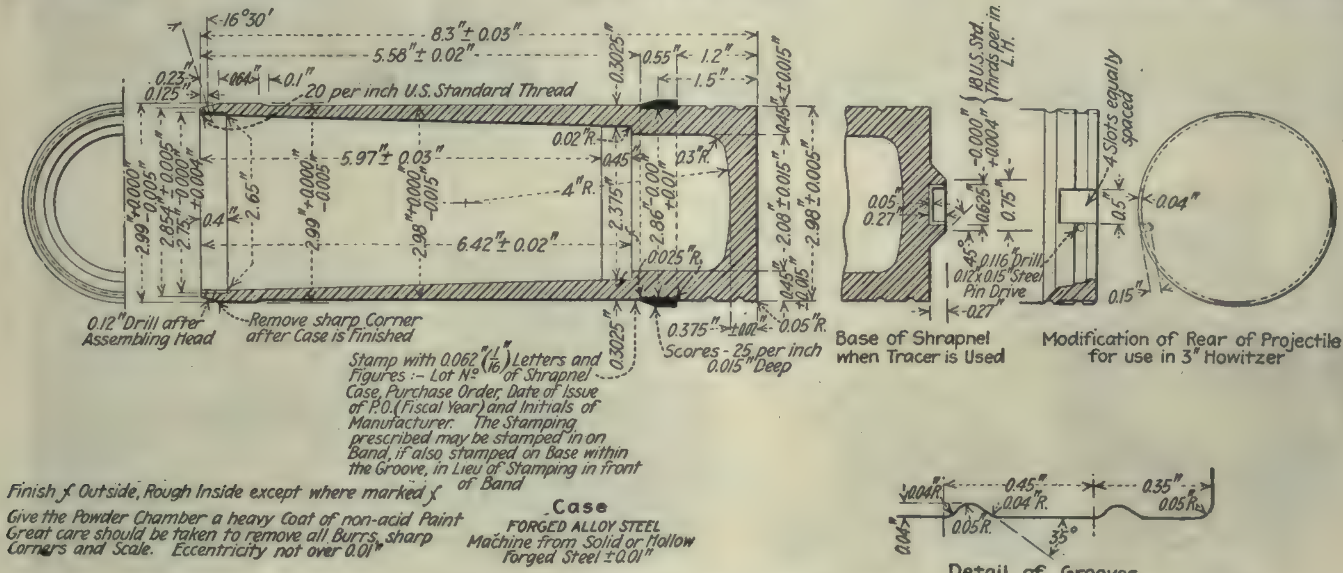


FIG. 2. DIMENSIONED FINISHED CASE

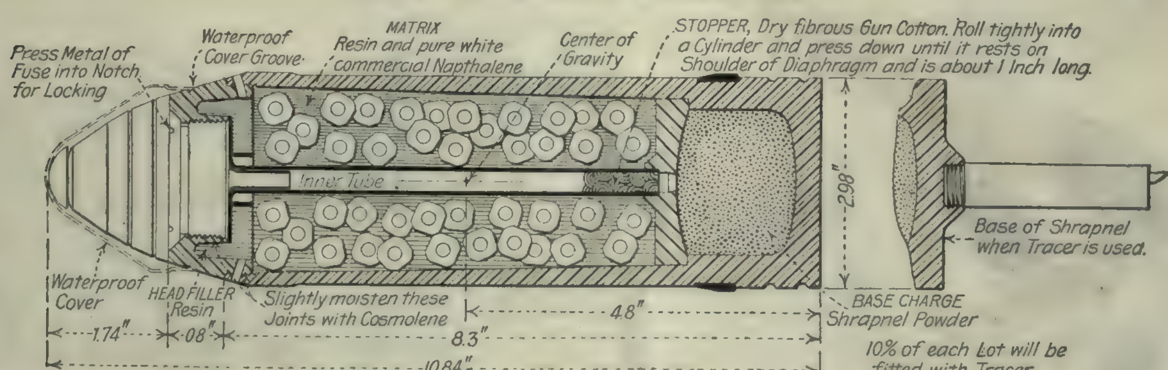
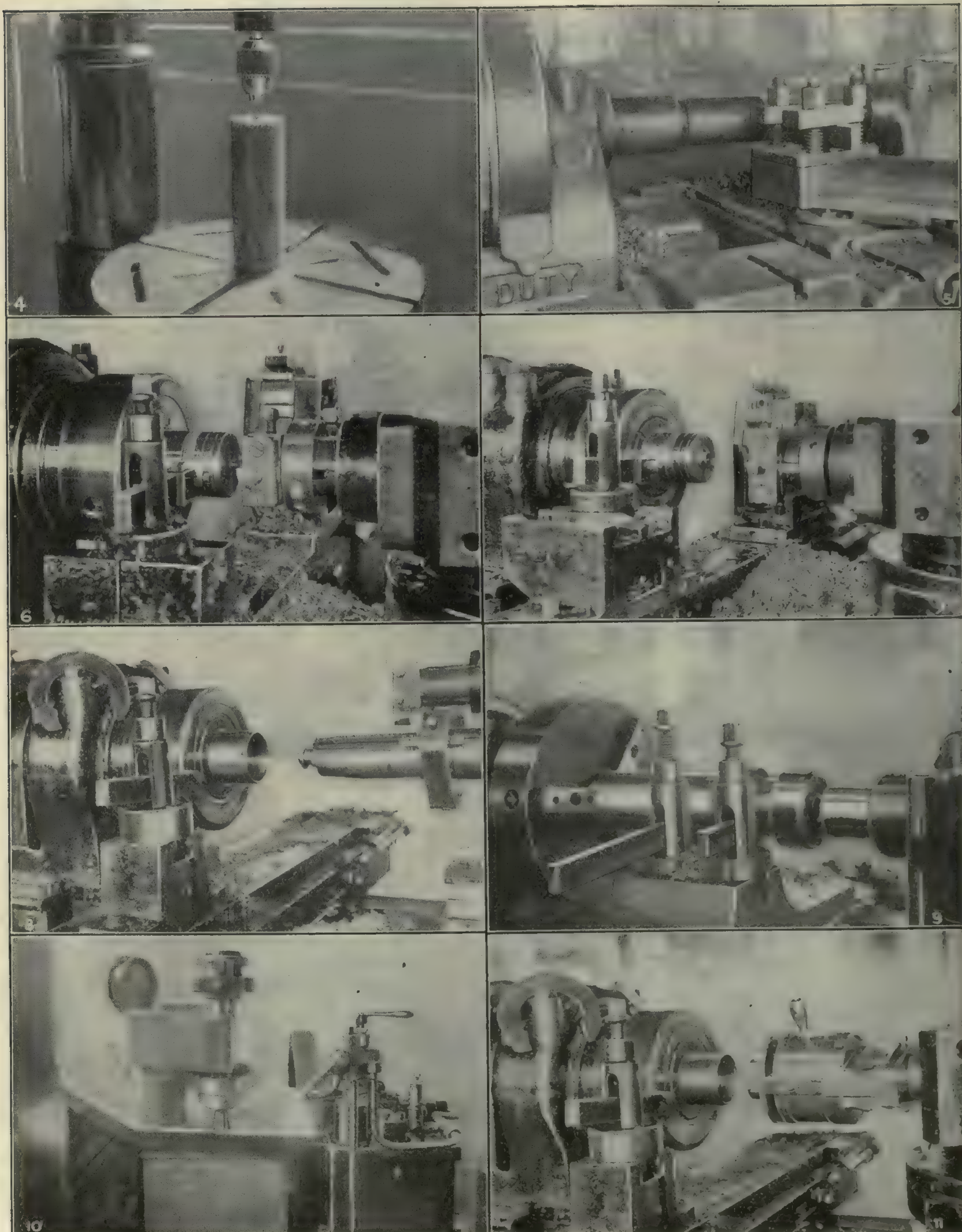


FIG. 3. DETAILS OF COMPLETE PROJECTILE



FIGS. 4 TO 11. VARIOUS OPERATIONS ON 3-IN. COMMON SHRAPNEL CASES

Fig. 4—Centering in drilling machine. Fig. 5—Turn body on lathe. Fig. 6—Finish outside (without tracer support). Fig. 7—Finish outside (with tracer support). Fig. 8—Finish interior on automatic. Fig. 9—Turning the bands. Fig. 10—Hydraulic testing apparatus. Fig. 11—Tapping for head.

LATHE TOOLS

Kind of Tool	Stock	Width C	Kind of Steel	Face To Be Ground	Hor. Angle Deg.	Ver. Angle Deg.
Finishing	1¼x⅝	3/8, 1/2, 5/8	H	Side A	90½	4
	1x½	3/8, 1/2	H	Side B	90½	4
	1x½	1/4, 5/16, 3/8, 7/16, 1/2	C	End C	0	6
				Top D	105	0
Parting	1x½	1/8, 1/4	H	Side A	90	3
	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side B	91	3
				End C	0	10
				Top D	91	0
Round Nose	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side A	90½	3
				Side B	90½	3
				End C	F	10
				Top D	91	0
Roughing-Blunt Right Hand	1x½		H	Side A	F2	6
				Side B	F2	6
	1¼x⅝		H	End C	F2	6
				Top D	98	14
Roughing-Sharp Right Hand	1x½		H	Side A	F1	6
				Side B	F1	6
	1¼x⅝		H	End C	F1	6
				Top D	98	22
Side Right Hand	1x½		C	Side A	85	6
				End C	35	6
				Top D	91	12
Inside Bend Right Hand	1x½		C	Side A	135	6
				End C	15	6
				Top D	81½	8½
Diamond Point Right Hand	1x½		C	Side A	48	13
				Side B	48	10
				End C		
				Top D	105	8½

Kind of Tool	Stock	Width C	Kind of Steel	Face To Be Ground	Hor. Angle Deg.	Ver. Angle Deg.
Bent Finishing Left Hand	1¼x⅝	3/8, 1/2, 5/8	H	Side A	135½	4
	1x½	3/8, 1/2	H	Side B	45½	4
	1x½	1/4, 5/16, 3/8, 7/16, 1/2	C	End C	45	6
				Top D	100½	0
Bent Parting Left Hand	1x½	1/8, 1/4	H	Side A	136	3
	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side B	45	3
				End C	45	10
				Top D	91	0
Bent Round-Nose Left Hand	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side A	136	3
				Side B	45	3
				End C	F	10
				Top D	91	0
Roughing-Blunt Left Hand	1x½		H	Side A	F2	6
				Side B	F2	6
	1¼x⅝		H	End C	F2	6
				Top D	98	14
Roughing-Sharp Left Hand	1x½		H	Side A	F1	6
				Side B	F1	6
	1¼x⅝		H	End C	F1	6
				Top D	98	22
Side Left Hand	1x½		C	Side A	85	6
				End C	35	6
				Top D	91	12
Inside Bend Left Hand	1x½		C	Side A	135	6
				End C	15	6
				Top D	81½	8½
Diamond Point Left Hand	1x½		C	Side A	48	10
				Side B	48	13
				End C		
				Top D	105	8½

Kind of Tool	Stock	Width C	Kind of Steel	Face To Be Ground	Hor. Angle Deg.	Ver. Angle Deg.
Bent Finishing Right Hand	1¼x⅝	3/8, 1/2, 5/8	H	Side A	45½	4
	1x½	3/8, 1/2	H	Side B	135½	4
	1x½	1/4, 5/16, 3/8, 7/16, 1/2	C	End C	45	6
				Top D	100½	0
Bent Parting Right Hand	1x½	1/8, 1/4	H	Side A	45	3
	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side B	136	3
				End C	45	10
				Top D	91	0
Bent Round-Nose Right Hand	1x½	1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8	C	Side A	45	3
				Side B	136	3
				End C	F	10
				Top D	91	0
Bent Roughing-Blunt Right Hand	1x½		H	Side A	F2	6
				Side B	F2	6
	1¼x⅝		H	End C	F2	6
				Top D	104	8
Bent Roughing-Sharp Right Hand	1x½		H	Side A	F1	6
				Side B	F1	6
	1¼x⅝		H	End C	F1	6
				Top D	108	15
Bent Side Right Hand	1x½		C	Side A	45	6
				End C	75	6
				Top D	98½	8½
Boring		3/16, 1/4, 5/16, 3/8, 1/2, 5/8, 3/4, 7/8, 1	C	Side A	60	12
				Side B	60	12
				End C	0	
				Top D	90	0

Kind of Tool	Stock	Width C	Kind of Steel	Face To Be Ground	Hor. Angle Deg.	Ver. Angle Deg.
Brass	1x½		H	Side A	70	10
				Side B	70	6
				End C	25	10
				Top D	90	0
Bent Brass Right Hand	1x½		H	Side A	45	10
				Side B	95	6
				End C	50	10
				Top D	90	0
Bent Brass Left Hand	1x½		H	Side A	85	6
				Side B	45	10
				End C	50	10
				Top D	90	0
Brass (F.A.)	1x½		C	Side A	70	13
				Side B	70	13
				End C	0	25
				Top D	90	0
Bent Brass (F.A.) Right Hand	1x½		C	Side A	40	13
				Side B	100	13
				End C	30	25
				Top D	90	0
Bent Brass (F.A.) Left Hand	1x½		C	Side A	100	13
				Side B	40	13
				End C	30	25
				Top D	90	0
Roughing (F.A.)	1x½		H	Side A	F1	10
				Side B	F1	10
			C	End C	F1	10
				Top D	98	22
Bent Roughing (F.A.) Right Hand	1x½		H	Side A	F1	10
				Side B	F1	10
			C	End C	F1	10
				Top D	108	15
Bent Roughing (F.A.) Left Hand	1x½		H	Side A	F1	10
				Side B	F1	10
			C	End C	F1	10
				Top D	108	15
Bent Roughing-Blunt Left Hand	1x½		H	Side A	F2	6
				Side B	F2	6
	1¼x⅝		H	End C	F2	6
				Top D	104	8
Bent Roughing-Sharp Left Hand	1x½		H	Side A	F1	6
				Side B	F1	6
	1¼x⅝		H	End C	F1	6
				Top D	108	15
Bent Side Left Hand	1x½		C	Side A	45	6
				End C	75	6
				Top D	98½	8½
Boring Inserted Tool			H	Side A	60	12
				Side B	60	12
				End C	0	
				Top D	90	0

F = Former used on Grinding machine. F1 = Former No. 1. F2 = Former No. 2. H = High speed steel. C = Carbon steel.

Fig. 12. STANDARD LATHE TOOLS FOR GENERAL SHOP USE

OPERATION 1. CENTERING

Transformation—Fig. 13. Machine Used—Drilling machine, Fig. 4. Number of Operators per Machine—One. Work-Holding Devices—Arbor, Fig. 14. Tool-Holding Devices—Drill chuck. Cutting Tools—No. 42 combination center drill. Cut Data—350 r.p.m. Production—1200 per 8 hr. Note—A little red lead is used where drilled.

OPERATION 2. TURN BODY

Transformation—Fig. 15. Machine Used—Le Blond 17-in. lathe, Fig. 5. Number of Machines per Operator—Three. Work-Holding Devices—Centering chuck, Fig. 16. Cutting Tools—Left-hand turning tool, Fig. 12. Number of Cuts—One. Cut Data—50 ft. surface speed; 60 r.p.m.; 0.040-in. feed. Average Life of Tool Between Grindings—15 to 20 cases. Gages—Length from base to bourrelet, Fig. 17; combination maximum and minimum snap, Fig. 18; maximum, rear of band ring, Fig. 19; minimum rear of band ring, Fig. 20. Production—250 per 8 hr. Note—Speed given is maximum, as lower speed is used on harder cases.

OPERATION 3. FINISH OUTSIDE (CASE WITHOUT TRACER SUPPORT)

Transformation—Fig. 21. Machine Used—Potter & Johnston automatic, Fig. 6. Number of Machines per Operator—Two. Tool-Holding Devices—Facing-tool holder, forming-tool holder, tool post. Cutting Tools—Facing tool, Fig. 22; form tool, Fig. 23; knurl, Fig. 24. Cut Data—40 to 70 surface speed; 56 to 90 r.p.m.; fast speed and feed used for knurl and end work. Coolant—Zurn cutting oil. Special Fixtures—Internal split collet; bushing for collet, Fig. 25. Gages—Maximum and minimum width of band seat, Fig. 26; position of crimping grooves, Fig. 27; combination snap, diameter of band seat, Fig. 28; thickness of base and test piece, Fig. 29; position and width of band seat, Fig. 30. Production—300 per 8 hr.

OPERATION 3-A. FINISH OUTSIDE (CASE WITH TRACER SUPPORT)

Transformation—Fig. 31. Machine Used—Fig. 7. Cutting Tools—Facing tool, Fig. 32. Gages—Combination sheet gage, Fig. 33. Note—This operation is exactly the same as operation 3, except for different facing tool and one gage.

OPERATION 4. FINISH INTERIOR (AND BOURRELET WHEN CASES ARE FINISHED AT FRANKFORD ARSENAL)

Transformation—Fig. 34. Machine Used—Potter & Johnston automatic, Figs. 8 and 9. Number of Machines per Oper-

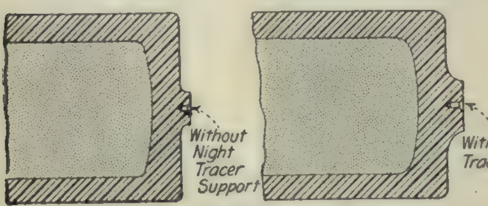
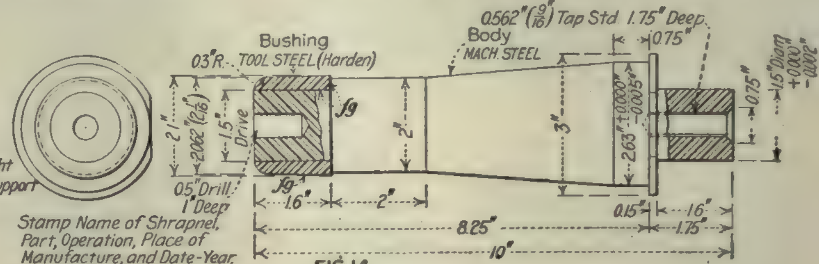


FIG. 13



OPERATION 1

FIG. 14

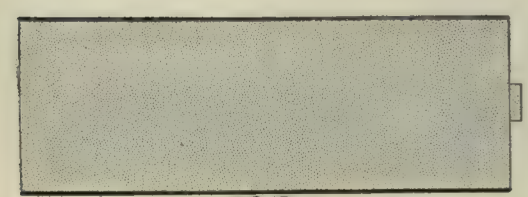
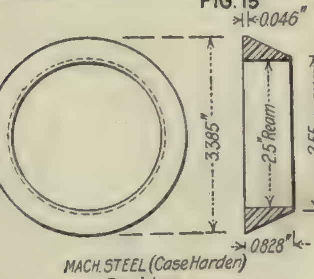


FIG. 15



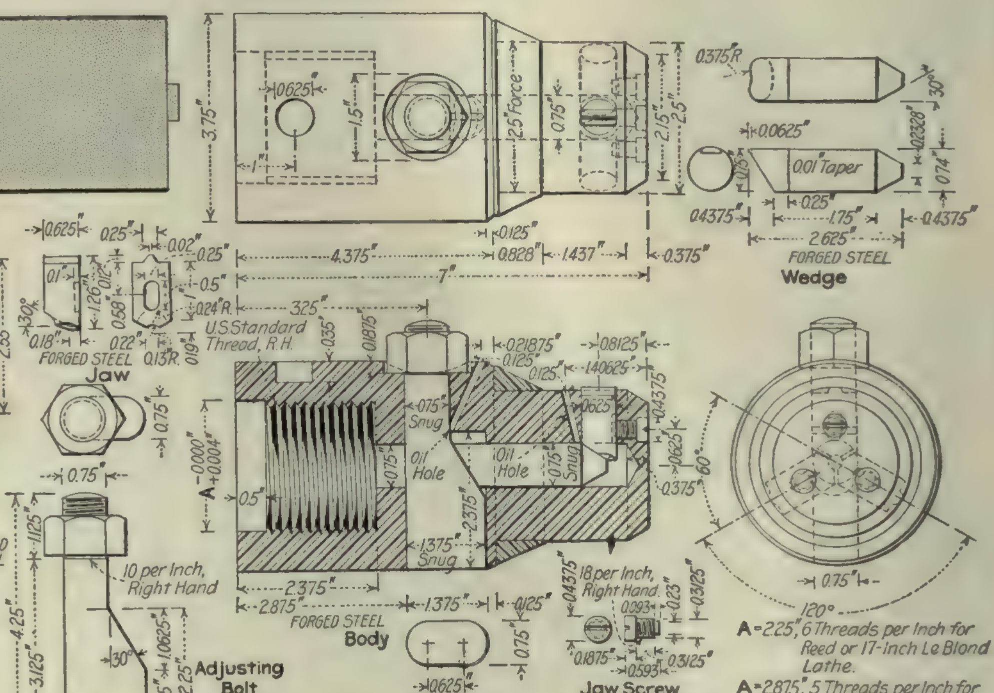


FIG. 16

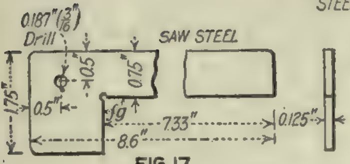


FIG. 17

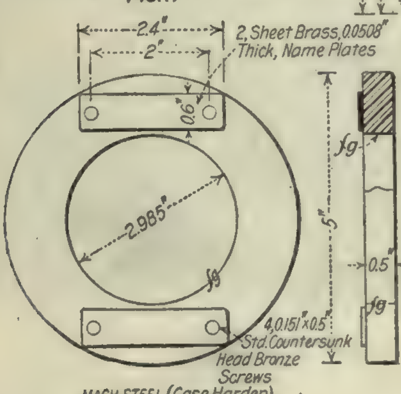


FIG. 19

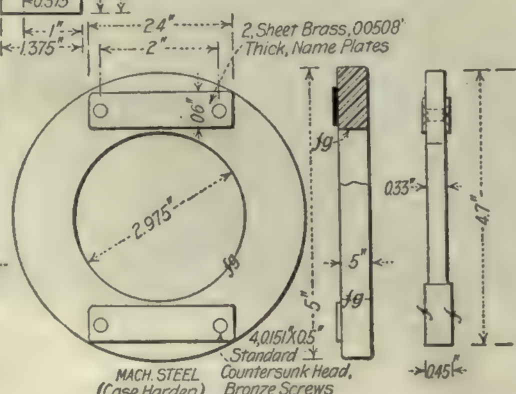


FIG. 20

OPERATION 2

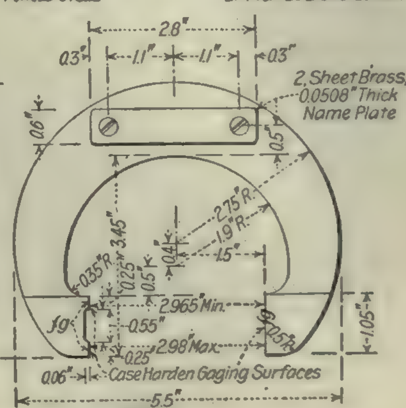


FIG. 18

ator—Two. Work-Holding Devices—Split chuck. Tool-Holding Devices—Rough boring bar; finish boring bar; tool holder for rough bourrelet, Fig. 35; tool post. Cutting Tools—Rough diaphragm-seat cutter, Fig. 36; rough boring tool, Fig. 36; rough facing tool, Fig. 36; finish diaphragm-seat cutter, Fig. 36; finish boring tool, Fig. 36; finish facing tool, Fig. 36; chamfering tool, Fig. 36; rough outside beveling tool, Fig. 37; turning tool for bourrelet, Fig. 35; square-nose lathe tool, Fig. 12; finish beveling tool, Fig. 37; No. 2½ geometric tap. Cut Data—50 ft. surface speed; 60 r.p.m. working speed; 35 r.p.m. tapping speed; 20 ft. surface speed. Coolant—Zurn oil. Gages—Maximum and minimum depth of diaphragm seat, Fig. 38; combination maximum and minimum diameter diaphragm seat, Fig. 39; combination maximum and minimum diameter rear of thread, Fig. 40; combination length of case, Fig. 41; combination maximum and minimum outside diameter and taper of mouth, Fig. 42; combination snap, bourrelet diameter, Fig. 28; maximum ring, bourrelet diameter, Fig. 43; minimum ring, bourrelet diameter, Fig. 44; maximum thread, plug, Fig. 45; minimum thread, plug, Fig. 45; maximum and minimum diameter, powder chamber, Fig. 46. Production—180 per 8 hr. Note—Powder chamber is machined by forgers.

OPERATION 5. ASSEMBLE BAND

Note—This is exactly the same as for the 3-in. common steel shell, except that only 1000-lb. pressure is used, on account of the thinner wall of the case.

OPERATION 6. HYDRAULIC TEST

Number of Operators—One. Description of Operation—Operator places case in fixture, mouth down, pours a cup of water in top of fixture over end of case, turns on 1000-lb. hydraulic pressure and watches water and case for bubbles or jets. Apparatus and Equipment Used—Special fixture, Fig. 47; pressure pump. Production—1200 per 8 hr.

OPERATION 7. TURN BANDS

Transformation—Fig. 48. Machine Used—Fig. 9. Gages—Finished band profile and position, Fig. 49. Note—Operation same as for 3-in. common steel shell.

OPERATION 8. TAP FOR NIGHT TRACER

Transformation—Fig. 50. Machine Used—Warner & Swasey turret lathe, Fig. 51. Number of Operators per Machine—One. Tool-Holding Devices—Tap holder, drill holder, recessing-tool holder, Fig. 52. Cutting Tools—Drill, reamer, Fig. 53; recessing tool, Fig. 54; tap, Fig. 55. Cut Data—334 r.p.m. machinery speed; 58 r.p.m. tapping speed. Coolant—Zurn oil. Gages—Combination depth, Fig. 56; maximum and minimum thread, plug, Fig. 57. Production—185 per 8 hr.

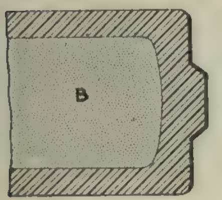


FIG. 31

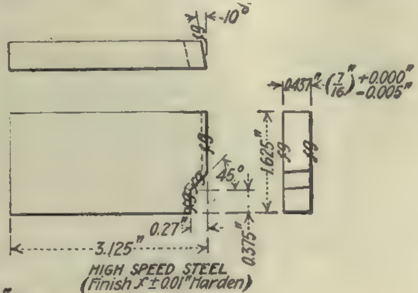


FIG. 32

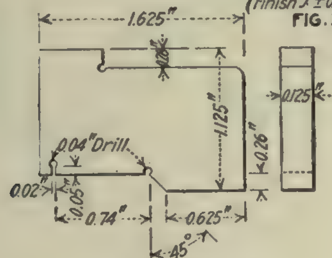


FIG. 33

OPERATION 3A

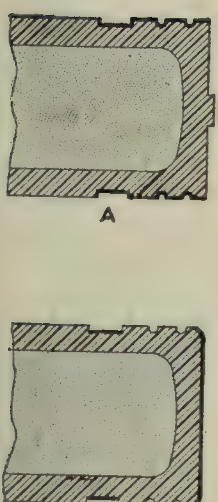


FIG. 21

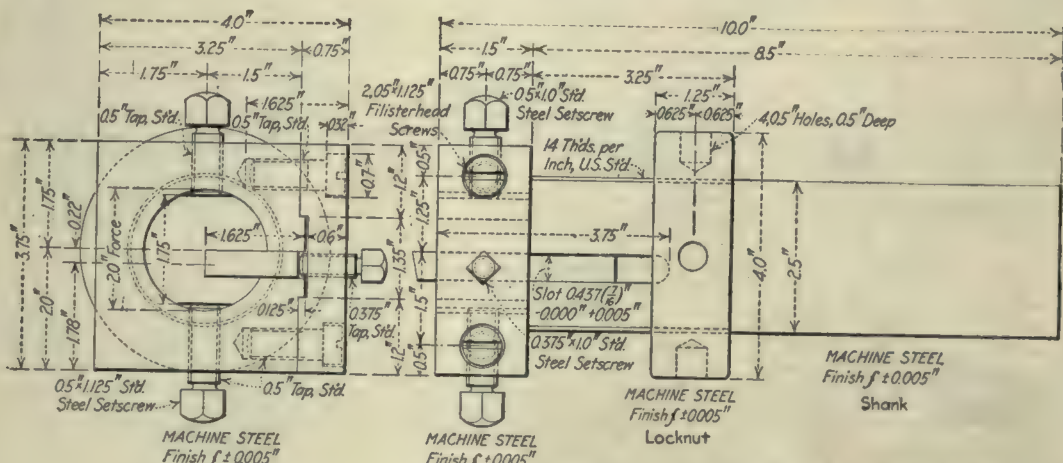
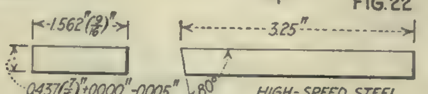
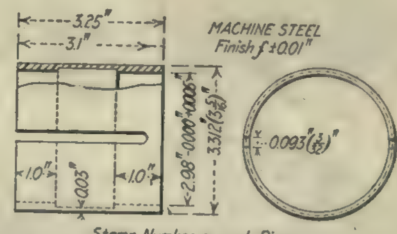


FIG. 22



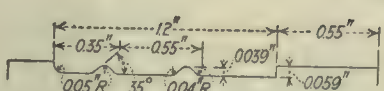
Finish f ± 0.005", Grind Cutting Edge

Facing Tool



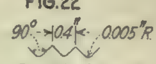
Bushing for Collet on P. & J. Automatic

FIG. 25

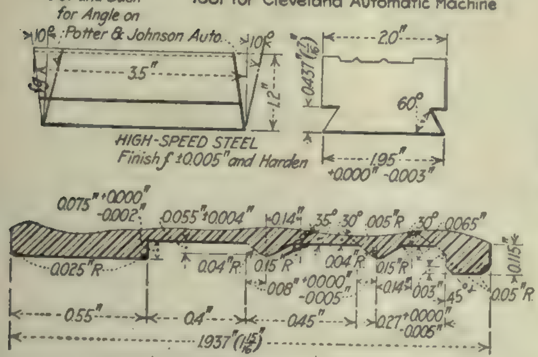


Tool for Cleveland Automatic Machine

FIG. 22

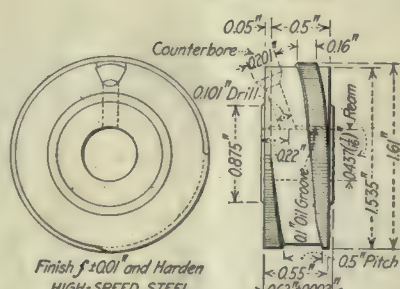


Detail of Knurls



Tool for Potter & Johnson Automatic

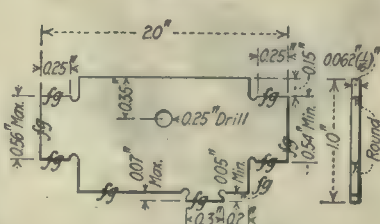
FIG. 23



Finish f ± 0.01" and Harden HIGH-SPEED STEEL

Knurling Tool

FIG. 24



Finish f ± 0.005" and Harden SAW STEEL

Band Seat Width and Depth

FIG. 26

OPERATION 3

The forgings shall be free cutting and readily machined. The machinability will be determined by turning the body of the forgings, as received, from the drawing diameter to a diameter of 3.062 in. on an engine lathe. This turning will be done at an average rate of 14 shells per hour per lathe, and at this speed the tool consumption shall not exceed one tool for each 20 shells turned at this rate.

For the purpose of the test for physical qualities and for phosphorus and sulphur content the forgings will be separated into lots of 2000 each. From each lot of 2000 the inspector will select six forgings for physical test, provided that additional forgings may be selected, if necessary, to obtain not less than one forging from each lot of forgings as heat-treated. Two specimens for physical test will be taken from each sample forging from such parts of the forging as, in the judgment of the inspector, will best indicate the uniformity of physical qualities throughout. The contractor shall furnish the inspector with an analysis of each heat of steel used, which may be verified by the inspector if he so desires.

Forgings must be homogeneous in structure and free from pipes and cracks. Forgings in which these defects develop during machining will be replaced by the contractor. The interior of the forgings must be smooth and free from scale, and machining must be resorted to in order to produce this result, in case smoothness is not obtained by forging under the press.

A finished shrapnel case with all dimensions is illustrated in Fig. 2, and a completely assembled projectile is shown in Fig. 3. This last weighs approximately 15 lb., divided as follows:

	Lb.		Lb.
Case	5.89	Balls (238)	5.71
Band	0.15	Matrix	0.43
Washer	0.02	Head filler	0.07
Head	0.7	Diaphragm	0.48
Retainer	0.01	Base charge	0.17
Tube (including inner tube)	0.09	Fuse	1.28
		Total weight	15 ±0.15

The efficiency equals 38 per cent., and the velocity of the balls must be not less than 260 ft. per sec.

The night tracer referred to is a small device placed on 10 per cent. of the projectiles, for use at night. As the shell is fired, the tracer leaves a trail of fire behind it, commencing a few seconds after it leaves the muzzle of the gun and making it possible to follow the flight easily. This device will be described in detail elsewhere.

The sequence of operations from the centering of the case forging to the final crimping on of the waterproof cover is as follows:

1. Centering
2. Turn body
3. Finish outside (case without tracer support)
3-A. Finish outside (case with tracer support)
4. Finish interior (and bourrelet when cases are finished at Frankford Arsenal)
5. Assemble band
6. Hydraulic test
7. Turn bands
8. Tap for night tracer

Head (Bar Stock)

1. Machine without thread and countersink
2. Countersink
3. Turn threads
9. Mill notches
4. Crimp in washer
5. Wash in hot soda water
6. Paint inside
7. Insert retainer and fill with resin
8. Face off resin

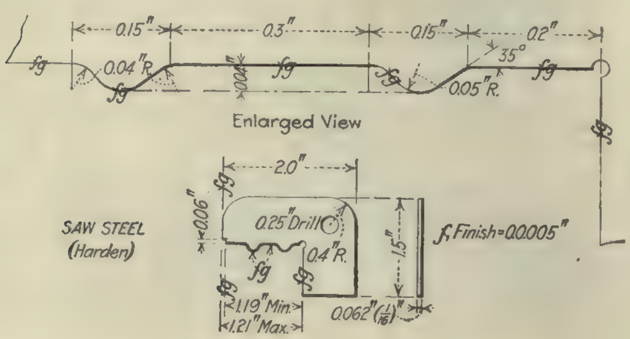
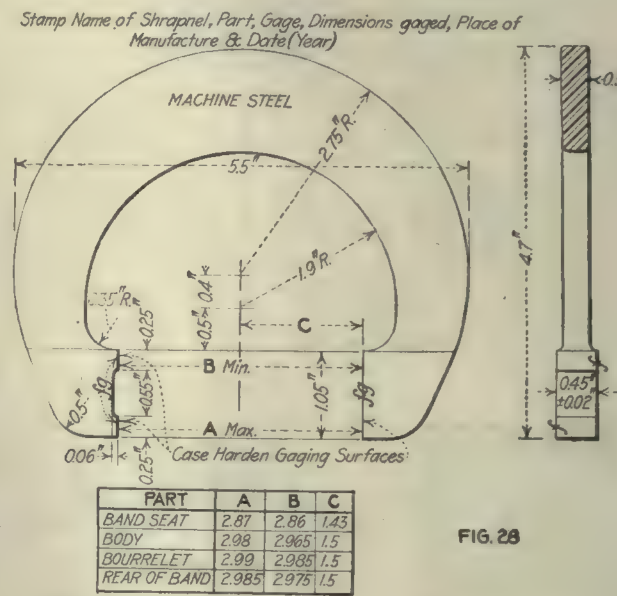


FIG. 27



PART	A	B	C
BAND SEAT	2.87	2.86	1.43
BODY	2.98	2.965	1.5
BOURRELET	2.99	2.985	1.5
REAR OF BAND	2.985	2.975	1.5

FIG. 28

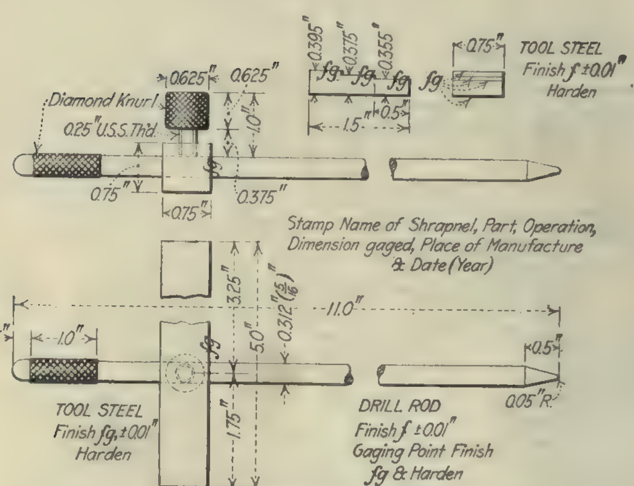


FIG. 29

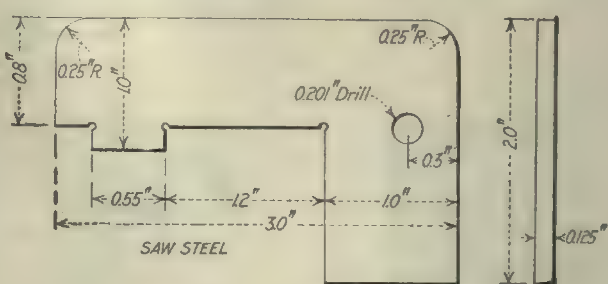


FIG. 30

OPERATION 3

Diaphragm (Forging)

1. Drill and counterbore
2. Heat-treatment
3. Remove scale from counterbore
4. Grind base
5. Paint base
6. Assemble tube

Locking Pins (Bar Stock)

1. Machine

Assembling

1. Wash case in hot soda water
2. Paint interior

3-A. Assemble tube and diaphragm

3-B. Fill case

3-C. Compress balls

4. Cut out surplus resin
5. Moisten threads with cosmoline, assemble head to case and insert inner tube
6. Pin head to case

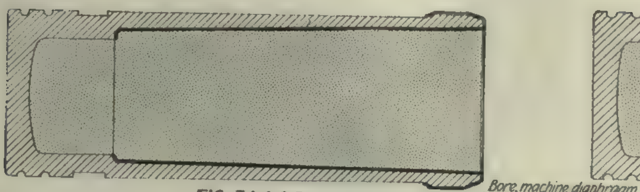


FIG. 34 A & B

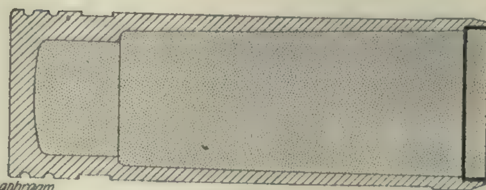


FIG. 34 C

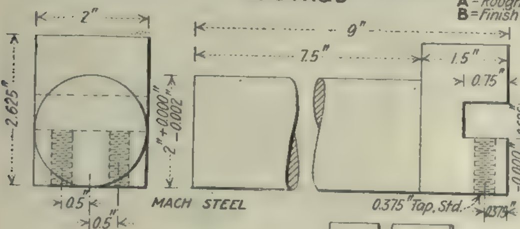
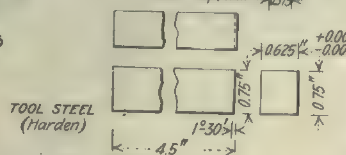


FIG. 35



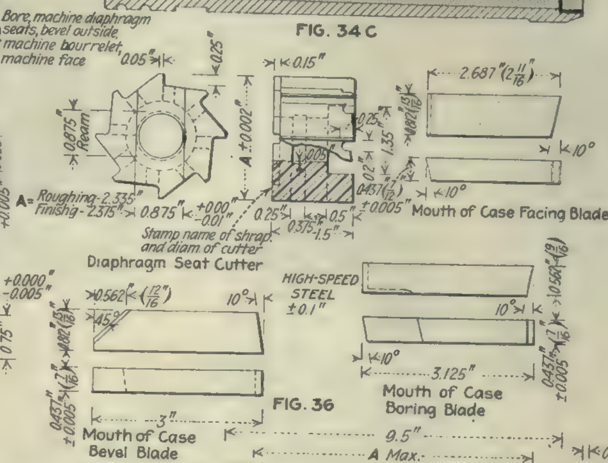


FIG. 36

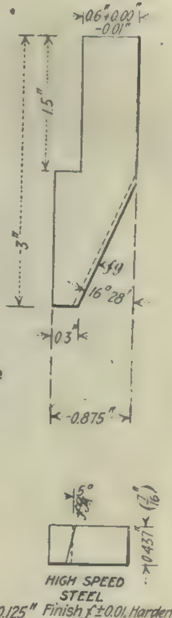


FIG. 37

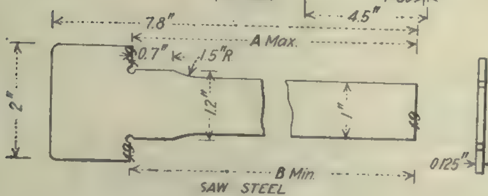


FIG. 38

OPERATION	A	B
FIRST	6.47	6.44
FINISHED	6.44	6.4

OPERATION 4

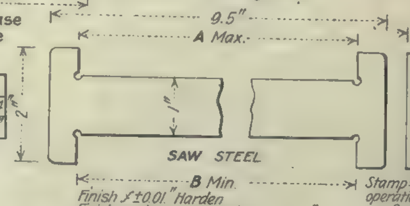


FIG. 41

OPERATION	A	B
FIRST	8.36	8.33
FINISHED	8.33	8.27

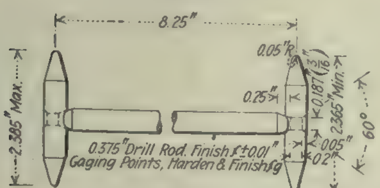


FIG. 39

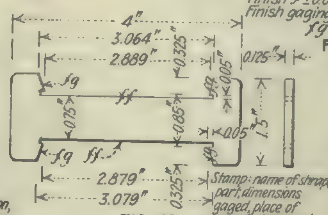


FIG. 42

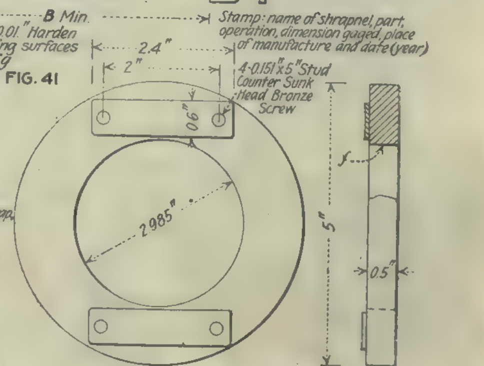


FIG. 44

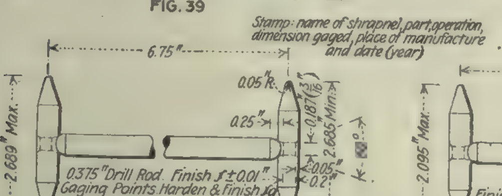


FIG. 40

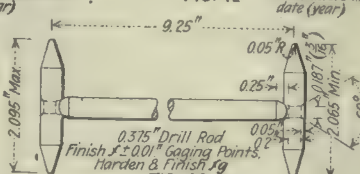


FIG. 46

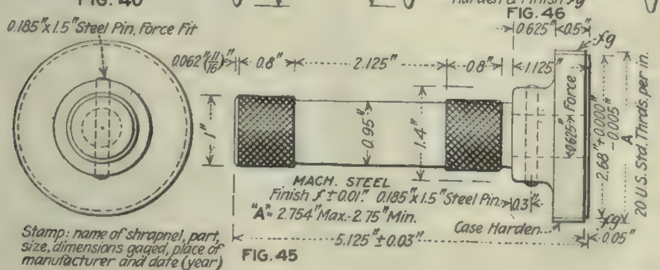


FIG. 45

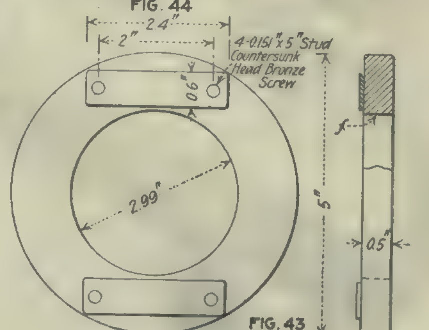


FIG. 43

Tube (Central)

1. Machine

Tube (Inner)

1. Machine

Retainer

1. Machine

Washer (Sheet Steel)

1. Punch

Making Balls

1. Casting ingots
2. Extruding the wire
3. Forming balls on special machine

3-A. Forming balls on punch press

7. Turn bourrelet (when cases are finished by outside contract)
8. Groove for waterproof cover
9. Paint outside
10. Load powder charge
11. Brush cosmoline on fuse threads
12. Screw in fuse and lock
13. Set fuse to safety point
14. Crimp on waterproof cover

The centering is a simple operation. Following this is the turning of the body, Fig. 5. The outside finishing.

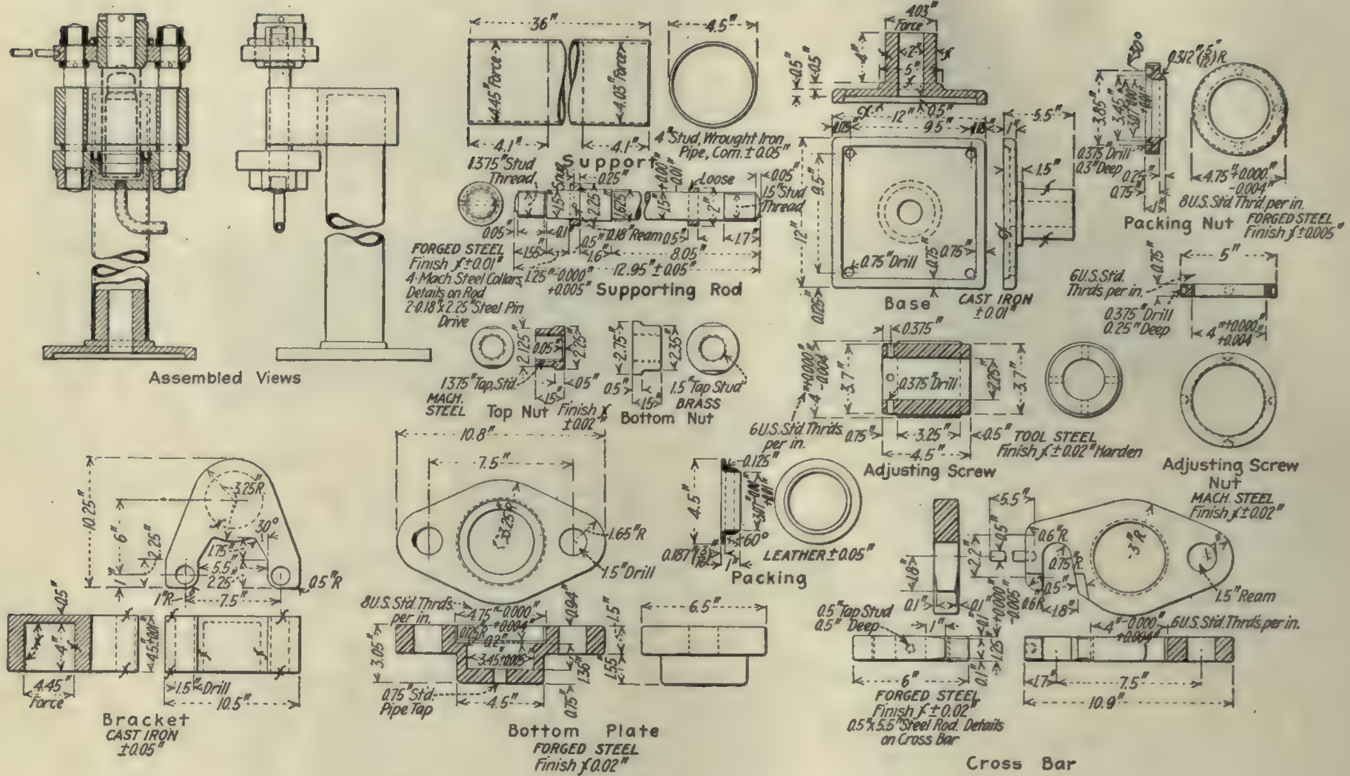


FIG. 47

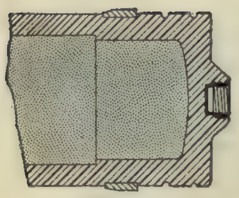


FIG. 50

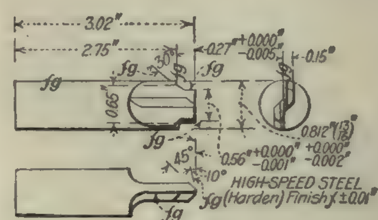


FIG. 53

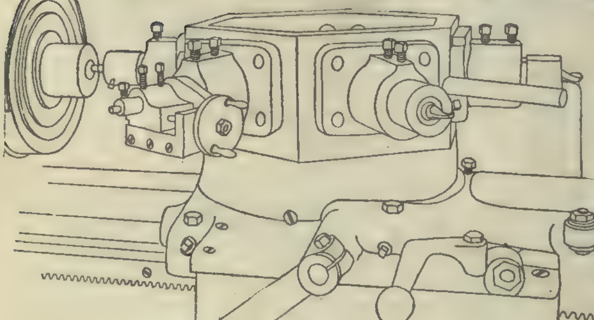


FIG. 51

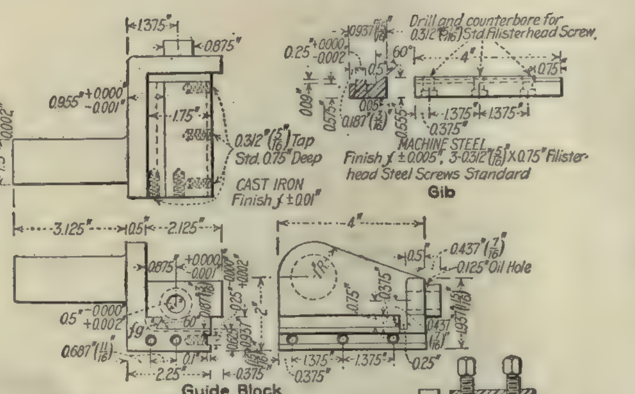
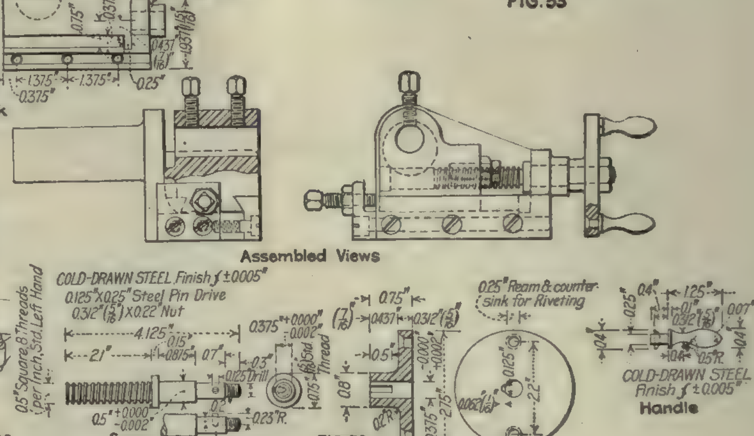



FIG. 52

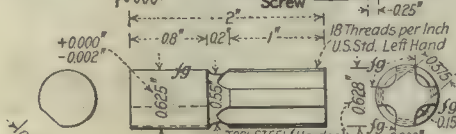


FIG. 55

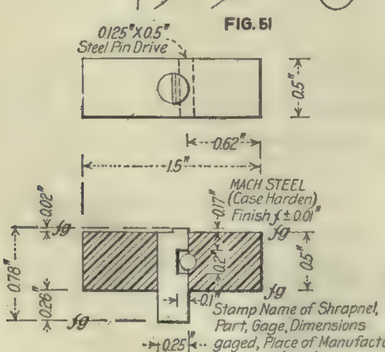


FIG. 56

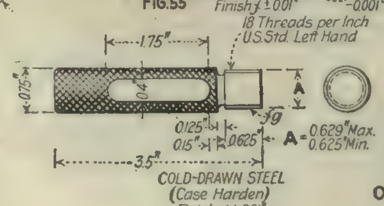
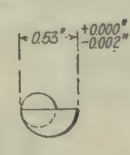


FIG. 57



OPERATION 8

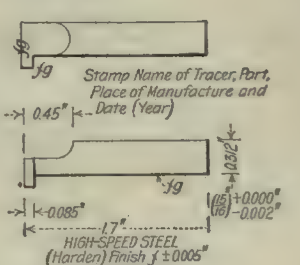
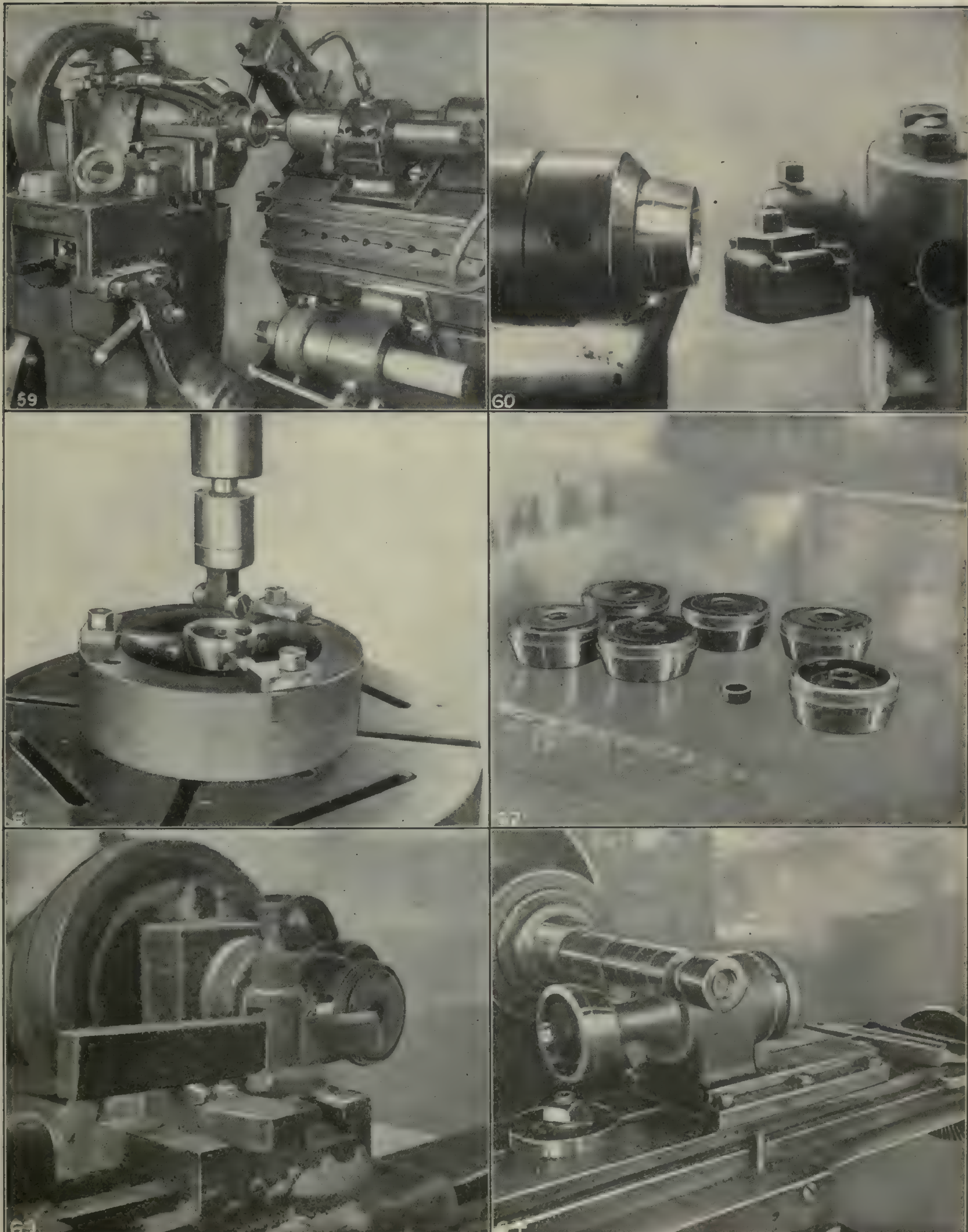


FIG. 54



FIGS. 59 TO 64. VARIOUS OPERATIONS ON THE HEAD

Fig. 59—Machining the head. Fig. 60—Countersinking head. Fig. 61—Crimping in washer. Fig. 62—Inserting retainer and filling with resin. Fig. 63—Facing off resin. Fig. 64—Notching head

shown in Figs. 6 and 7, differs principally in that in the latter case a larger place has to be left on the end for the tracer support, a special tool being used. Finishing the interior, Fig. 8, is done on both Potter & Johnston and Cleveland machines, as shop conditions at the time or as the sizes of the various shells dictate.

The method of assembling and turning the copper rotating bands is described in the article on the 3-in. common steel, or high-explosive, shell. The making of the band is also described in the article.

Standard cutting tools, which are used for all regular operations, are charted in Fig. 12 and will be designated

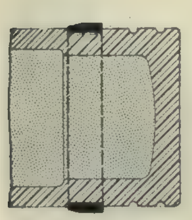


FIG. 48

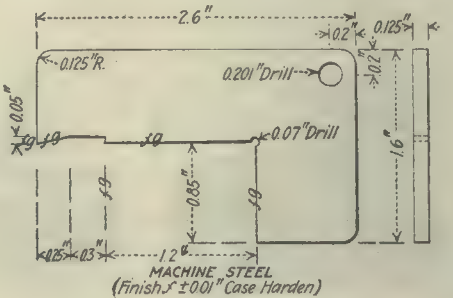


FIG. 49

OPERATION 7

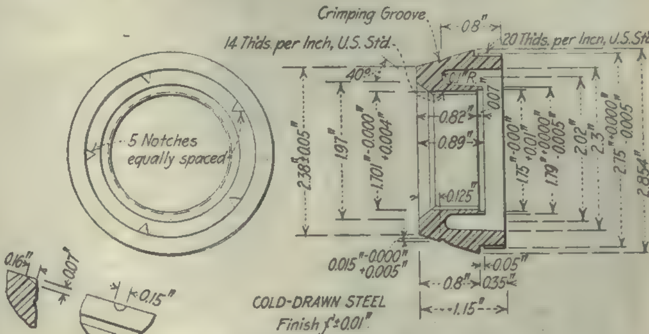


FIG. 58. DETAILS OF HEAD

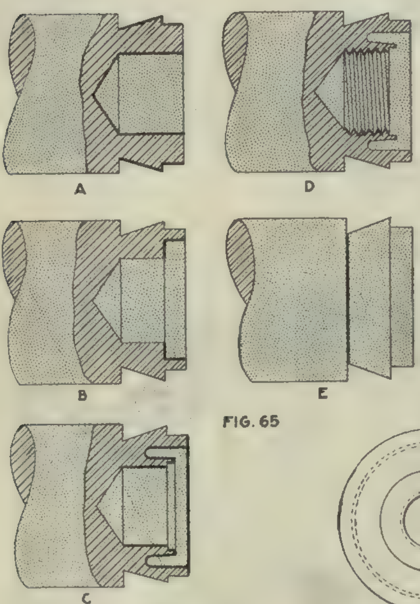


FIG. 65

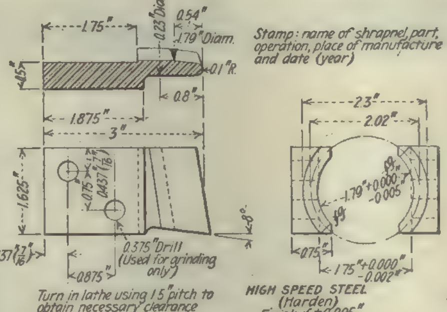


FIG. 70

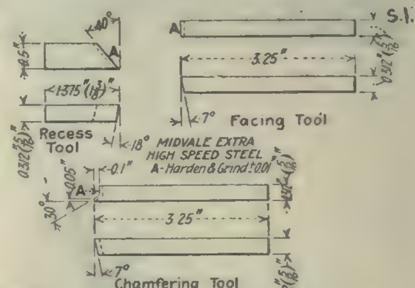


FIG. 71

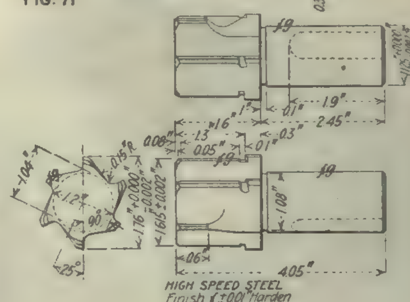


FIG 72

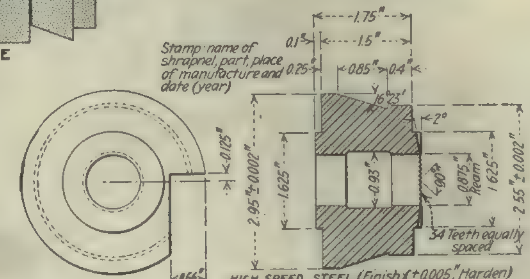


FIG 66

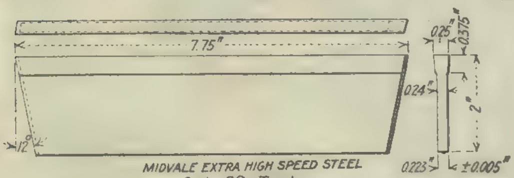


FIG. 67

OPERATION 1

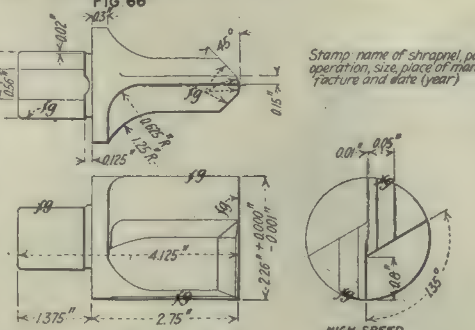


FIG. 69

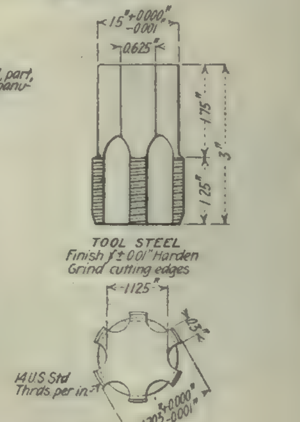


FIG. 73

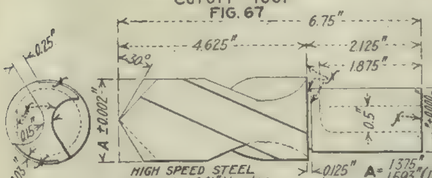


FIG. 68

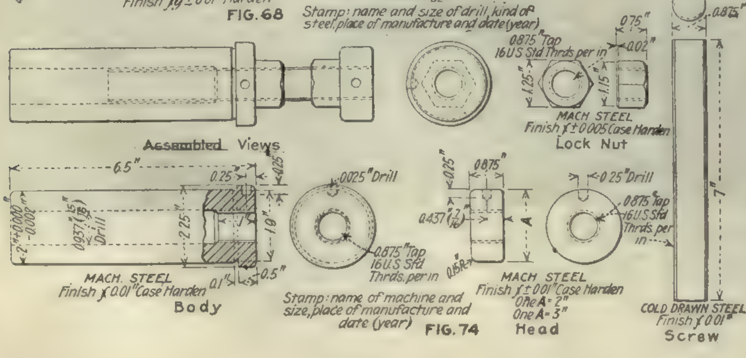


FIG. 74

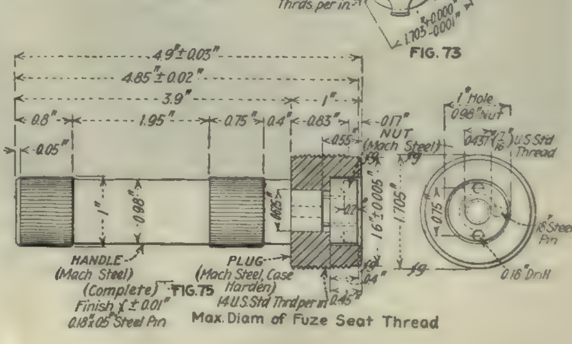


FIG. 75

individually only by their common names, such as left-hand lathe tool. The dimensions and shape of the various tools can be quickly obtained by reference to the chart.

Work on the Head

Details of the head are illustrated in Fig. 58. This is machined from bar stock on automatic machines, as shown in Fig. 59, each operator tending three machines. The end of the bar is drilled, bored, counterbored, reamed, grooved, faced and tapped for the fuse. At the same time the outside is formed with a circle tool. The tap used is of the collapsing type, oil being forced to the work from the rear. As can be seen, ample provision is made for supplying all the tools with oil. Owing to the size of the piece, the number of operations and the accuracy needed, the rate of production is here comparatively low. After the machined head is severed from the bar, it is placed in a special chuck, Fig. 86, on a turret lathe, and the mouth is countersunk with a beveling tool carried in the turret, as shown in Fig. 60. The thread for holding the head to the case is chased on in a turret lathe.

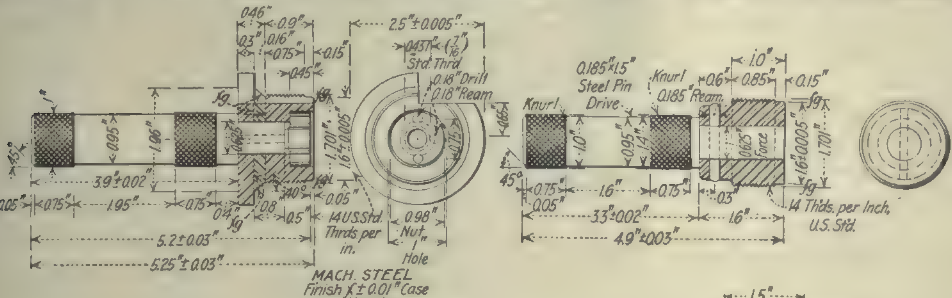
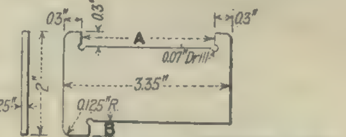


FIG. 76



OPERATION	A	B
First	2.77"	0.36"
Finished	2.75"	0.35"

FIG. 77

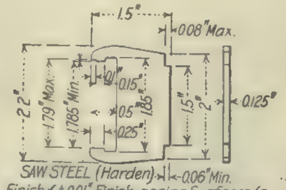


FIG. 82

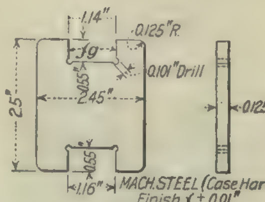
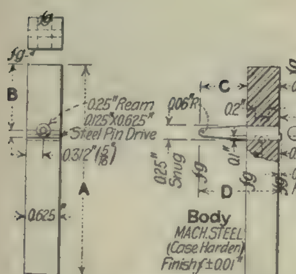


FIG. 78



HEAD	A	B	C	D
2.95-inch Shrapnel	4"	1"	0.69"	1.335"
3 " "	4"	1"	0.79"	1.435"
3.8 " "	4.5"	1.25"	1.11"	1.755"
4.7 " "	5"	1.25"	1.915"	2.56"
6 " "	6"	1.75"	2.64"	3.285"

FIG. 80

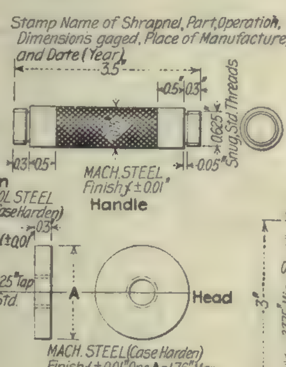


FIG. 81

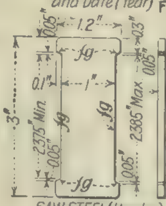


FIG. 83
OPERATION 1

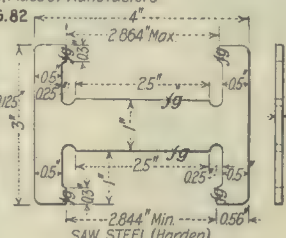


FIG. 84

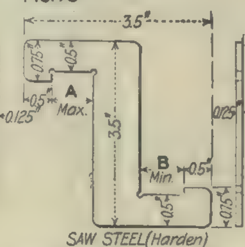


FIG. 79

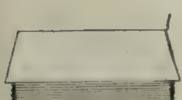


FIG. 90

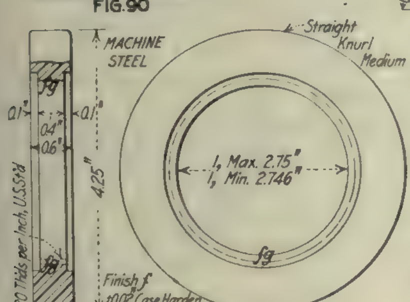


FIG. 93

FIG. 91

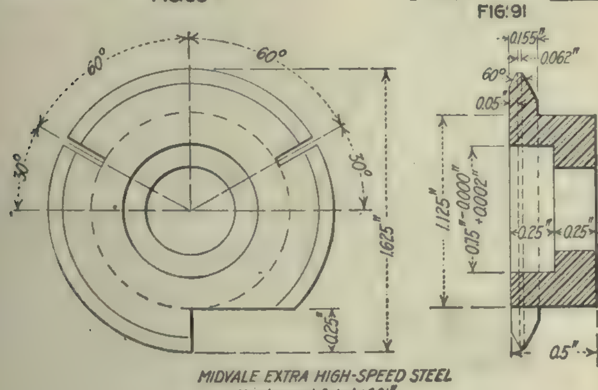


FIG. 92


FIG. 98
OPERATION 6

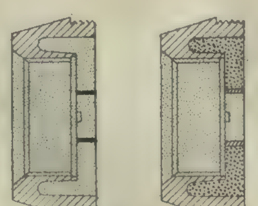


FIG. 99
OPERATION 7


FIG. 100

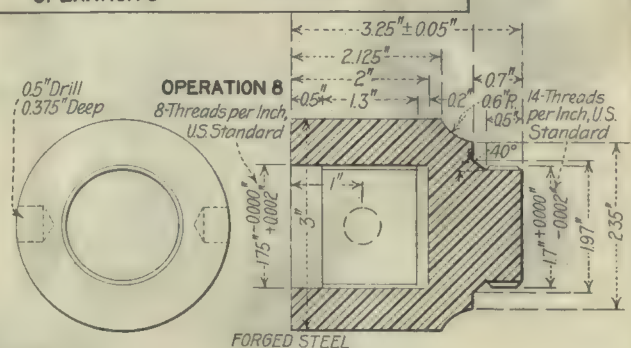


FIG. 101

The washer is made of thin sheet metal and is placed in the head, and the edges are crimped down into the grooves of the head with a double roller tool, as shown in Fig. 60, details of the tool being given in Fig. 96.

After the head has been thoroughly washed in hot soda water, the inside is painted by hand; then the short piece of tube, or retainer, is put in place and melted resin is poured in, as shown in Fig. 62. The resin is allowed to cool, and then the head is placed in a special screw chuck and the resin faced off, as shown in Fig. 63, details of the chuck being given in Fig. 101. The tool used is a standard left-hand facing tool.

The purpose of milling notches in the head is to provide means for locking the fuse securely after it is screwed into the mouth of the case, metal on the fuse being forced into these notches with a punch and hammer. The notch milling is illustrated in Fig. 64, the fixture being a rather simple one, but answering the purpose perfectly.

Head (Bar Stock)

OPERATION 1. MACHINE WITHOUT THREAD AND COUNTERSINK

Transformation—Fig. 65. Machine Used—Gridley or Cleveland automatic, Fig. 59. Number of Machines per Operator—Three. Work-Holding Devices—Split chuck. Tool-Holding Devices—Circular form-tool holder, cutoff-tool holder, drill holder, rough-tool holder, combination groove-tool and reamer holder, tap holder and adapter. Cutting Tools—Circular form tool, Fig. 66; cutoff tool, Fig. 67; twist drill, Fig. 68; roughing tool, Fig. 69; set (2) grooving tools, Fig. 70; facing tool, Fig. 71; combination counterbore and reamer, Fig. 72; tap, Fig. 73. Cut Data—50 ft. surface speed. Coolant—Zurn oil. Special Fixtures—Stop, Fig. 74. Gages—Maximum thread, plug, Fig. 75; minimum thread, plug, Fig. 76; diameter and length of thread (operation 1), Fig. 77; length over all, Fig. 78; length of shoulder (operation 1), Fig. 79; depth of groove, Fig. 80; maximum and minimum inner diameter of crimp wall, Fig. 81; outer diameter and depth of crimp wall, Fig. 82; diameter of small end, Fig. 83; diameter of large end, Fig. 84. Production—115 per 8 hr.

OPERATION 2. COUNTERSINK

Transformation—Fig. 85. Machine Used—Brown & Sharpe turret lathe, Fig. 60. Number of Operators per Machine—One. Work-Holding Devices—Special chuck, Fig. 86. Tool-Holding Devices—Tool holder, Fig. 87. Cutting Tools—Beveling tool, Fig. 88. Cut Data—210 r.p.m. Gages—Diameter of fuse-seat bevel, Fig. 89; minimum diameter of fuse seat and fuse-seat thread, Fig. 76. Production—800 per 8 hr.

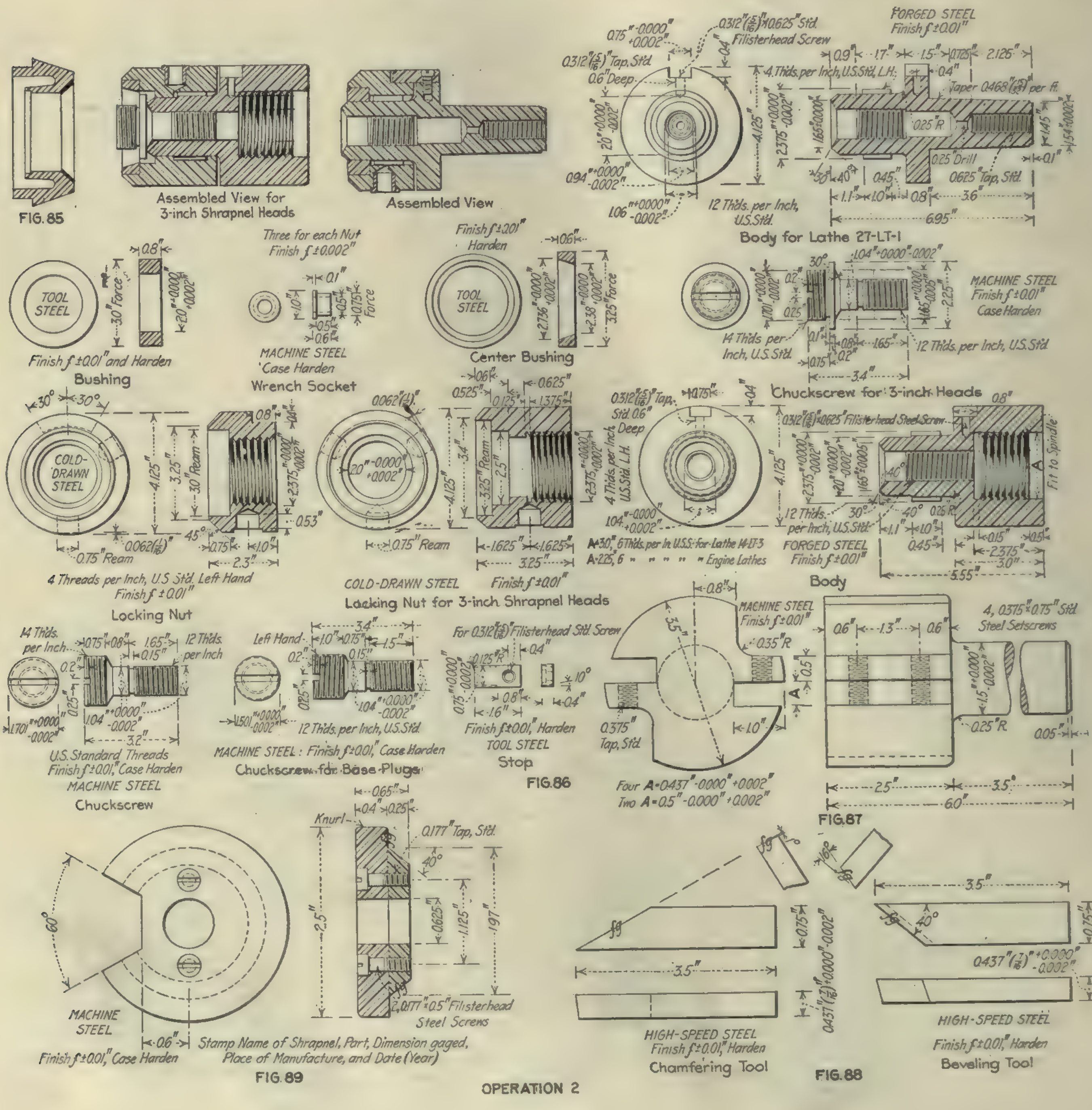


FIG. 85 FIG. 86 FIG. 87 FIG. 88 FIG. 89

OPERATION 2

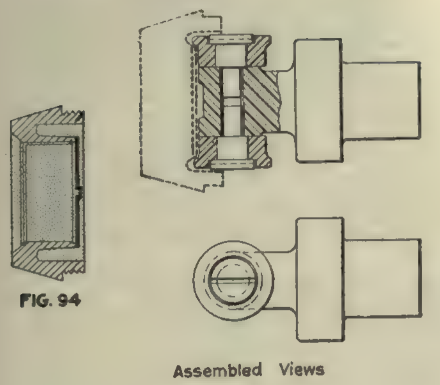


FIG. 94

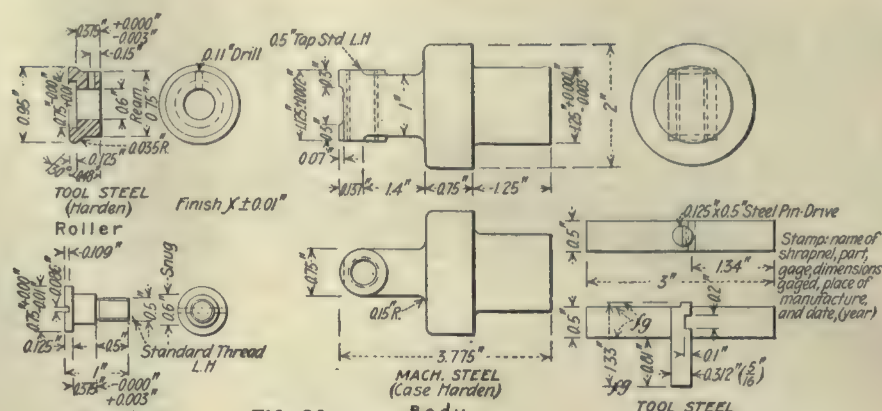


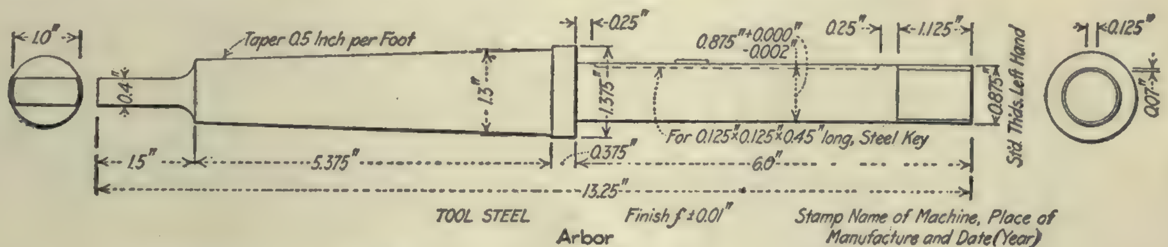
FIG. 96 OPERATION 4 FIG. 97

OPERATION 3. TURN THREAD

Transformation—Fig. 90. Machine Used—Brown & Sharpe turret lathe. Number of Operators per Machine—One. Work-Holding Devices—Special chuck, Fig. 86. Tool-Holding Devices—Chamfering-tool holder, holder for circular thread cutter. Cutting Tools—Forming tool, Fig. 91; chamfering tool, Fig. 88; circular thread cutter, Fig. 92. Cut Data—200 ft. surface speed. Coolant—Lard oil, put on with brush. Gages—Maximum thread, ring, Fig. 93; minimum thread, ring, Fig. 93; diameter length of finished thread, Fig. 77; maximum and minimum length of shoulder, Fig. 79. Production—250 per 8 hr. Note—This is a thread-chasing operation, as can be seen from the illustration.

OPERATION 9. MILL NOTCHES

Transformation—Fig. 102. Machine Used—Brown & Sharpe miller, Fig. 64. Number of Operators per Machine—One. Tool-Holding Devices—Arbor, Fig. 103. Cutting Tools—Milling cutter. Cut Data—Cutter runs 370 r.p.m. Special Fixtures—Fig. 104. Production—1400 per 8 hr.



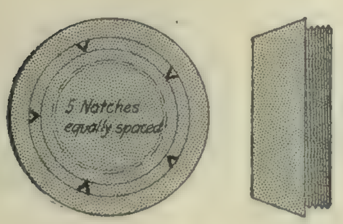


FIG. 102.

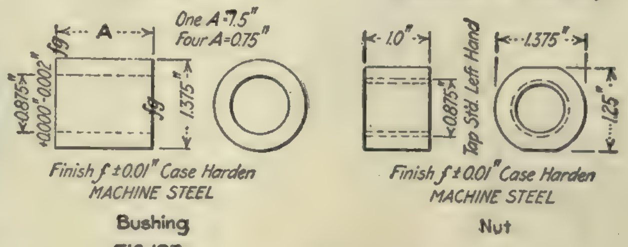


FIG. 103

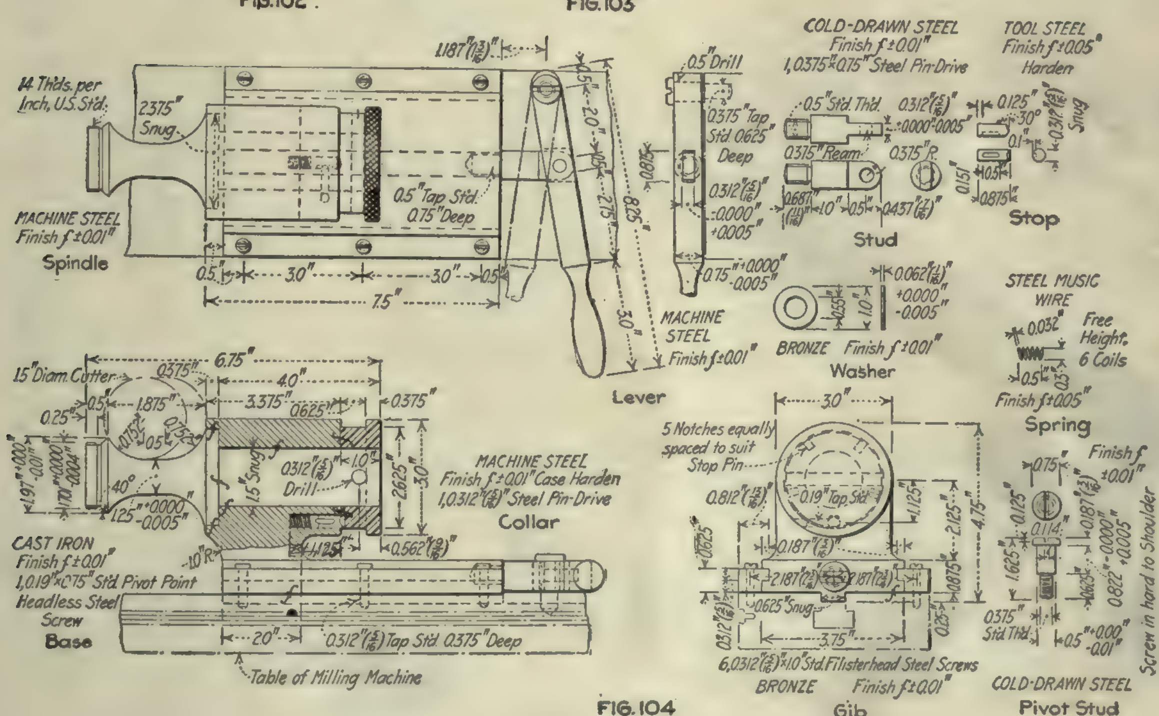


FIG. 104
OPERATION 9

OPERATION 4. CRIMP IN WASHER

Transformation—Fig. 94. Machine Used—Drilling machine, Fig. 61. Number of Operators per Machine—One. Work-Holding Devices—Special chuck. Tool-Holding Devices—Crimping-tool holder. Tools—Crimping tool, Fig. 96. Cut Data—260 r.p.m. Gages—Depth of disk, Fig. 97. Production—1400 per 8 hr.

OPERATION 5. WASH IN HOT SODA WATER

Number of Operators—One. Description of Operation—Operator puts 40 heads into a dipping basket and sets it in cleaning solution; when grease is off, the heads are rinsed in hot water; if not too greasy, about 2 min. is enough time for cleaning. Apparatus and Equipment Used—One tank of boiling Wyandotte metal-cleaner solution; one tank of boiling water; metal dipping baskets. Production—2500 per day.

OPERATION 6. PAINT INSIDE

Transformation—Fig. 98. Number of Operators—One. Apparatus and Equipment Used—Brush and pot of asphaltum varnish. Production—1200 per day.

OPERATION 7. INSERT RETAINER AND FILL WITH RESIN

Transformation—Fig. 99. Description of Operation—Operator places head, small end down, on plate, then puts in retainer and pours in melted resin, Fig. 62. Apparatus and Equipment Used—Metal plate, furnace and kettle, pouring ladle. Production—1200 per 8 hr.

OPERATION 8. FACE OFF RESIN

Transformation—Fig. 100. Machine Used—Small lathe, Fig. 63. Number of Operators per Machine—One. Work-Holding Devices—Special screw chuck, Fig. 101. Cutting Tools—Left-hand facing tool. Cut Data—220 r.p.m. Production—1200 per 8 hr.

Diaphragm (Forging)

OPERATION 1. DRILL AND COUNTERBORE

Transformation—Fig. 106. Machine Used—Turret lathe. Number of Operators per Machine—One. Work-Holding Devices—Special screw chuck, Fig. 107. Tool-Holding Devices—Drill holder and bushing, countersink holder and bushing, counterbore holder and bushing. Cutting Tools—Twist drill; countersink, Fig. 108; counterbore, Fig. 109. Gages—Maximum diameter, ring, Fig. 110; minimum diameter, ring, Fig. 111; maximum and minimum diameter counterbore, plug, Fig. 112; depth of counterbore, Fig. 113. Production—400 per 8 hr. Note—These are forgings, trimmed outside in a die, and only have to be drilled and counterbored.

OPERATION 2. HEAT-TREATMENT

Number of Operators—One. Description of Operation—Diaphragms are kept in furnace until temperature reaches 1600 deg. F., then taken out and placed in cottonseed-oil bath to harden; next, are rumbled in hot soda water to remove scale, and are then drawn to 900 deg. F. in saltpeter bath. Apparatus and Equipment Used—Furnace; perforated copper basket, 24 in. long, 15 in. wide, 12 in. deep; rumbling device. Production—4800 per 8 hr.

OPERATION 3. REMOVE SCALE FROM COUNTERBORE

Machine Used—Drilling machine. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill, ground to suit. Production—1400 per 8 hr.

OPERATION 4. GRIND BASE

Transformation—Fig. 114. Machine Used—Diamond-disk grinder, Fig. 115. Number of Operators per Machine—One. Note—Operator holds piece on disk until a flat seat is ground on the bottom; one operator generally grinds, paints and assembles with a total of from 800 to 1000 per day.

OPERATION 5. PAINT BASE

Transformation—Fig. 116. Description of Operation—Operator applies asphaltum varnish to base with a brush. Production—See grinding note.

OPERATION 6. ASSEMBLE TUBE

Transformation—Fig. 117. Description of Operation—Operator presses tube into diaphragm, as shown in Fig. 118. Apparatus and Equipment Used—Fixture, Fig. 119. Gages—Length, Figs. 120 and 121. Production—See grinding note.

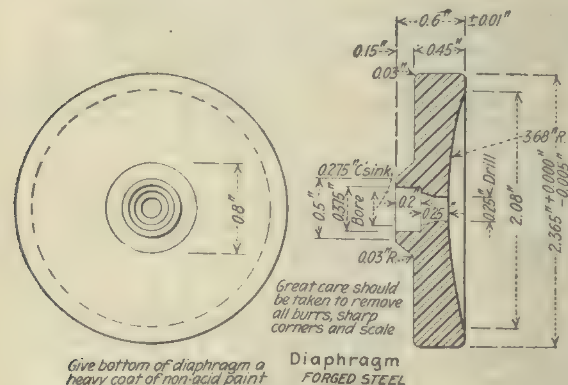


FIG. 105


FIG. 106

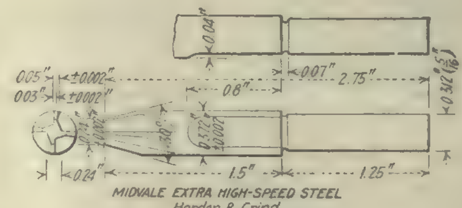


FIG. 108

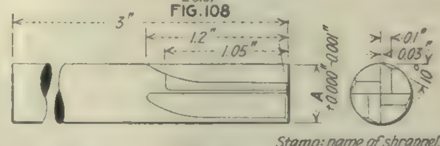


FIG. 109

SIZE	A
2.95"	0.375"
3"	0.375"
3.8"	0.5"
4.7"	0.5"
6"	0.5"

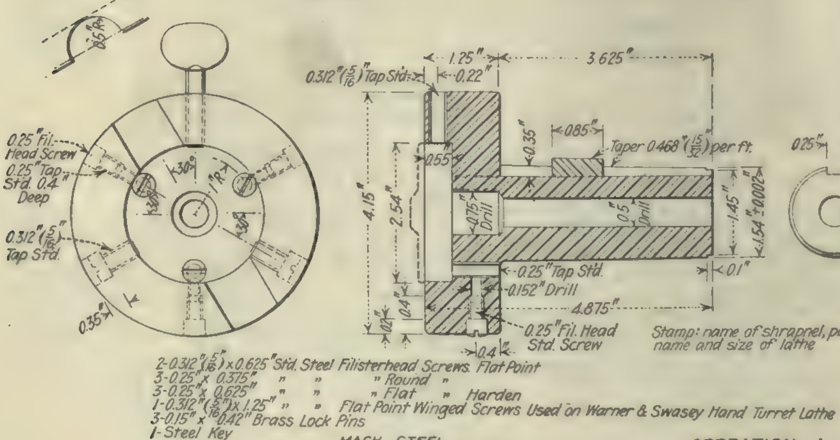


FIG. 107

OPERATION 1

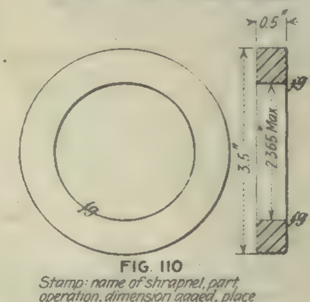


FIG. 110

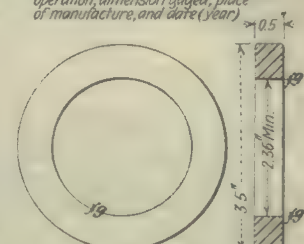


FIG. 111

ALL MATERIAL TOOL STEEL EXCEPT WHERE OTHERWISE NOTED FINISH X ± 0.01" HARDEN

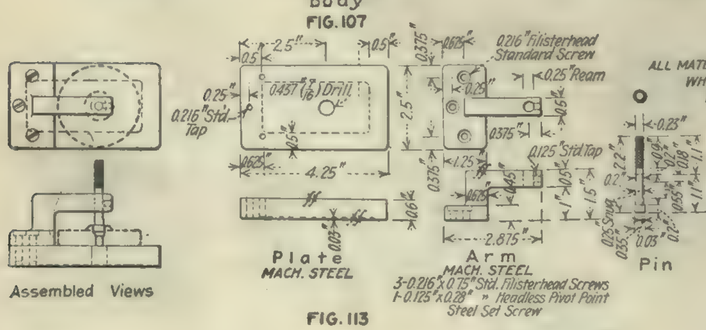


FIG. 113

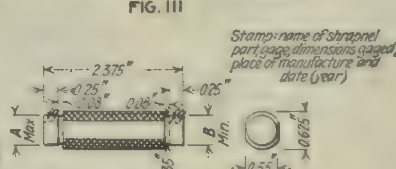


FIG. 112

SIZE	A	B
2.95"	0.375	0.375"
3"	0.375"	0.375"
3.8"	0.5"	0.498"
4.7"	0.5"	0.498"
6"	0.5"	0.498"

Locking Pins

OPERATION 1. MACHINE (BAR STOCK)

Transformation—Fig. 122. Machine Used—Brown & Sharpe automatic. Number of Machines per Operator—Three. Cutting Tools—Cutoff and form tool, Fig. 123. Coolant—Zurn oil. Gages—Length, Fig. 124. Production—2500 per 8 hr.

Work on the Diaphragm

Since a diaphragm is forged and then trimmed in a die, the amount of machining work needed is small. It is held in a special chuck, Fig. 107, in a turret lathe and drilled and counterbored. Following the heat-treatment, which is given in detail under the proper heading, the base is ground on a disk grinder in order that it may seat properly in the case. Removing scale from the counterbore is simply a scraping operation, and an old twist drill, ground to suit, is used in a drilling machine. The base is next painted, and the center tube is pressed in with the special fixture, Fig. 119. The work on locking pins, central tubes, inner tubes and retainers is all simple.

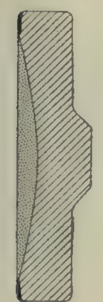


FIG. 114

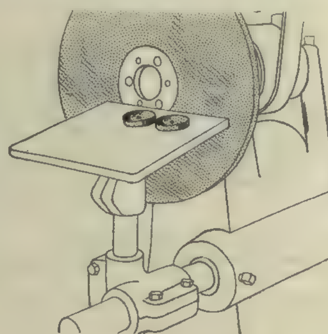


FIG. 115

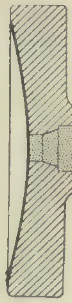
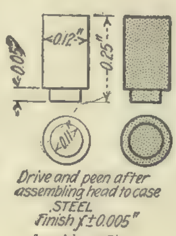


FIG. 116, OP. 5

OPERATION 4

S.1



Locking Pin
FIG. 122

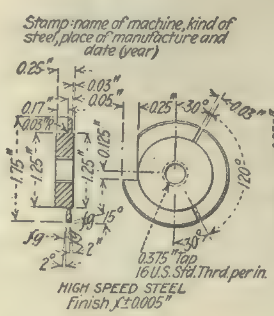


FIG. 123

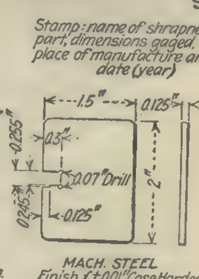


FIG. 124

FIG. 117

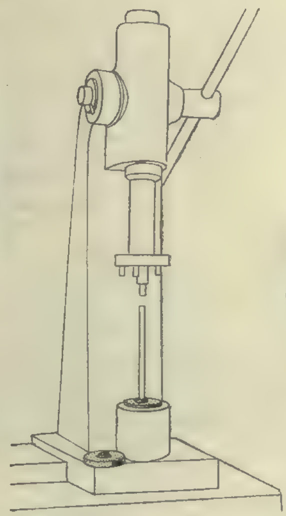


FIG. 118

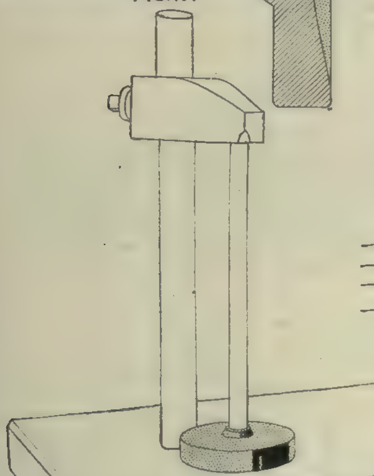


FIG. 120

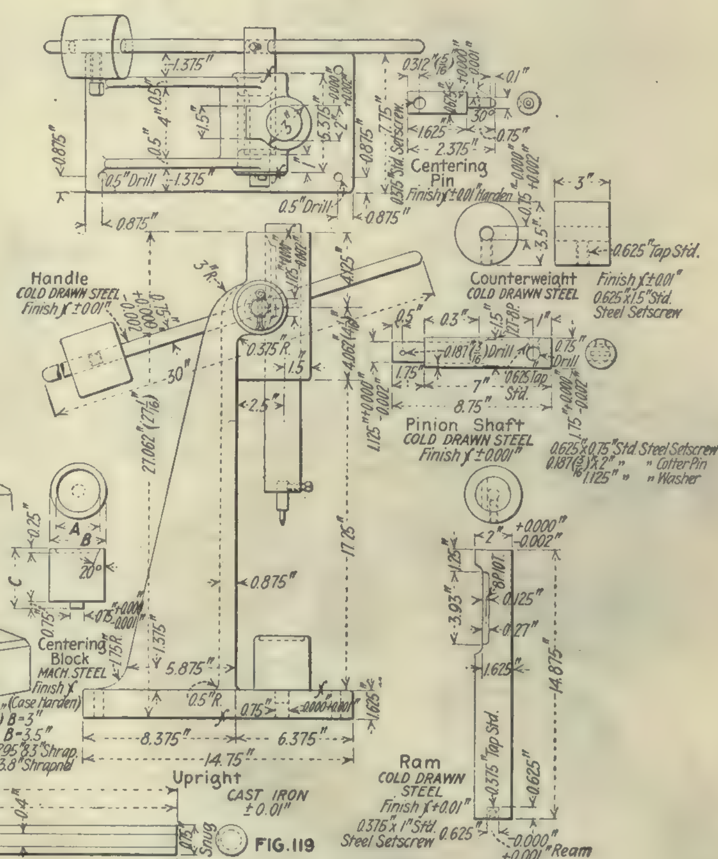


FIG. 119

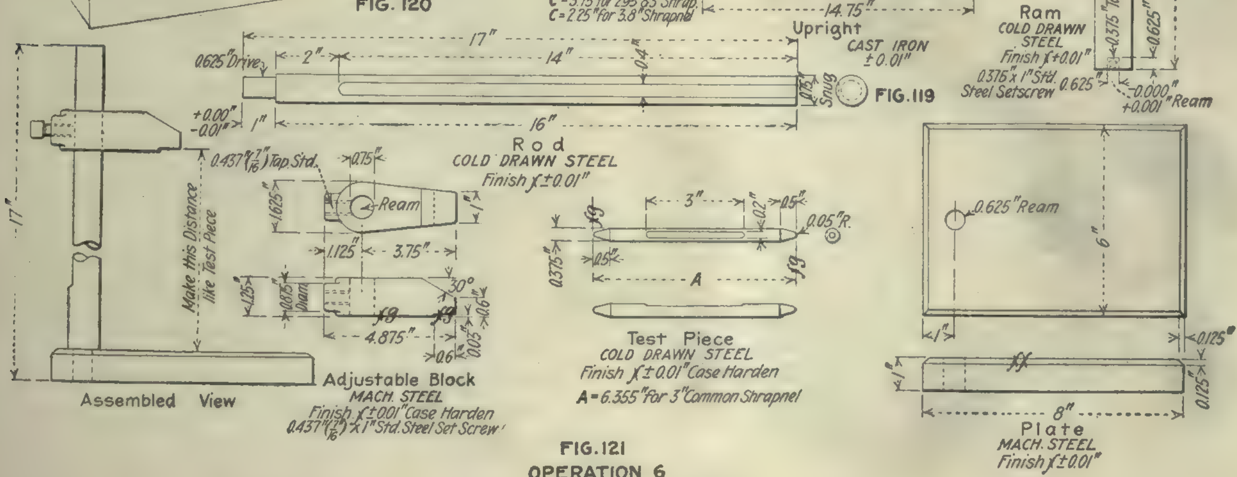


FIG. 121
OPERATION 6

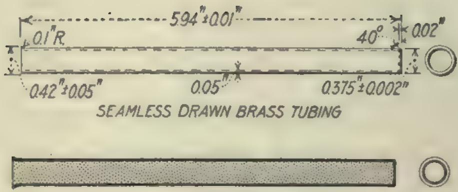


FIG. 125

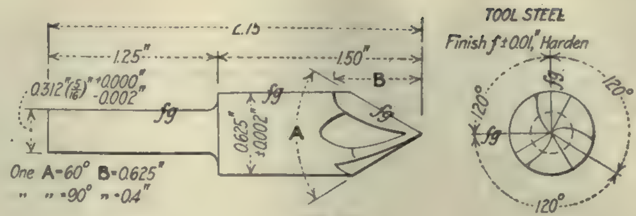


FIG. 126

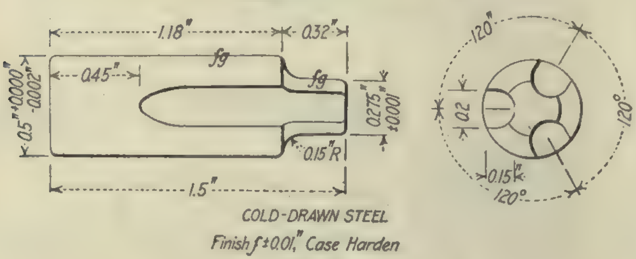


FIG. 127

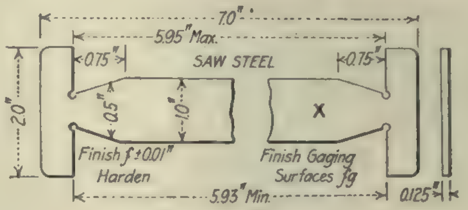


FIG. 129

X=Stamp Name of Shrapnel, Part, Dimension gaged, Place of Manufacture and Date (Year)

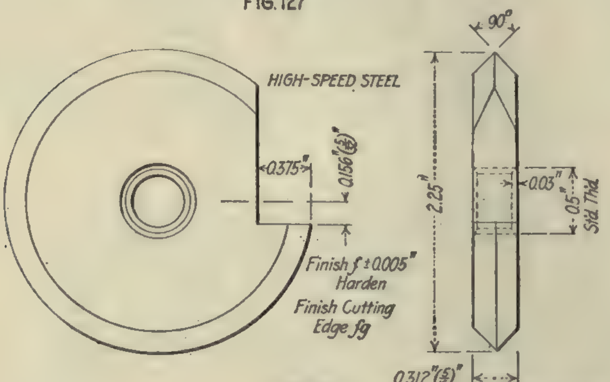


FIG. 128

OPERATION 1

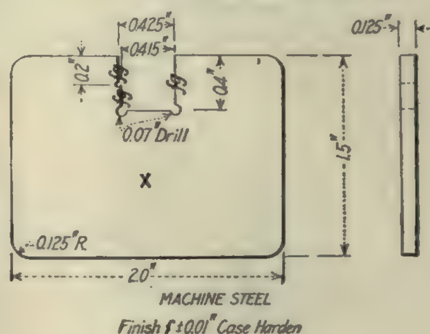


FIG. 130

Tube (Inner)

OPERATION 1. MACHINE

Transformation—Fig. 131. Machine Used—Brown & Sharpe automatic. Number of Machines per Operator—Three. Tool-Holding Devices—Four tool holders. Cutting Tools—Two countersinks, Fig. 126; two belling tools, Fig. 132; chamfering tool, Fig. 133; cutoff tool, Fig. 134. Cut Data—2400 r.p.m. Coolant—Lard oil. Gages—Overall length, Fig. 135; maximum and minimum diameter of bell, Fig. 135. Production—4200 per 8 hr. Note—Seamless copper tubing is used.

Tube (Central)

OPERATION 1. MACHINE

Transformation—Fig. 125. Machine Used—Brown & Sharpe automatic. Number of Machines per Operator—Three. Tool-Holding Devices—Four tool holders. Cutting Tools—Two countersinks, Fig. 126; two belling tools, Fig. 127; cutoff tool, chamfering tool, Fig. 128. Cut Data—2400 r.p.m. Coolant—Lard oil. Gages—Overall length, Fig. 129; maximum and minimum diameter of bell, Fig. 130. Production—2500 per 8 hr. Note—Seamless brass tubing is used.

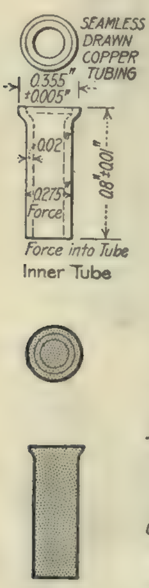


FIG. 131

Stamp Name of Shrapnel, Part, Size, Place of Manufacture and Date (Year)

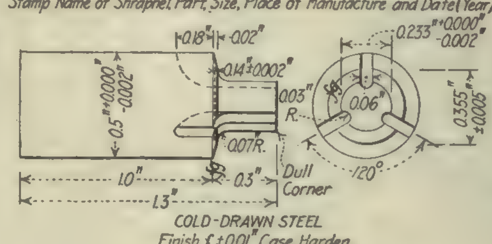


FIG. 132

Stamp Place of Manufacture and Date (Year)

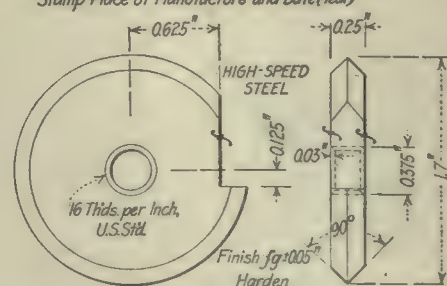


FIG. 133

Stamp Name of Machine, kind of Steel, Place of Manufacture and Date (Year)

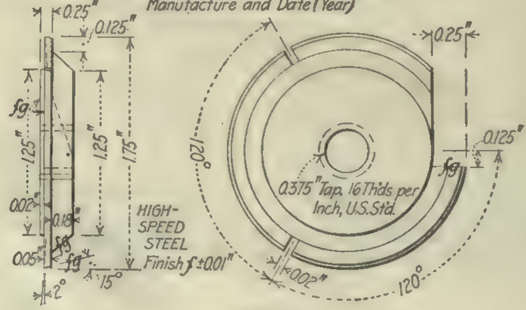


FIG. 134

Stamp Name of Shrapnel, Part, Dimensions gaged, Place of Manufacture and Date (Year)

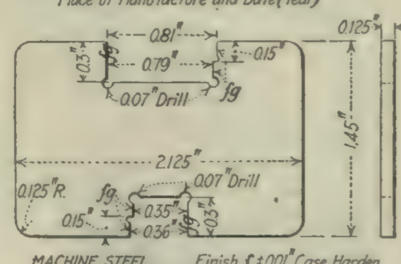
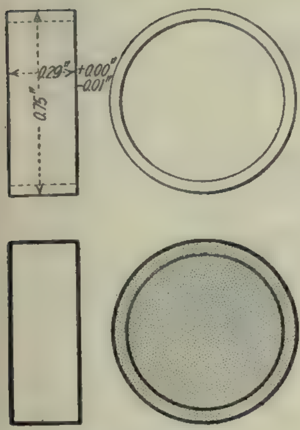


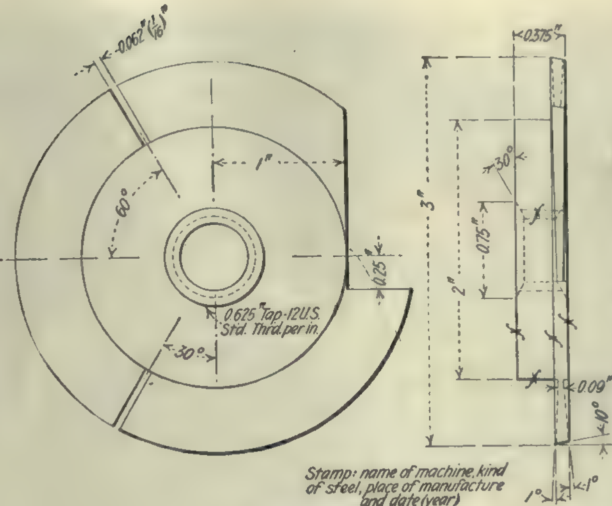
FIG. 135



Retainer

Seamless Drawn Brass Tubing 0.058" Thick ±0.01"

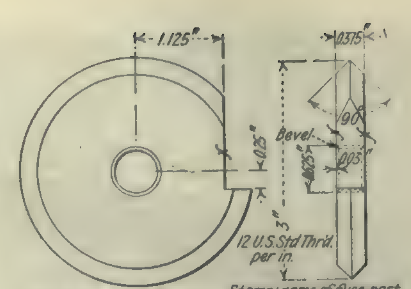
FIG. 136



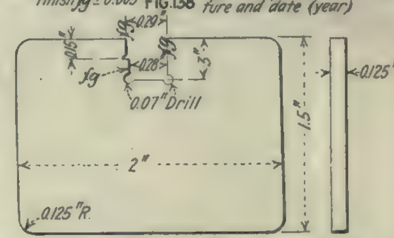
HIGH-SPEED STEEL (Harden) Finish fg ±0.01"

FIG. 137

OPERATION 1



HIGH-SPEED STEEL (Harden) Finish fg ± 0.005" FIG. 138



MACH. STEEL (Case Harden) Finish f ± 0.01"

FIG. 139

Retainer

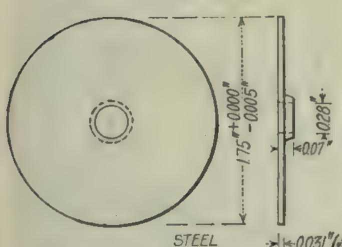
OPERATION 1. MACHINE

Transformation—Fig. 136. Machine Used—Brown & Sharpe automatic. Number of Machines per Operator—Three. Cutting Tools—Cutoff tool, Fig. 137; chamfering tool, Fig. 138. Gages—Length, Fig. 139. Production—2500 per 8 hr. Note—Brass tubing used.

Washer

OPERATION 1. PUNCH (SHEET STEEL)

Transformation—Fig. 140. Machine Used—Crank press. Number of Operators per Machine—One. Punches and Punch Holders—Punch, Fig. 141. Dies and Die Holders—Die, Fig. 142. Lubricant—Machine oil. Production—8000 per 8 hr. Note—This completes the washer.



STEEL

FIG. 140

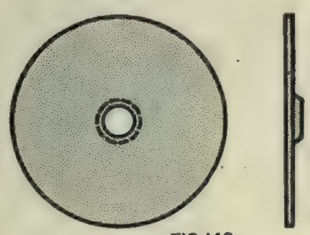
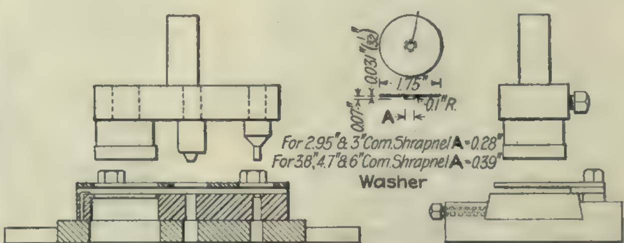


FIG. 140



Assembled Views

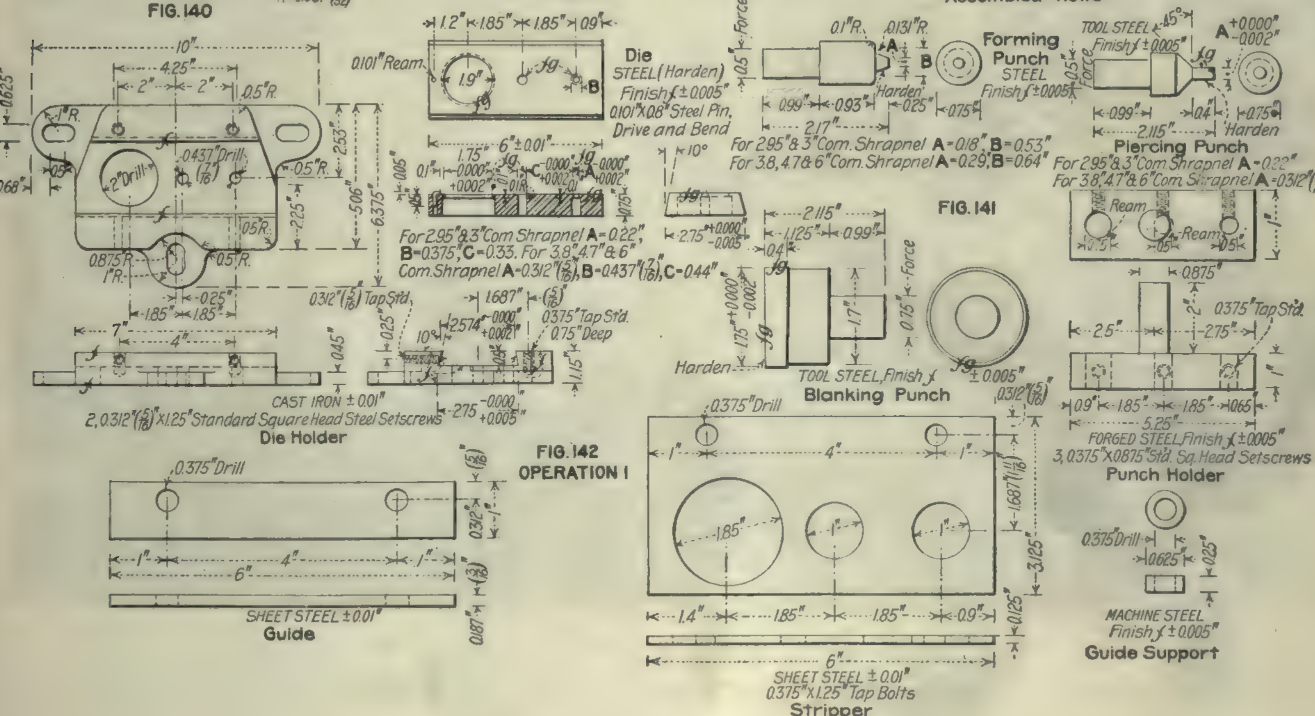
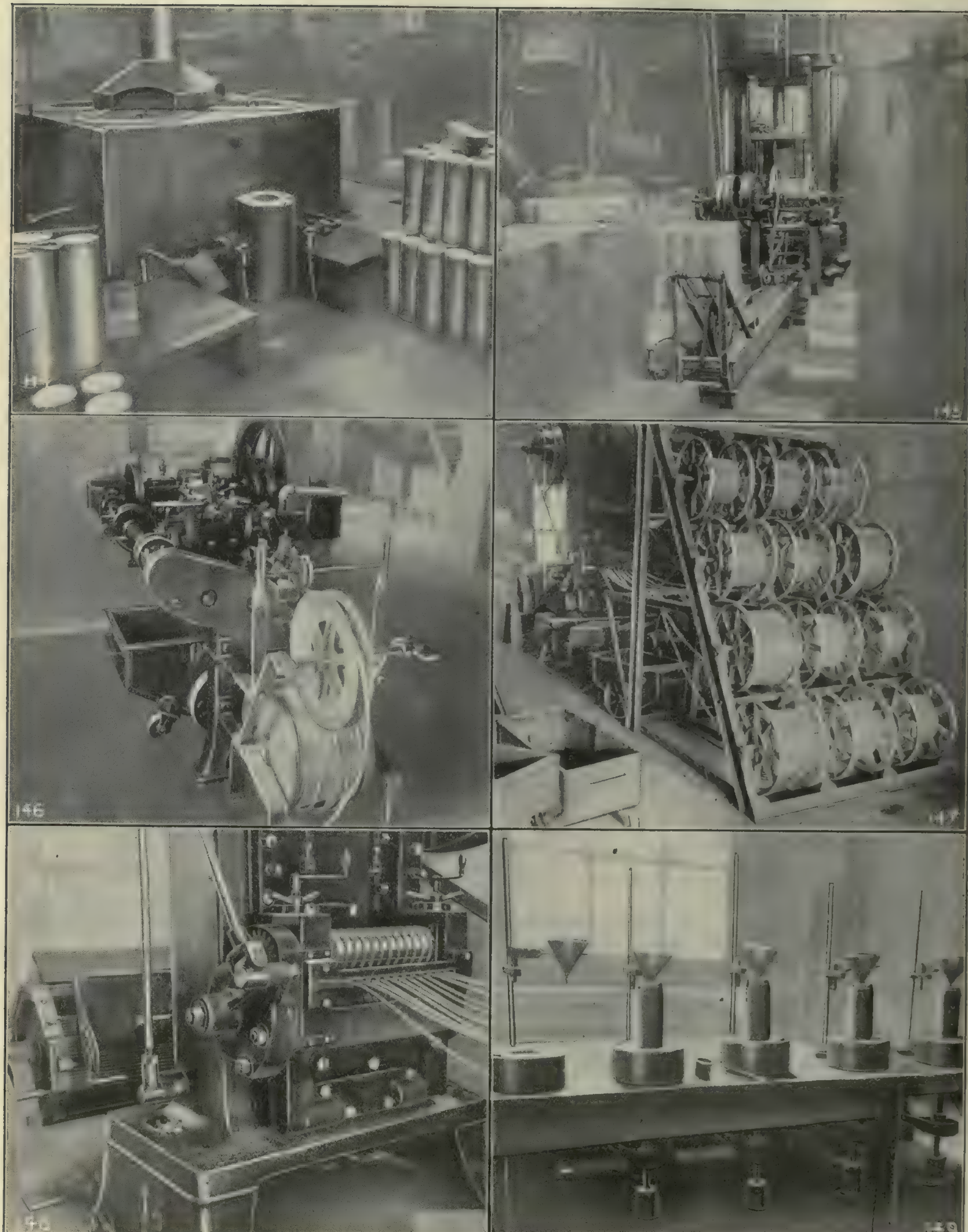


FIG. 142

OPERATION 1



FIGS. 144 TO 149. VARIOUS BULLET-MAKING AND POWDER-LOADING OPERATIONS

Fig. 144—Casting ingots. Fig. 145—Extruding the wire. Fig. 146—Special ball-forming machine. Fig. 147—Press and wire reels. Fig. 148—Roll feed and tumbler. Fig. 149—Powder-loading machines

The lead balls used in shrapnel are both round and six-sided, as shown in Fig. 152, and are made in practically the same way, only different dies being used.

DIMENSIONS	SHRAPNEL SIZE	DRAWING NO.	PIECE MARK
0.5" Diam. 6 Faces 0.46" Flats	2.95"	75-2-41	41 F
	3"	75-2-4	4 F
	3"	75-2-137	137 F
	3"	75-2-151	151 G
	3"	75-2-152	75 H
0.54" ± 0.005"	3.8"	75-2-145	145 B1
	4.7"	75-2-147	147 A
	5"	F.A. 3574	
0.6" ± 0.005"	6"	75-4-12	12 C1
	6"	75-7-37	37 C1
	7"	F.A. 3578	
COMPOSITION OF BALLS: 12.5% Antimony, 87.5% Lead			

FIG. 152. BALL DIMENSIONS

Making Balls

OPERATION 1. CASTING INGOTS

Transformation—Fig. 143. Number of Operators—One. Description of Operation—Operator pours melted mixture of 7 parts lead and 1 part antimony into mold and allows it to cool for 3 or 4 min., then inverts mold and allows ingot to drop out, the shrinkage being sufficient for ample clearance. Apparatus and Equipment Used—Rockwell melting furnace, ladles, tongs and water-cooled mold, Fig. 144. Production—43 per day per mold.

OPERATION 2. EXTRUDING THE WIRE

Transformation—Fig. 150. Machine Used—Waterbury-Farrel 700-ton hydraulic press, Fig. 145. Number of Machines per Operator—One. Dies and Die Holders—Fig. 151. Pressure Required—About 650 tons total. Production—75 per day. Note—A spool of wire usually consists of five extruded ingots, or about 500 lb.

OPERATION 3. FORMING BALLS ON SPECIAL MACHINE

Transformation—Fig. 153. Machine Used—Special Waterbury-Farrel machine, Figs. 146 and 154. Number of Machines per Operator—Four. Tools—Shearing ring punch, Fig. 155; forming punch and die, Fig. 156; shearing punch and die, Fig. 157; transfer plate, Fig. 158. Cut Data—68 strokes per minute. Production—30,000 per day. Note—500 lb. of wire makes about 380 lb. of balls; the balls for 3-in. shells run 41 to the pound; for 4.7-in. shells, 32 to the pound; and for 6-in., 22.90 to the pound.

OPERATION 3-A. FORMING BALLS ON A PUNCH PRESS AND RUMBLING

Transformation—Fig. 159. Machine Used—Waterbury-Farrel crank press, Figs. 147 and 148. Number of Operators per Machine—Two. Punches and Dies—Fig. 160. Production—200,000 per day. Note—500 to 600 lb. of balls are rumbled at a turn to remove fins left by dies; this operation takes about 15 min.; press runs 80 strokes per minute and takes 12 wires at once.

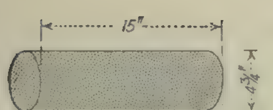


FIG. 143

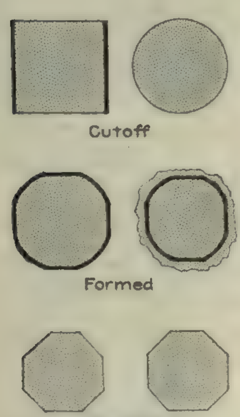


FIG. 153

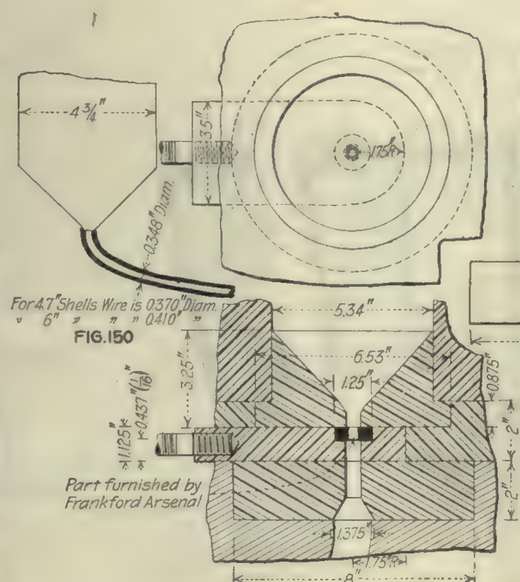


FIG. 150

FIG. 151

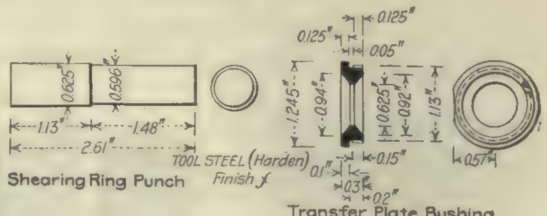


FIG. 155

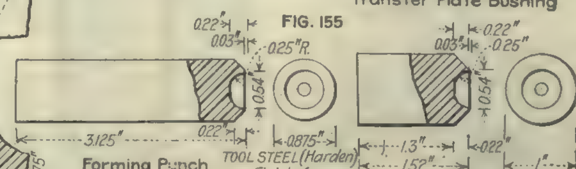


FIG. 156

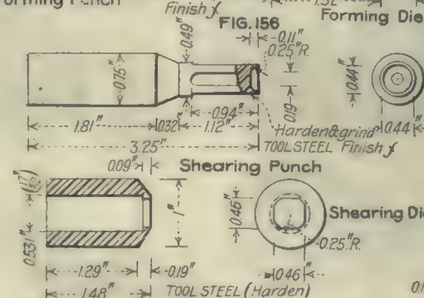


FIG. 157

FIG. 159

FIG. 160

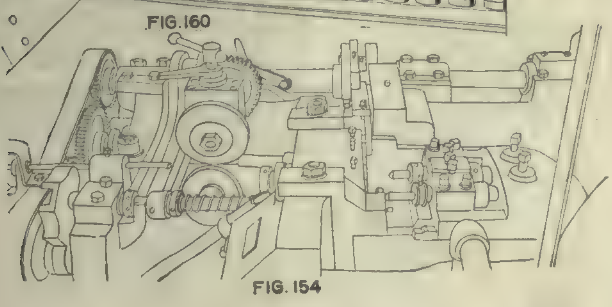


FIG. 154

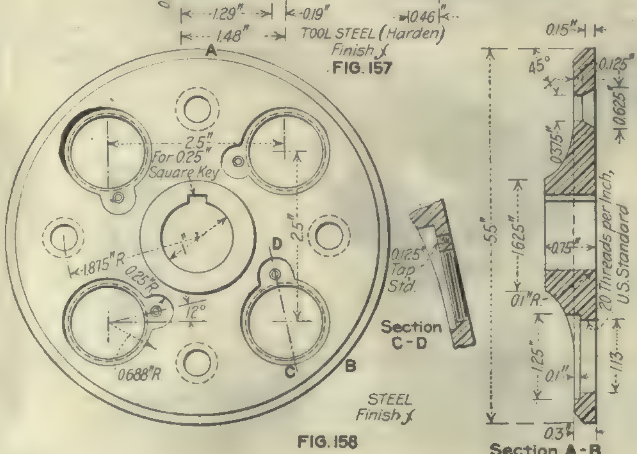


FIG. 158

Commonly, however, the hexagon balls are made on the special machines and the spherical ones on the press.

The mix for the balls is melted in large pots and cast into ingots. A furnace and a mold are shown in Fig. 144. The mold in the foreground is water cooled and so made as to be swung over on trunnions, allowing the cooled ingot to drop out.

As shown in Fig. 145, the wire from which the balls are made is extruded in a hydraulic press. As the wire issues from the die, it is carried down through a trough of water. At the farther end of the trough it runs over a large grooved pulley carried in a "floating" frame. From this pulley the wire is run back toward the press and is automatically wound on a reel. Friction drive is used in the reel-turning mechanism, adjusted so that the wire will be closely wound, but not pulled so hard as to sever it.

In making balls on the type of machine shown in Fig. 146 a reel of wire is placed in the bracket and fed into the machine. A cam-operated slide cuts the wire off into short slugs, which are carried over and fed into a rotating disk. This disk carries the slug between two forming punches, which compress and form the lead into a ball. As the disk again indexes, the ball is carried to the next set of dies, where the flash is trimmed off. An extra punch in a slide removes all lead particles that might cling to the dies and cause trouble as the disk indexes to the different positions.

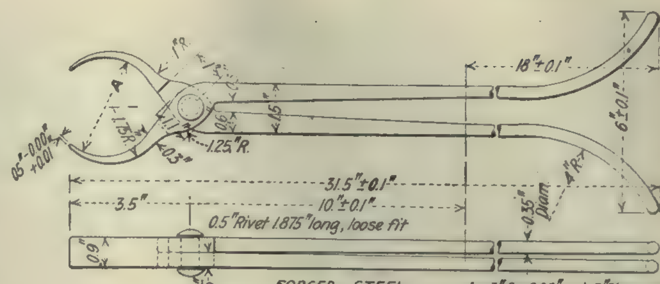


FIG. 161, OP. 1

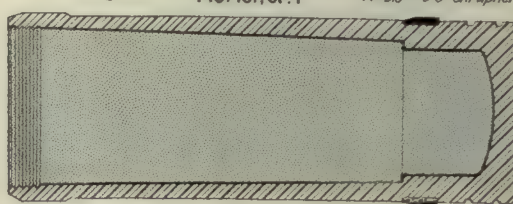


FIG. 162

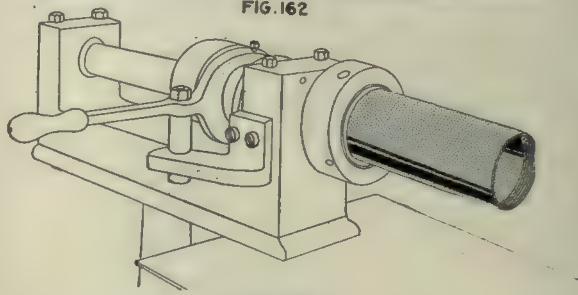


FIG. 163
OPERATION 2

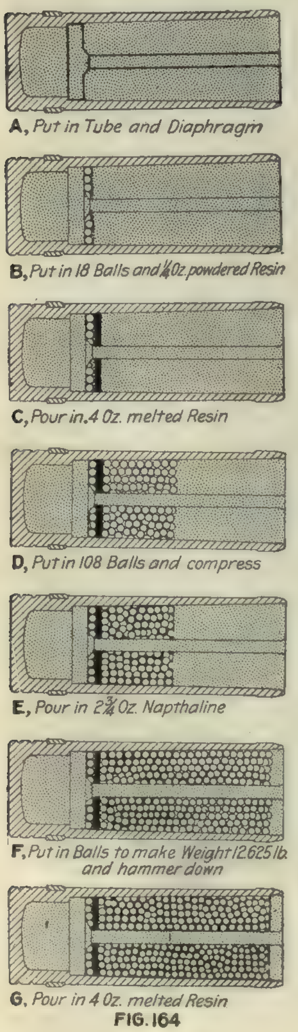
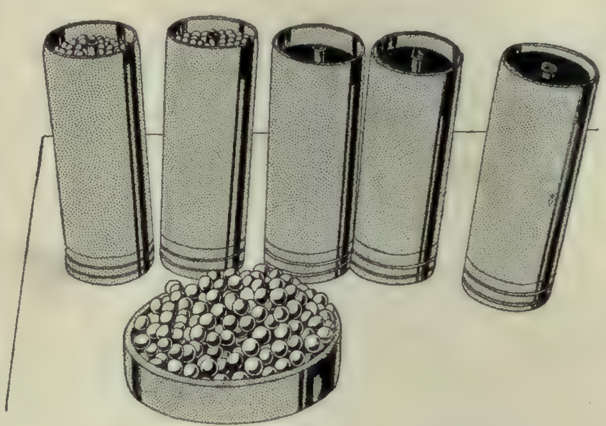


FIG. 164



164 A

OPERATION 3

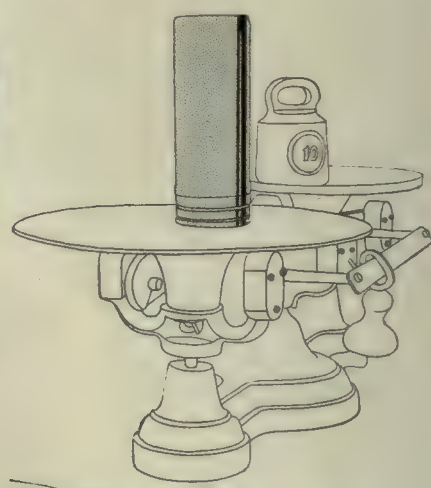


FIG. 166

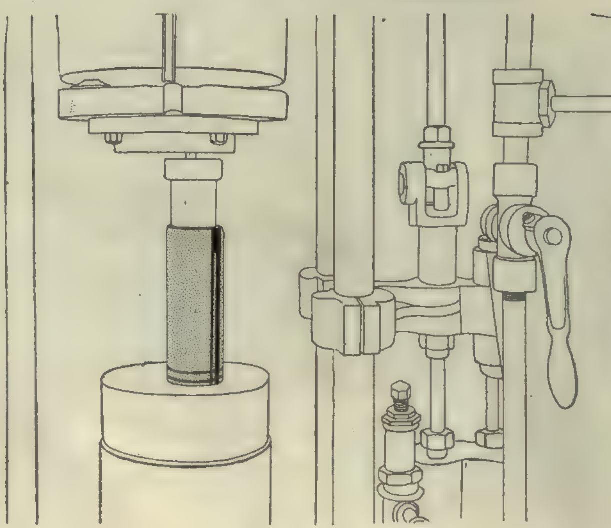


FIG. 165

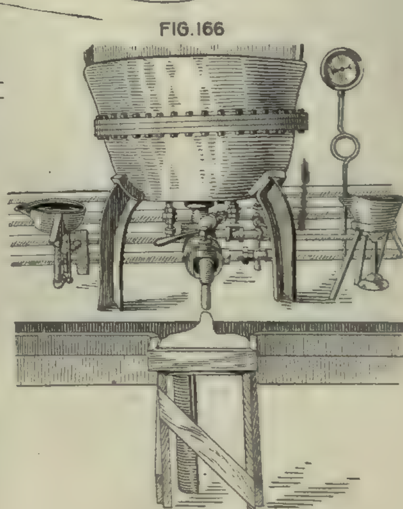


FIG. 167

Where the balls are made on a punch press, as shown in Figs. 147 and 148, twelve are made at each stroke of the press. The 12 reels are carried on a slanting frame in such a way that any individual reel may be removed and replaced without disturbing the others. This is especially necessary, as it is impossible to empty the reels all at once on account of varying lengths of wire.

After the balls are formed in the press, they drop into a tumbling barrel placed close to the machine, as shown at the back in Fig. 148. The balls are tumbled in this to remove the flash, the rubbing together accomplishing the desired result.

After the case has been washed in hot soda water, the interior is painted and then is ready for assembling and for receiving the balls. The standard shop directions for this operation are as follows:

Make sure that the diaphragm seats very firmly on the shoulder; pour in 0.25 oz. powdered resin to seal joints and shake down well to fill all cracks. The powdered resin becomes plastic when the melted resin is poured in.

Put in one layer of balls (18) and pour in 0.4 oz. of melted resin. Put in 108 balls and settle by a pressure of 6 tons. Pour in 2.25 oz. of melted pure white commercial naphthalene. Put in sufficient number of balls to bring the weight to 12.625 lb. Drive down with mallet and pour in 4 oz. of melted resin. After the mass has thoroughly cooled, face off matrix so that the depth from end of case shall be 0.35 in. to allow for screwing in of head, which should bear down hard on matrix.

Final Operations

Assembling

OPERATION 1. WASH CASE IN HOT SODA WATER

Number of Operators—One. Description of Operation—Operator places case in solution until grease is cut off, then rinses in hot water and drains it. Apparatus and Equipment Used—Tongs, Fig. 161; tank of Wyandotte metal-cleaner solution; tank of hot water. Production—350 per day.

OPERATION 2. PAINT INTERIOR

Transformation—Fig. 162. Number of Operators—One. Description of Operation—Operator chucks case and applies the paint inside so as not to daub up the threads; machine runs 140 r.p.m. Apparatus and Equipment Used—Small special machine, Fig. 163; pot of asphaltum varnish; long-handled brush. Production—1000 per day.

OPERATIONS 3-A, 3-B AND 3-C. ASSEMBLE TUBE AND DIAPHRAGM, FILL CASE, COMPRESS BALLS

Transformation—Figs. 164 and 164-A. Number of Operators—Two. Description of Operation—First operator puts in diaphragm and tube, making sure the diaphragm seats firmly; then he pours in ¼ oz. powdered resin; next, he places a layer of 18 balls on the diaphragm and pours in 0.4 oz. of melted resin; 108 balls are put in and pressed down by second operator with 6 tons' pressure; 2¼ oz. of melted pure white commercial naphthalene is poured in; sufficient balls are next added to bring weight to 12.625 lb.; these balls are driven down with mallet, and 4 oz. of melted resin is poured in. Apparatus and Equipment Used—Watson-Stillman hydraulic press, Fig. 165; scale, Fig. 166; melting pots for resin and naphthalene, Fig. 167; mallet. Production—340 per 8-hr. day.

OPERATION 4. CUT OUT SURPLUS RESIN

Transformation—Fig. 168. Machine Used—Small lathe, Fig. 169. Number of Operators per Machine—One. Work-Holding Devices—Special chuck, Fig. 170. Tool-Holding Devices—Shank for cutter, Fig. 171. Cutting Tools—Resin cutter, Fig. 172. Cut Data—250 r.p.m. Gages—Depth, Fig. 173. Production—1000 per 8 hr.

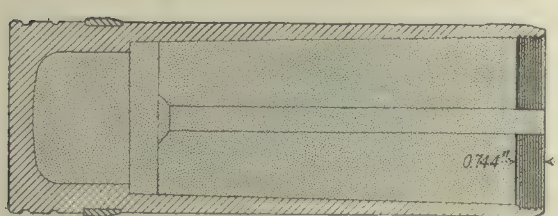


FIG. 168

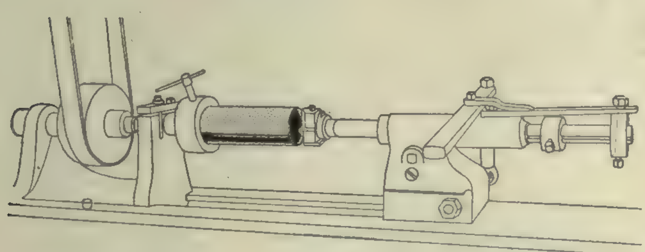


FIG. 169

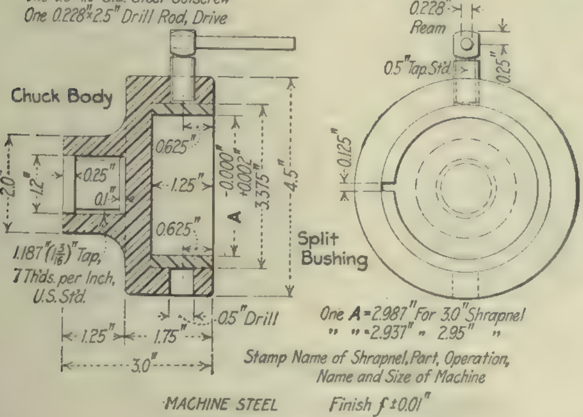


FIG. 170

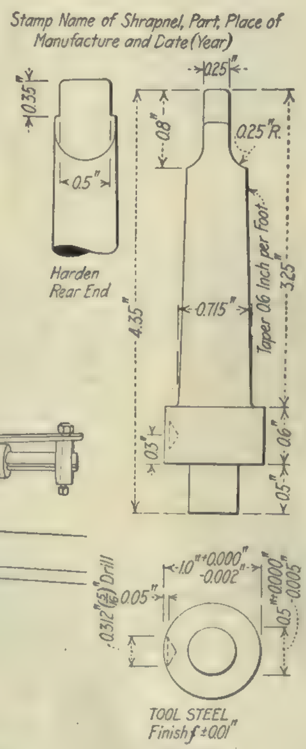


FIG. 171

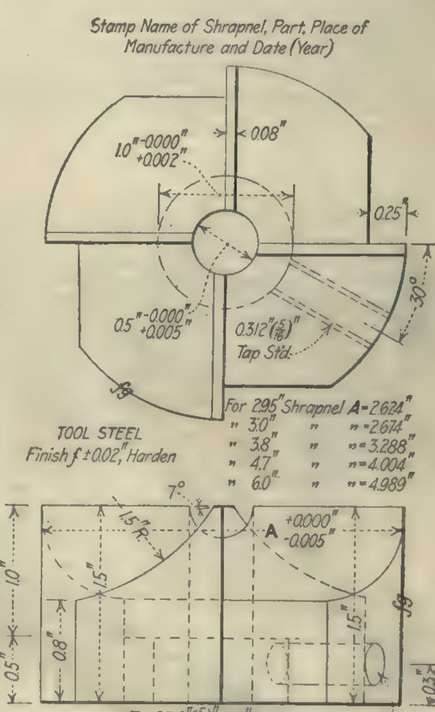


FIG. 172

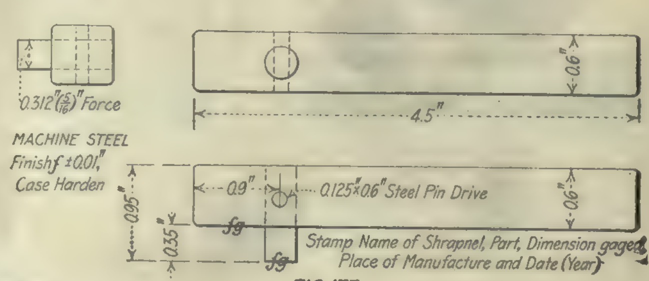


FIG. 173

OPERATION 4

OPERATION 5. MOISTEN THREADS OF HEAD WITH COSMOLINE, ASSEMBLE HEAD TO CASE AND INSERT INNER TUBE

Transformation—Fig. 174. Number of Operators—One. Description of Operation—Operator brushes a little cosmoline on threads of head, places case in bench holding block and screws head into place, Fig. 175; he then puts in inner tube and hammers it in place with hammer and special punch, Fig. 176. Apparatus and Equipment Used—Holding block; wrench, Fig. 177; punch, Fig. 178; hammer. Production—515 per day.

OPERATION 6. PIN HEAD TO CASE

Transformation—Fig. 179. Machine Used—Small drilling machine, Fig. 180. Number of Operators per Machine—One. Tool-Holding Devices—Drill chuck. Cutting Tools—No. 31 twist drill. Special Fixtures—Fixture to hold case, Fig. 187. Production—600 per 8 hr. Note—Pins are supplied of correct size and are driven in by hand.

OPERATION 7. TURN BOURRELET (WHEN CASES ARE FINISHED BY OUTSIDE CONTRACT)

Transformation—Fig. 182. Machine Used—Le Blond 17-in. lathe. Number of Operators per Machine—One. Work-Holding Devices—Special chuck, Fig. 184; steadyrest. Cutting Tools—Left-hand lathe tool. Cut Data—50 ft. surface speed. Special Fixtures—Split bushing; form and form follower, Fig. 183. Gages—Maximum diameter, ring, Fig. 43; minimum diameter, ring, Fig. 44; diameter, nose thread, plug, Fig. 45. Production—180 per 8 hr.

In all cases where two parts are screwed together it is the practice to put on enough cosmoline to coat the threads. This is simply slushed on with a small brush. With the threads moistened with cosmoline, the head is screwed into the case, using the special wrench and holding block shown in Fig. 175.

Following this the same operator forces in the inner tube with a punch and hammer, as shown in Fig. 176, the two transformations *A* and *B*, Fig. 174, showing what is done. Details of both the wrench and punch are given in Figs. 177 and 178.

The pinning of the head to the case is done by one operator who first drills the two holes in a small drilling machine, using a special holding fixture as shown in Fig. 180, the details being given in Fig. 181. After drilling the holes he drives in small pins, which are bought in quantities for the purpose.

No accurate spacing of the pin-holes is necessary, the operator drilling them approximately opposite each other.

The turning of the bourrelet indicated in operation 7, is only done where the cases are finished by outside contractors, as when they are machined at the arsenal the bourrelet is finished along with the point.

The grooving for the waterproof cover is done in a lathe, the shell being held in a special screw chuck, Fig. 187, in conjunction with a revolving tail center, Fig. 189, the cutting tool used being shown in Fig. 188.

Painting of the outside is done by chucking the shell in a lathe and applying the paint in broad bands with a brush, the operator after a little practice judging the width of the bands with his eye. On large shells they are held in a vertical position on a rotating fixture, the operator using pointers on an upright piece to indicate the width of the bands until accustomed to his work.

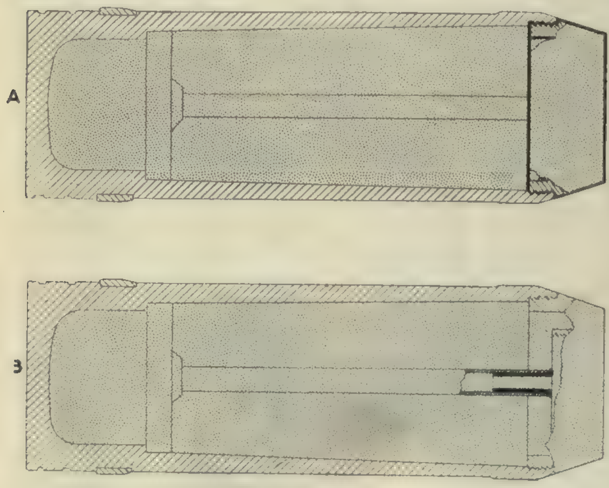


FIG. 174

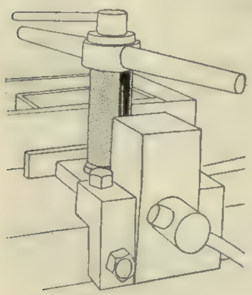


FIG. 175

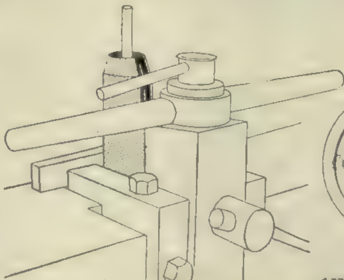


FIG. 176

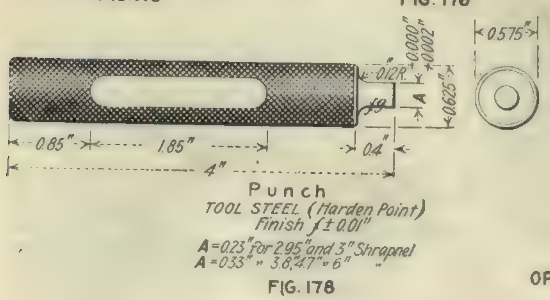


FIG. 178

OPERATION 5

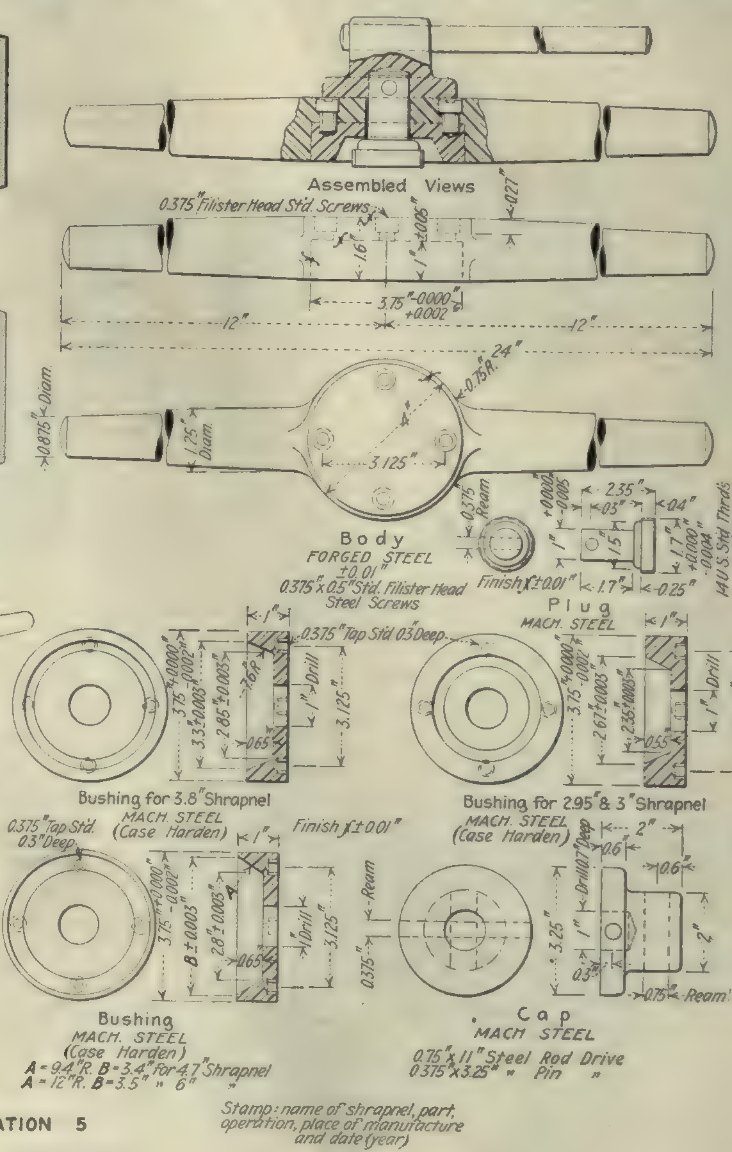


FIG. 177

The paints used are for two purposes: (a) To protect metal from corrosion, and (b) to identify different kinds of projectiles and contents. Red indicates a bursting charge, or high explosive; gray, forged-steel case; yellow, explosive of low power; olive green, cast iron; and so on. In some cases slushing oil is put on back of the band; but where it is not to be immediately assembled with the cartridge case, red paint is used.

The various colors and the method of mixing are here given, the exact proportions being given in each case.

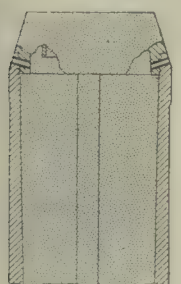


FIG. 179

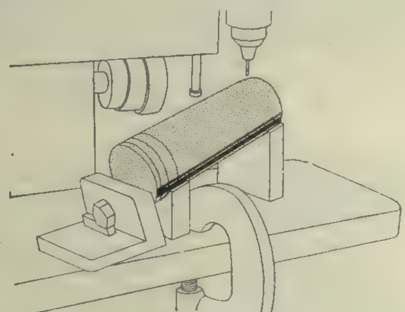
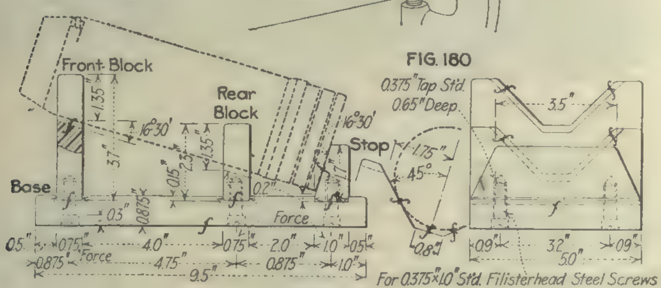


FIG. 180



MACHINE STEEL
FIG. 181
OPERATION 6

Body (Black)—1 Gal.:

Lampblack, dry	1 lb.
Linseed oil, raw	7/16 gal.
Texene	5/16 gal.
Japan drier	1/16 gal.
Copal varnish	1/16 gal.

Cast Iron (Light Olive Green)—1 Gal.:

French yellow ocher, in oil	7¾ lb.
Lemon chrome yellow, in oil	15 oz.
Chrome green, in oil	6 oz.
Lampblack, in oil	3 oz.
Linseed oil, raw	5/16 gal.
Texene	⅛ gal.
Japan drier	1/32 gal.
Copal varnish	1/32 gal.

Powder (Vermilion)—1 Gal.:

Deepfast vermilion, in oil	2 lb.
Red lead, dry	7 lb.
Whiting, dry	4½ lb.
Linseed oil, raw	⅝ gal.
Japan drier	1/16 gal.

Priming Coat (Red)—1 Gal.:

Red lead, dry	10 lb.
Whiting, dry	4 lb.
Linseed oil, raw	¾ gal.
Japan drier	1/16 gal.

Explosive D (Deep Yellow)—1 Gal.:

French yellow ocher, in oil	7½ lb.
English Venetian red, in oil	3 oz.
Lemon chrome yellow	4½ lb.
Linseed oil, raw	⅛ gal.
Texene	3/16 gal.
Japan drier	1/32 gal.
Copal varnish	1/32 gal.

Cast Steel (Warm Gray)—1 Gal.:

White lead, in oil	8 lb.
Whiting, dry	4½ lb.
French yellow ocher, in oil	¾ lb.
Lampblack, in oil	½ oz.
Lemon chrome yellow, in oil	1 oz.
Linseed oil, raw	5/16 gal.
Texene	3/16 gal.
Japan drier	1/16 gal.
Copal varnish	1/16 gal.

Forged Steel (Blue Gray)—1 Gal.:

White lead, in oil	7 lb.
Whiting, dry	5 lb.
Lampblack, in oil	3 oz.
Linseed oil, raw	⅜ gal.
Texene	3/16 gal.
Japan drier	1/16 gal.
Copal varnish	1/16 gal.

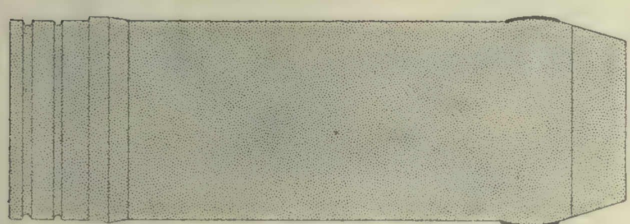
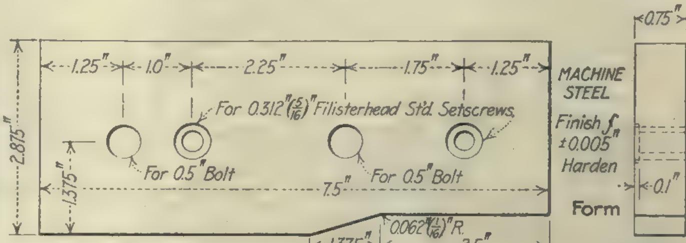
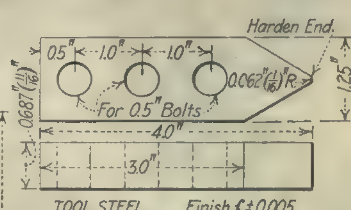


FIG. 182

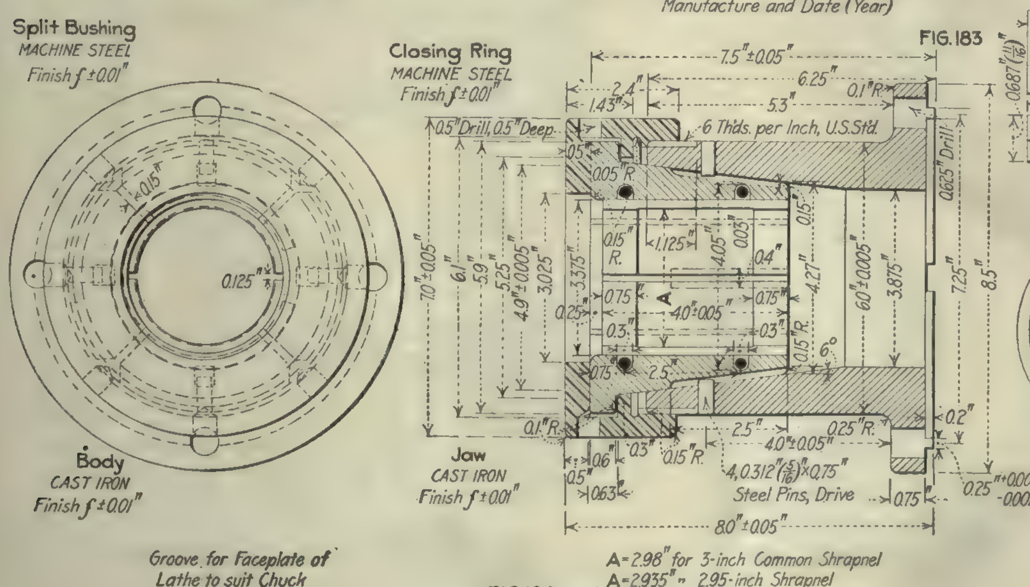


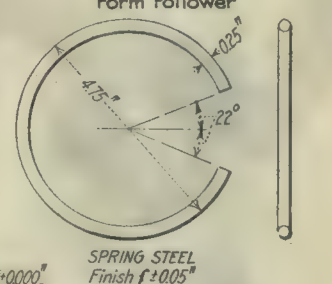
Stam Name of Shrapnel, Part, Place of Manufacture and Date (Year)



Form Follower

FIG. 183





Expansion Spring

FIG. 184
OPERATION 7

The powder charge is loaded in the machine shown in Fig. 149. The shells are placed in rotating holders, and a funnel is swung over them. The powder charge is then poured into the funnel and runs down through the center tube into the powder chamber. A second operator then takes the shell and pokes a small wad of gun cotton down into the center tube to hold the powder in place.

Following the loading, the shells go to a gang of three men, who put on the fuse. The first brushes cosmoline on the threads and partly screws in the fuse. The next man sets the shell in a bench chuck, Fig. 195, screws down the fuse and locks it in place with punch and hammer. The third man places the fuse setter over the fuse and sets it to the safety point.

From this gang the shell goes to the crimping machine, Fig. 197. The operator paints the cover groove, slips a brass waterproof cover in the holder, places the shell in the fixture and starts the machine. The disk roller revolves around the head and securely crimps the cover in place. Following this the edges of the cover and the junction with the shell are painted by hand with asphaltum varnish in order that the joint may be water-tight.

OPERATION 8. GROOVE FOR WATERPROOF COVER

Transformation—Fig. 185. Machine Used—Le Blond 17-in. lathe, Fig. 186. Number of Operators per Machine—One. Work-Holding Devices—Special screw chuck, Fig. 187. Cutting Tools—Special lathe tool, Fig. 188. Cut Data—50 ft. surface speed. Special Fixtures—Revolving center, Fig. 189. Gages—Position, scratch gage, Fig. 190; position gage, Fig. 191. Production—600 per 8 hr.

OPERATION 9. PAINT OUTSIDE

Transformation — Fig. 192. Number of Operators — One. Description of Operation—Operator chucks butt end of case in small lathe and applies paint with wide brushes. Apparatus and Equipment Used—Pot of black paint, pot of yellow paint, two brushes. Production—800 per day. Note—Machine runs 250 r.p.m.

OPERATION 10. LOAD POWDER CHARGE

Transformation—Fig. 193. Number of Operators—Three (two loaders and a trucker). Description of Operation—Cases are placed in the revolving fixtures shown, and 1180 gr. shrapnel powder is poured in through the funnels; next, a wad of gun cotton is pushed down through the tube to retain the powder and assist ignition; powder is measured by means of the little dipper shown on the bench; the cases rotate about 200 r.p.m. as the powder runs in through a $\frac{3}{32}$-in. opening in the funnels. Apparatus and Equipment Used—Loading fixtures, Fig. 149; measuring dipper; trucks. Production—2200 per day per gang.

OPERATION 11. BRUSH COSMOLINE ON FUSE THREADS

Number of Operators—One (three in gang). Production—1200 per day. Note—Three men do operations 11, 12 and 13 in succession.

OPERATION 12. SCREW IN FUSE AND LOCK

Transformation—Fig. 194. Number of Operators—One (in gang of three). Apparatus and Equipment Used—Bench chuck, wrench, punch and hammer, as shown in Fig. 195. Production—1200 per day.

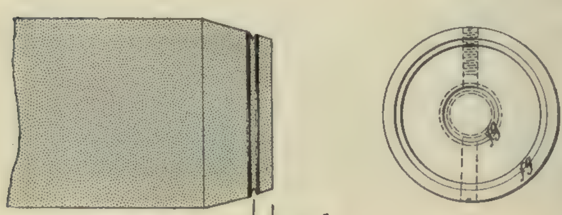


FIG. 185

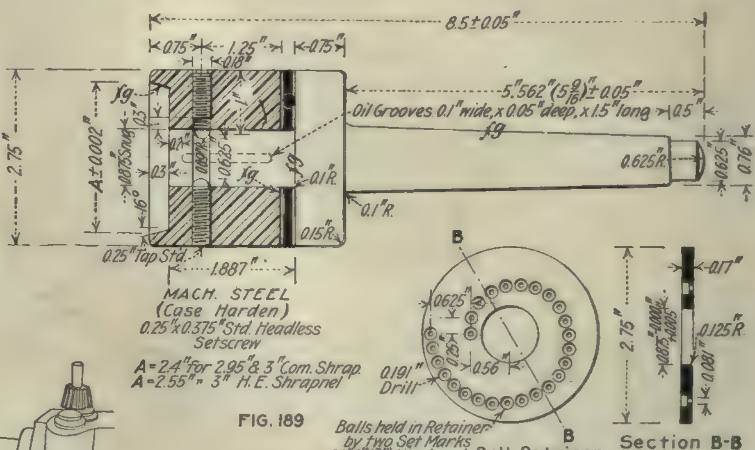


FIG. 189

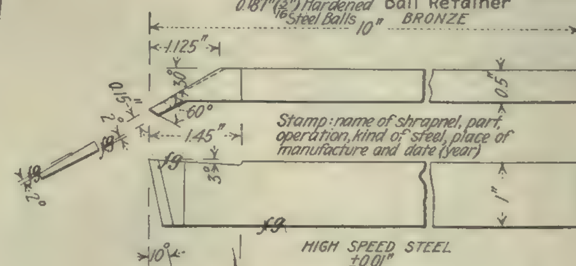


FIG. 188

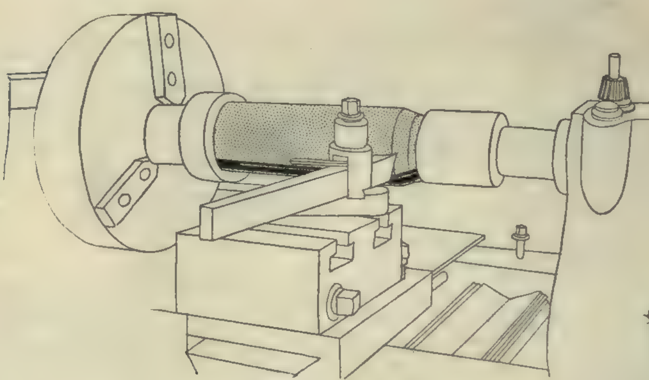


FIG. 186

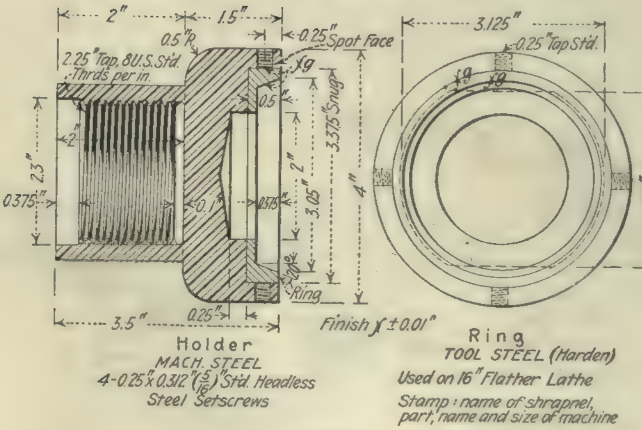


FIG. 187

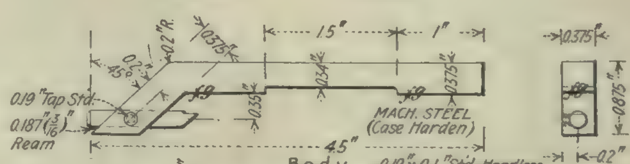


FIG. 190

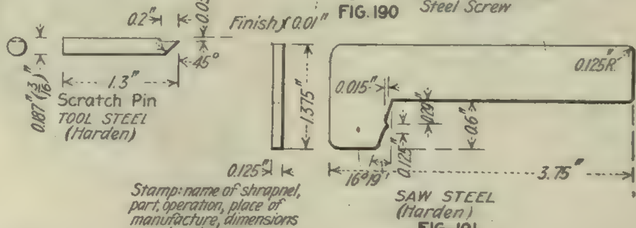


FIG. 191

OPERATION 8

OPERATION 13. SET FUSE TO SAFETY POINT

Number of Operators—One (in gang of three). Description of Operation—Operator places projectile in chuck, places fuse setter over the fuse nose, as shown in Fig. 196, and sets fuse to safety point. Production—1200 per day.

OPERATION 14. CRIMP ON WATERPROOF COVER

Transformation—Fig. 196. Machine Used—Lathe, Fig. 197. Method of Operation—Operator spreads asphaltum paint in the groove with a brush, presses on waterproof cover and places in machine, as shown; he then sets lever so that roller will press metal of cover into groove and starts machine; afterward he coats junction of cover and head with asphaltum paint to make water-tight; another slightly different form of machine is shown in Fig. 198; these machines run about 50 r.p.m. Production—700 per day.

OPERATIONS THAT HAVE BEEN OMITTED

In the foregoing article a number of operations of considerable importance have not been described in detail for the reason that they are the same as those on the 3-in. common steel shell, which will be described in a subsequent article. For instance the making of the copper band will later be given in detail from the time it is cut from copper tubing through all the steps, such as pickling, planishing, heating, pressing into place and finishing.

The night tracer will also be described and will be found of considerable interest. These tracers are made from brass rod, in automatic machines, so that the machining is not as interesting as the process of loading, which must be so arranged that the trail of fire does not show until the shell is some distance from the muzzle of the gun. Otherwise the position of the piece would be revealed to the enemy and afford a well-located target. The explosion of the propelling charge first ignites a slow-burning powder, which in turn sets off an ignition mixture followed by the blazing of the illuminant.

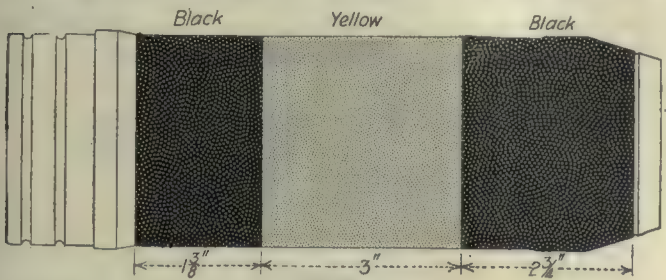


FIG. 192 OPERATION 9

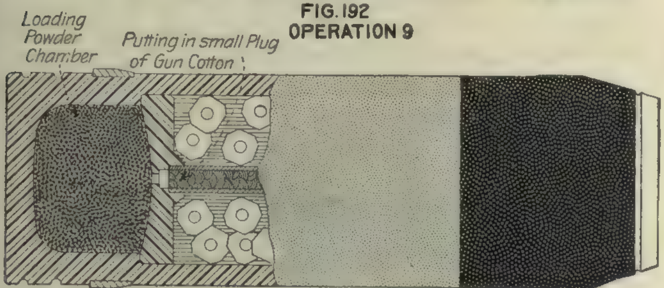
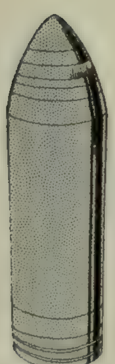


FIG. 193 OPERATION 10



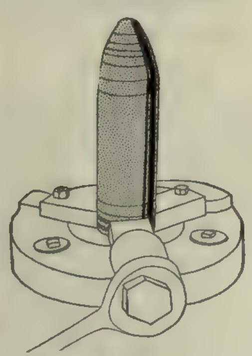


FIG. 194 OPERATION 12 FIG. 195

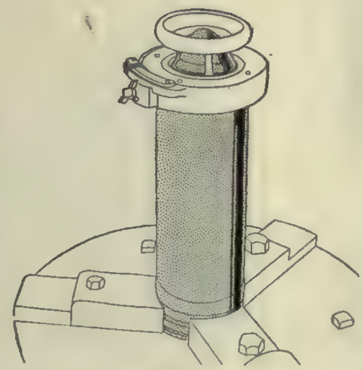


FIG. 196 OPERATION 13

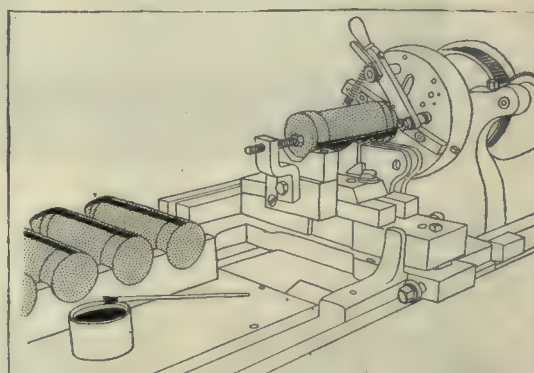


FIG. 198

FIG. 197

OPERATION 14

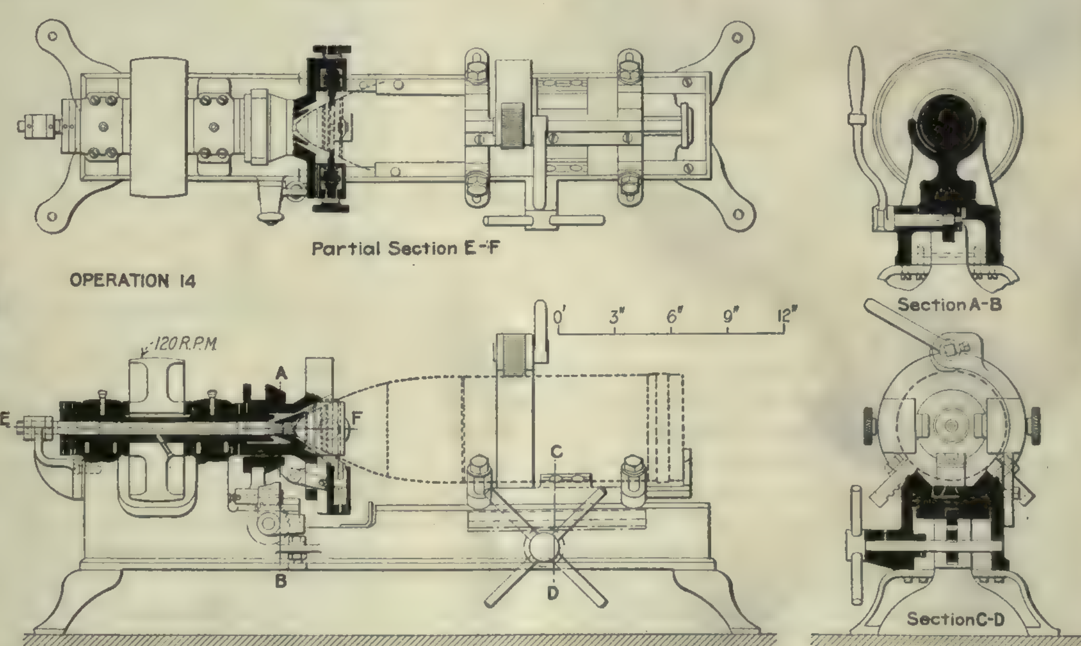


FIG. 199

Changes in the Rivett Shop

EDITORIAL CORRESPONDENCE

Those who knew the shop of the Rivett Lathe and Manufacturing Co., Brighton, Mass., before the new building and the rearrangement of the machinery will find many changes. The growth of the business and the fact that "Ed" Rivett, as he is affectionately called by his friends, gave up the financial end of the business made a reorganization necessary. And while such a change offers excellent opportunity for making mistakes, the present

THE ANTI-SPIT CORNER

business organization has things moving very satisfactorily in every way.

The old building is now largely used for storage, for cutting off bar stock and for some of the lighter parts of the business. Machines have been grouped according to their kind and with reference to the routing of the work through the shop, so far as possible. The varied kinds of work and the sizes and quantity preclude arranging the machines in accordance with the sequence of the operations to be performed. An old pair of stairs is used as a chute for materials, so as to handle them direct to the storage racks without loss of time and labor; passageways are defined by painted lines on the floor; no material is allowed to pass beyond these bounds, and everything is done to keep the shop neat and tidy.

An anti-spit corner on the stairways and in the hall is novel, but effective; it is shown in the small illustration. A man must have more than an ordinary amount of nerve to spit into a corner that is so glaringly white and that shows the disfigurement so clearly. This corner simply requires a little white paint and is ever so much better than signs of warning or the cuspidors that invite trials of marksmanship as one goes by.

Staff organization has become a part of the plant, each man having his duty clearly outlined so as to avoid overlapping, and work is scheduled in accordance with known rates of production from this plant. The Rivett house, which was famous for its hospitality, is now the office of the institution, the works manager desecrating the dining room by using it as his office.

Illustrations fail to convey the real work of such a reorganization. This can only be realized by a knowledge of the original conditions and a careful study of the changes made. But the points outlined will show that such a task is not to be entered into lightly, and it is only necessary to know that a new business management has made good in such a case to be assured that its members must have had a wide experience in manufacturing lines.

American Institute of Weights and Measures

On page 1100 of Vol. 45 the formation of a society to carry on an educational campaign with respect to the importance of our weights and measures and to promote legislation for the conservation of our basic English units was briefly noticed and its constitution printed in full.

The work of organization has now been completed and a full staff of officers elected at a meeting held on Feb. 19. The president is W. R. Ingalls, editor in chief of the *Engineering and Mining Journal* and president of the Mining and Metallurgical Society of America; vice-presidents, Henry D. Sharpe, treasurer of the Brown & Sharpe Manufacturing Co., and D. H. Kelly, secretary of the Toledo Scale Co.; treasurer, W. M. McFarland, of the Babcock and Wilcox Co.; commissioner and secretary, F. A. Halsey, editor emeritus of the *American Machinist*.

In addition to the president, vice-president and treasurer the following well-known men compose the council of the institute: John F. Farrell, superintendent weights and measures, State of New York; Fred A. Geier, president Cincinnati Milling Machine Co.; E. M. Herr, president Westinghouse Electric and Manufacturing Co.; Alexander C. Humphreys, president Stevens Institute of Technology, past president American Society of Mechanical Engineers; Henry M. Leland, president Cadillac Motor Car Co., past president Society of Automobile Engineers; William Lodge, president Lodge & Shipley Machine Tool Co.; Stevenson Taylor, president American Bureau of Shipping, past president Institute of Naval Architects and Marine Engineers; Charles N. Thorn, president Inter-Continental Machinery Corporation; Henry R. Towne, president Yale & Towne Manufacturing Co., past president American Society of Mechanical Engineers; W. H. Van Dervoort, president Root and Van Dervoort Engineering Co., president National Metal Trades Association; Worcester R. Warner, vice-president Warner & Swasey Co., past president American Society of Mechanical Engineers.

Graduations on Feed Dials

BY ROSS LEWIS

Is there any practical reason why the graduations on some of the modern high-duty machine tools are made to read by 0.002 in. rather than 0.001 in., as is the usual practice? The writer has seen several costly errors caused by this difference.

Speaking from the machinists' standpoint, I would say that one division on any feed-screw dial should represent 0.001 in. on any and all machine tools.

[To what extent is this method of graduating to 0.002 in. practiced?—Editor.]

Bending Typewriter Parts

By Frank A. Stanley

SYNOPSIS—In the manufacture of the various parts of a typewriter a considerable number of bending operations are necessary. A number of the interesting dies and punches used at the plant of the Noiseless Typewriter Co. are described and illustrated.

The accompanying illustrations represent some handy punches and dies used at the plant of the Noiseless Typewriter Co., Middletown, Conn., in the manufacture of certain parts of their machines.

Fig. 1 shows the press tools for forming up the ribbon-reverse detent spring, illustrated in detail in Fig. 5. Fig. 3 gives a plan view and elevation of the press tools for this work.

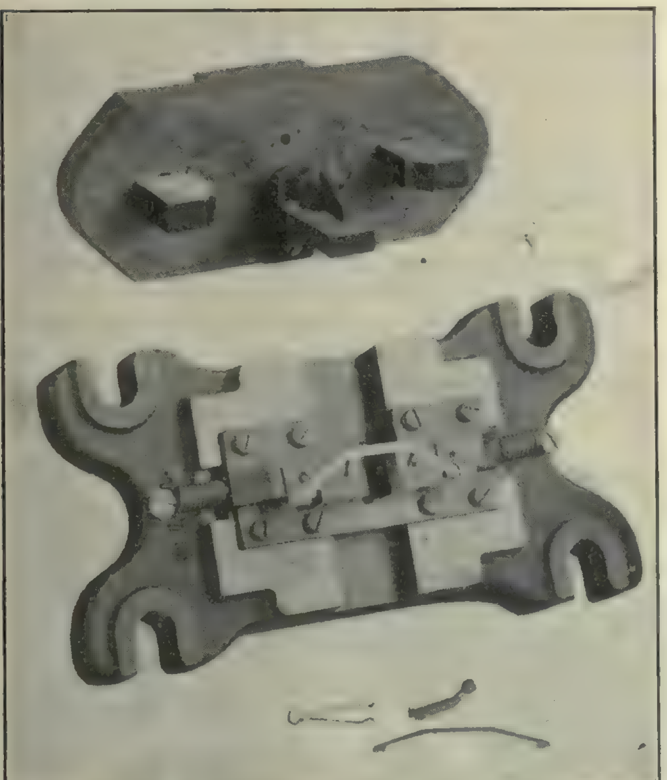


FIG. 1. BENDING TOOLS FOR A SPRING

The material is tool steel 0.020 in. thick, and the strip stock is 3⅛ in. wide. Before bending the spring the blank is punched practically the full width of the stock, the blanks being formed crosswise of the strip. The character of the blank as it appears before bending is well illustrated in Fig. 1, where a blank and two springs are seen in the foreground, and on the face of the die a blank ready for bending. It will be seen from this illustration that the work is nested between angular guide plates on opposite sides of the die proper. The die itself consists of two movable jaws, which are carried in a longitudinal guide in the die block and slide toward the center when acted upon by the descent of the punch. These jaws are clearly shown in Fig. 3. It will be seen upon inspection of this illustration that the rear ends of the jaws are finished at an angle of 45 deg., as indicated at *AA*. Similar sloping surfaces are provided upon the inner faces of the blocks *BB;* the blocks are attached to the punch carrier overhead. When the punch comes down, the members *BB* come in contact with dies *AA* and force the latter inward, causing the blank to hug the punch closely. As a result, when the latter forces the blank down through, the work is pressed tightly against the sloping sides of the parts in contact with it and the V-shaped spring with the flaring opening at the top is formed at one stroke. It should be noticed that the open end of the spring is finished at 90 deg. included angle, this being secured by the angular lower face of that portion of the punch indicated at *C*.

The partial section in the elevation in Fig. 3 shows a heavy compression spring at *D*. This causes the punch, after it has reached the bottom of the die, to dwell in that position during the remaining portion of the downward stroke, while the operating blocks *BB* are carrying the jaws *AA* toward the center to form the spring snugly against the faces of the punch.

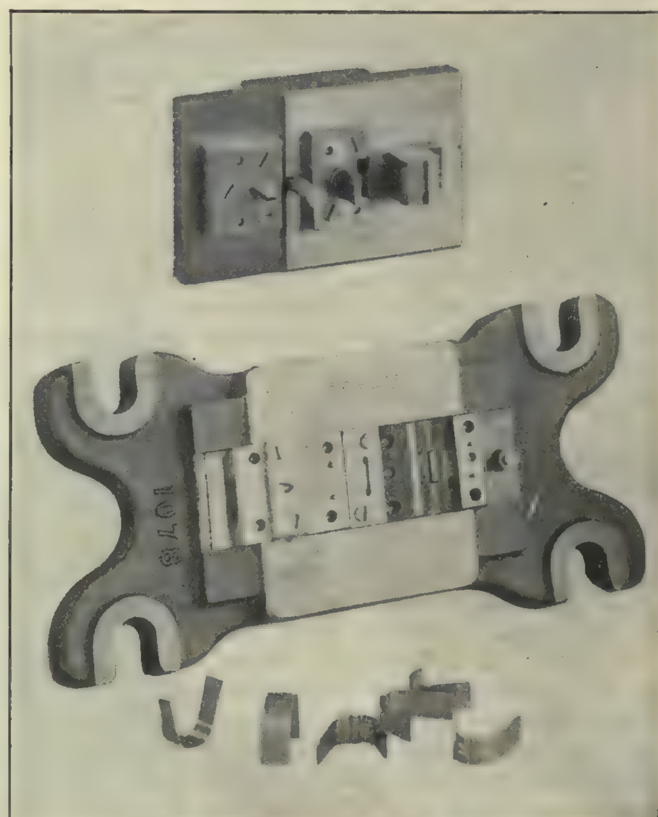


FIG. 2. PRESS TOOL FOR RIBBON CORES

On the upstroke of the press the die jaws are drawn open by the springs shown at each side. The formed flat spring is pulled up out of the die with the punch. From this member it is removed by drawing it off toward the front with the hand.

The ribbon core for this typewriter is about 2¾ in. long and approximately ½ in. in width. The material is 0.02 in. thick and of the same width as the finished core. The part before and after bending is shown in Fig.

4. When complete, it is formed into a circular ring 0.76 in. in diameter. At one side there is a rectangular recess the full width of the ring. Just below the recess there is an arrow-shaped projection, produced by punching a V-shaped slot through the metal, leaving a tongue. When this is bent out from the periphery of the ring, it forms a hook upon which the end of the ribbon is secured for winding upon the spools. The press tools for piercing, forming and cutting off this core are shown in Fig. 2. With the tools in this position the stock feeds in from the left-hand side, although when set up in the press this open side for the stock guide would come at the right. The strip of material is first fed forward until a shearing punch at the middle cuts off the end squarely, after which the stock is advanced to the stop at the extreme right. Thereafter a core is bent and cut off at each stroke of the press. The parts as they come from the dies appear as illustrated in the foreground of Fig. 2. The notching punch, which cuts the opening to produce the tongue, is the first in a series of punches and will be seen at the left side in the punch block. The next operating punch is the one in the center, which acts as a shear to sever the work. The rounded punch at the right, with the rectangular groove across its face, forms the work with a semicircular bottom and forms up the rectangular depression across its face. The material is guided under the stripper plate and between pairs of small pins, which control its lateral position accurately. This arrangement of tools means that after the process is once under way a core is being formed up at the right and cut at the same stroke, while the V piercing punch at the left is cutting out the outline for a tongue for the next core. On the next stroke of the press, the work is advanced again to the stop, this second piece is formed up and cut off while the third tongue is cut out in the stock. When the blanks leave the press, they are in a U form. They are bent to a complete circle by another set of tools not illustrated here. The ends of the core overlap in the finished ring about ⅛ in. and are joined under an electric welder while held on special fixtures.

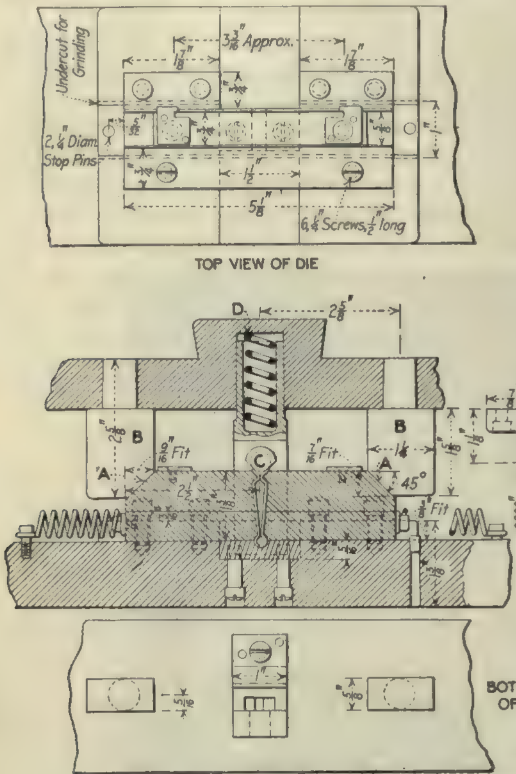


FIG. 3. FORMING DIE FOR SPRING

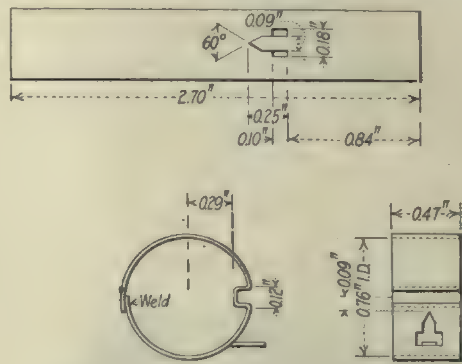


FIG. 4. DETAIL OF RIBBON CORE

Fig. 6 shows at the left-hand side a large carrying box filled with these cores ready for bending to the final circle and welding in the machine illustrated at the right in the same view. The fixtures on which the rings are held for

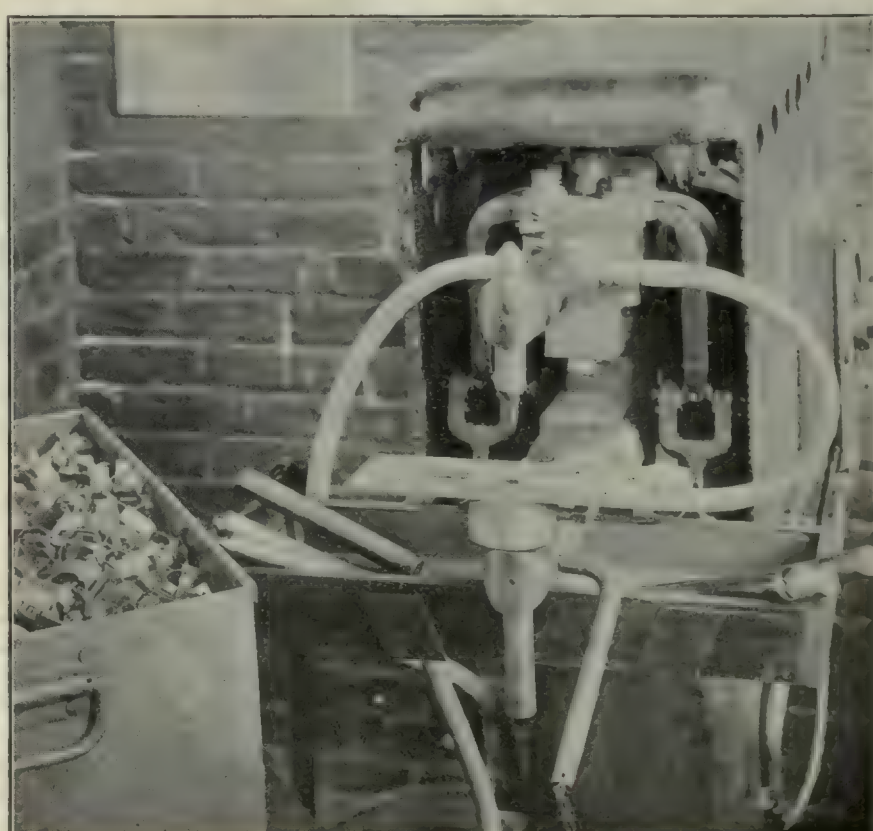


FIG. 6. FIXTURES ON ELECTRIC WELDER

the welding operation are seen resting against the right-hand side of the tray under the table of the welder. The table itself in this view is illustrated as set up with a special fixture for holding a certain group of levers while small clips are welded to them.

The welding machine is used for a number of similar operations and is very convenient for such purposes. A considerable number of holding fixtures of one kind or another have been made to carry the different parts that are joined in this manner. In fact, the same attention has been paid to equipping the welding machine with special tools as in the case of the general run of machine tools throughout the factory.

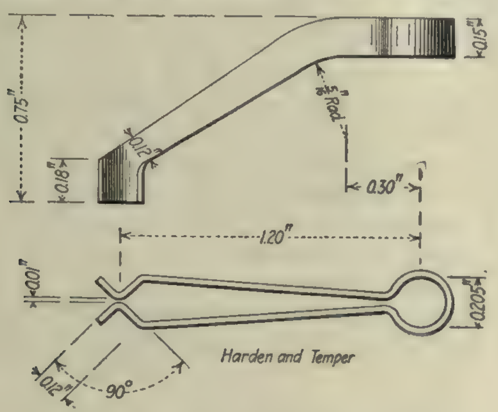
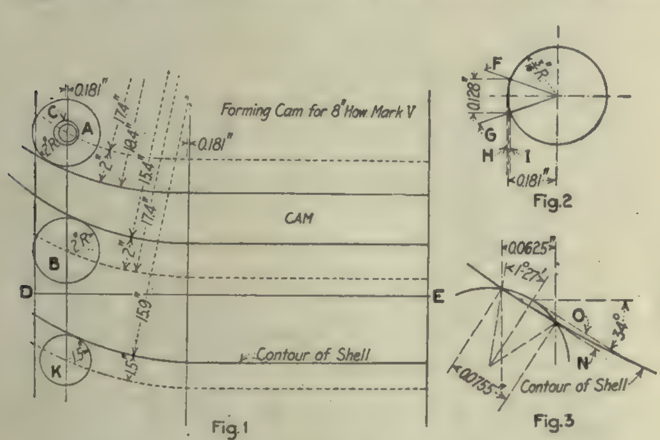


FIG. 5. DETAIL OF SMALL SPRING

Design of Cams for Form Turning Shells

By G. M. Strombeck

The turning and boring of the nose on the various sizes of shells presents an interesting problem in simple cam design. To illustrate: Consider the 8-in. howitzer—modified Mark V—shell. To secure positive action the cross-slide is controlled by two rollers A and B, Fig. 1, each rolling against opposite edges of the same cam. Slight variations in diameter of the rollers and thickness



FIGS. 1 TO 3. DETAILS OF DESIGN OF CAMS

of the cam, due either to wear or workmanship, are taken up by the eccentric pin C of the roller A. Every adjustment of this eccentric changes the location of the perpendicular to the shell axis DE through the center of the roller A and will shift the theoretically correct location of the cam outline for this roller by a small amount. This will make the roller either loose or tight at certain parts of the travel, and care must be taken to keep such variations at a minimum.

By referring to Fig. 2, showing an enlarged detail of the cam and rollers, it may be seen that this error is smallest when the eccentric is in its mid-position. Using the part of the eccentric between F and G and assuming the perpendicular halfway between its extremes, shown by the dotted lines H and I in Fig. 2, a condition is obtained such that the roller will at first be slightly loose at the cam point; but as the parts wear, it will become tighter until the mid-position is reached, after which it will again become loose. With an eccentric radius of $\frac{3}{16}$ in. the looseness at the beginning will be 0.0035 in. This will provide ⅛ in. for wear on the cam and rollers. The axial difference between the centers of the two rollers is then 0.181 in.

It is evident that the diameters of the rollers and also the radius of the cutting edge of the tool affect the cam outline. The first cam for the turning of the shell was developed by laying out the shell curve and adding to its radius the radius of the cutting tool. Taking any point K, Fig. 1, in this locus of the center, for the tool radius, and measuring back a fixed distance gives the relative position of the center of the roller B. Knowing the distance between the rollers and having fixed their linear relation, the center of the roller A is determined. By taking a sufficient number of points K the locus of the centers of the rollers is determined. Then with the radius of the roller, a number of arcs are drawn. The tangent to these determined the cam.

A more thorough study of the problem revealed a much simpler way of determining the cam outline, which is as follows: The outside radius of the shell nose is 15.9 in.; the radius of the finishing tool is 1.5 in., making the radius of its center 17.4 in. Since the centers of the rollers are fixed rigidly in the same piece that carries the tool block, it is evident that the radius of the locus of these centers is the same—namely, 17.4 in. Now by inspection of Fig. 1 it is seen that the radius of the cam for the roller A is 17.4 in. plus the radius of the roller (2 in.), or 19.4 in.; and the radius of the cam for the roller B is 17.4 in. minus 2 in. or 15.4 in. The centers for these cam curves are of course the same as for the centers of the loci of the roller centers. The cam outline is therefore fully determined.

The large radius of the finishing tool makes it possible to use a coarse feed and still obtain a smooth surface on the shell. The greatest unevenness of the surface is at the extreme point of the nose, Fig. 3. Here a 3 in. diameter cutter with $\frac{1}{16}$-in. feed would produce a roughness of NO, which is

$$\frac{0.0625}{\cos 34 \text{ deg.}} = 0.0755$$

$$\frac{0.0755}{2} \times \frac{1}{1.5} = \sin 1 \text{ deg. } 27 \text{ min.}$$

$$1.5 \times (1 - \cos 1 \text{ deg. } 27 \text{ min.}) = 0.00048 \text{ in.}$$

To this should be added an absolutely negligible amount due to the curvature of the nose, the total being less than one-half of one thousandth of an inch.

In machining the inside, the curvature of the shell reduces the error, making it still less. As the tool passes from the tip of the nose toward the body of the shell, it

continually presents a fresh cutting edge, since the point of tangency moves through an arc of 34 deg. By making the tool a circular disk the entire circumference can be used a little at a time, thus making a very durable tool.

For the roughing cut it is not desirable to have so large a radius on the cutting edge of the tool, and another cam outline will be required.

The cam for the boring is obtained in exactly the same manner as that for the turning.

Simplifying a Button-Setting Job

By Hugo F. Pusep

In the construction of a special machine of very intricate design several steel rings were to be made as shown in Fig. 1. All these parts had to be interchangeable, with the three 0.750-in. holes 120 deg. apart on a 3-in. radius and equidistant from the large central hole. To the casual observer the job seems to be a simple one. but it did not appear so to us; more so, when it was found that the greatest cumulative error was not to exceed 0.0002 in.

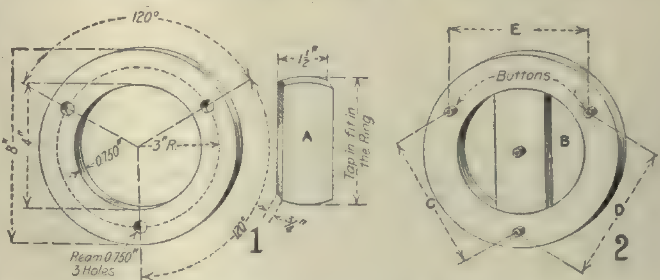
The rings illustrated in Fig. 1 came into the shop in the form of rough carbon-steel forgings. The first operation was lathework, which included turning the outside diameter, facing both sides and finish boring the 4-in. hole. Everything seemed to progress favorably until we were confronted with the problem of properly locating the ¾-in. holes in the rim of the rings, so as to be within the specified limit. The possibility of setting up the rings on the rotary table and boring the holes in the vertical miller was considered, but was discarded as impracticable in so close work. A method of buttoning up the job was finally agreed upon, which in my estimation has some interesting features whereby a job of this kind—where the locating of buttons is difficult on account of the large center hole—can be much simplified.

A piece of machine steel ¾x1½ in. and of suitable length was machined as shown at *A*, Fig. 1, with the diameter over the ends just sufficiently larger than the 4-in. bore in the rings to allow the piece to enter the bore with a few light taps from a hammer, but not large enough to spread the ring itself. As the bearing of the center piece *A* in contact with the bore of the ring is twice the arc of either end, it will be seen that in this case we have a little more than 3 in. of contact between the ring, Fig. 1, and the center piece *A*, therefore obviating all possibility of shifting, even if held in place very lightly.

At *B*, Fig. 2, is shown a ring with the center piece in position. The next operation was to lay out with a pair of dividers the center of the ring on the crosspiece and also the approximate locations of the three holes on the side of the ring, then center-punch mark, drill and tap with a 1/8 = 40 thread tap for the button screws. It might be said in explanation that the center locations of holes in all the rings were laid out before the button-screw hole in the center piece itself was drilled and tapped.

The setting up of buttons was carried out as follows: The faceplate was screwed on the spindle of an engine lathe and a light facing cut taken over it, in order to have it run perfectly true. Then a ring was clamped to the faceplate; and while held so that the clamps would grip the ring as near its perimeter as practicable, the large center hole was made to run dead true to an indicator held in the tool post of the lathe. The center piece *A* was put in place and a light facing cut taken near the center to provide a true bearing for the button, and was made, with an indicator, to run dead true. A button was then secured over each of the three locations on the side of the ring. With the aid of micrometers and the indicator, these three buttons were rapped into place till the measurements *C, D, E,* Fig. 2, coincided, and the micrometer readings over the central button and each of the three buttons on the ring showed 3 in. plus twice half the diameters of the buttons. The set-up of the buttons was further tested by revolving the lathe spindle by hand; and as each button in turn passed the indicator finger, the reading on the dial had to be the same for all the buttons.

This method of setting up buttons in the lathe in all work where holes are to be in a circle has much to



FIGS. 1 AND 2. INTERCHANGEABLE STEEL RING AND A METHOD OF SPACING HOLES

commend itself. There is always a double check against an error, because in case the feel over the center button and the buttons in the circle might vary so slightly as to be almost impossible to distinguish with a micrometer as to variation, a very sensitive indicator will show the error plainly.

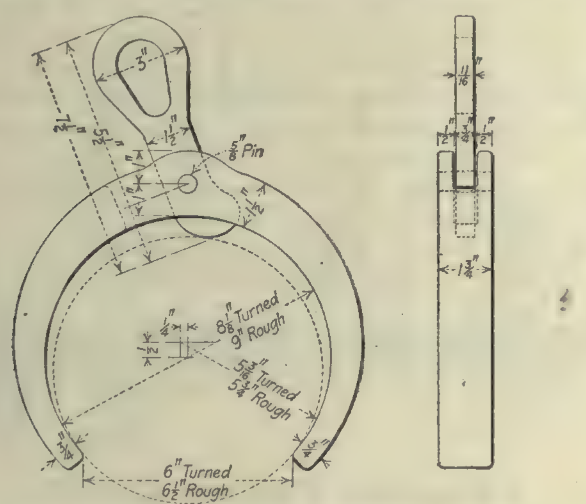
After all three buttons were correctly located, the ring was removed from the lathe faceplate; and with the center piece and button still in place, it was clamped on the table of a vertical miller. The three buttons—one by one—were then indicated to run true with the miller spindle, the buttons removed and the holes drilled, bored and reamed to finish size. With the center button undisturbed and 0.750-in. plugs inserted in the reamed holes, it was possible to check the center distances of holes in relation to each other. It was found that the greatest cumulative error, after a careful handling of all operations, did not exceed 0.0001 in. Every ring was now treated in identically the same manner, and a first-class job in all respects was the result. It would be well to remember that, although the center button is not disturbed, it should be tested with the indicator as often as a new ring is set up in the lathe, in order to be on the safe side.

Although the description of this method of setting the buttons is somewhat long, in very accurate work the actual time taken is much shorter than if the buttons were set on an angle plate or at the bench; and it is of course understood that the foregoing applies to jobs where buttons are to be located in circles and from some common center. On the job in question, however, no trouble was encountered due to the button being out of center after it was placed in a new ring.

Letters from Practical Men

Shell Grab for Large Shells

In a recent issue of the *American Machinist*, in an article on the production of 8-in. shells, some of the modes of lifting the shells were given. In the accompanying drawing is a shell grab that we found to surpass any of those previously suggested. It is made in such



SHELL GRAB FOR LIFTING LARGE SHELLS

a shape that it can be slipped over the shell while the latter is gripped in the chuck and supported with the tailstock center. The full weight comes on the tongue, which is consequently clamped tightly against the shell, thereby obviating any danger of the shell falling out. Both parts are steel castings with a cold-rolled steel pin. We use two sizes—one for rough forgings and one for finished shells.

This idea was first suggested by one of our millwrights, who went to the pattern shop and sawed out a shape on the bandsaw. We had one forged up, and it worked well, so we had a pattern made and obtained castings. The first ones were only 3/8 in. thick at the points; after some time they began to stretch out under the strain, and some broke off. We have now increased the points to 3/4 in. and we find this works perfectly.

Sherbrooke, Que. GEORGE M. DICK.

How To Graduate a Taper Attachment Correctly

In Fig. 1 is given a right-angle triangle intended to show the correct way to specify a given taper per foot. In Fig. 2 is a similar right-angle triangle, but at the same time the taper per foot is incorrectly shown. I have very seldom seen on any lathe a taper attachment that will cut a given taper correctly when the graduations on the attachment are relied upon. For that reason I have shown the conditions in Figs. 1 and 2 so that they may be compared.

It will be seen by looking at Fig. 2 that the spacing is graduated on a circle. This is the condition found on all taper attachments; therefore, instead of graduating as in Fig. 1, it is graduated in even spacing on the circumference of a circle, and it will be seen that there is an error of 0.017 in. in a 2-in. taper per foot. To graduate in taper per foot, correctly on the circumference of a circle, each angle should be figured separately, as in Fig. 1. For example, to graduate in 1/4-in. up to 2-in. taper per foot, find the angle by dividing the side adjacent (12 in.) by the amount of taper, 1/4 in., 1/2 in., 3/4 in., 1 in., 1 1/4 in., 1 1/2 in., etc., marking each angle on the drawing.

$$\text{Tangent} = \frac{\text{Side Opposite}}{\text{Side Adjacent}} = \frac{2}{12}$$

$$\text{Tangent} = 0.166666 = 9°28'$$

$$\text{Hypotenuse} = \frac{\text{Side Opposite}}{\text{Sine Angle A}} = \frac{2}{.16447}$$

$$\text{Hypotenuse} = 12.150$$

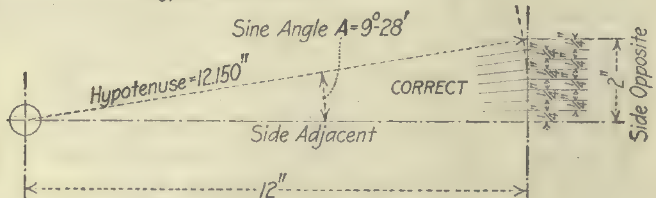


FIG. 1

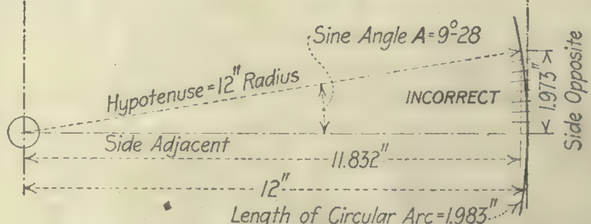


Fig. 1, Angle 9°28', Taper per Foot = 2.000"
Fig. 2, Angle 9°28', Length of Arc = 1.983"
Error 0.017"

FIG. 2

FIGS. 1 AND 2. CORRECT AND INCORRECT METHODS OF GRADUATING

so that the graduations can be made correctly. In this way a great saving of time in the shop will be saved, and the exact taper can be set on taper attachments at one setting. WILLIAM P. WINTERS.

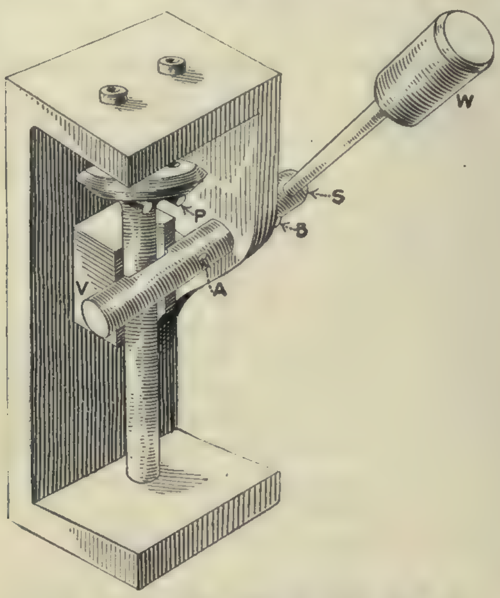
Cincinnati, Ohio.

Eccentric Gravity Clamp for Drill Jig

I am at present employed in a plant where the eccentric and weighted lever seems to be used to a considerable extent on small drill jigs. Few days pass that I do not happen on some new and different application of the same principle. Whether it was a pet idea of some production man, tool designer or tool maker is a question. I do not know how it originated. At any rate

it seems to fill the bill as well as some other more complicated and more expensive designs I have seen.

The drill jig for grinding bit holes in the head of poppet valves is shown herewith. It is a fair example



THE DRILL JIG FOR VALVE HEADS

of the adaptability of the principle, which finds a wide application on sensitive drilling operations.

A weighted lever *W* is attached to the shaft *S*, which is a sliding fit in the body of the jig. The valve is inserted from the front, the shaft *S* being slid out until the stop pin *A* strikes the jig. The valve stem is located in a V-block *V*, the drill thrust being taken by the two pins *P*.

The shaft *S* is flatted on the inner end, and when the weight is lowered to a horizontal position with the shaft, it is shoved in until stop pin *B* is against the jig. The valve stem is forced into the V-block and held securely for drilling.

Two $^{13}/_{64}$-in. holes are drilled $\frac{5}{32}$-in. deep in each valve, and this is done at the rate of 150 valves per hour on a single-spindle sensitive drilling machine. From this the reader may gain some idea of how rapidly it can be operated. H. E. McCray.

Waterloo, Iowa.

Truing Miller, Dividing Head and Tail Centers

Any toolmaker knows what a problem it is to true up dividing-head and tailstock centers and get them dead in line. The method I employ is to true them on their own bearings. The dividing-head center I trued by fastening the electric center grinder in the miller vise, after setting the wheel to the proper angle. I fed the wheel in with one hand, turning the dividing-head crank with the other; this accomplished the desired results.

For truing the tail center I made a high-speed steel cutter of ¼x¾-in. stock 2½ in. long, ground to the proper angle, with the cutting edge on the center line with the tailstock. I then fastened it in the dividing-head chuck and brought the tailstock up close to the cutter; after tightening the gib the desired amount, I took a scraping cut around the center by turning the dividing-head crank. When the chuck was removed and the centers brought together I found them to be dead in line both sideways and up and down. J. A. Raught.

Janesville, Wis.

[We thought the centers, especially the tail center, were usually hard.—Editor.]

Thread Cutting in the Lathe

When cutting threads in a lathe, with the compound rest set over to 30 deg. the best way to proceed is as follows: Run the tool up close to the work by means of the crossfeed, stopping the ball-handle in a position to which it can easily be returned, say horizontally, with the ball at the right. Set the stop for the crossfeed and, for the first cut, feed the compound rest to the work. At the end of the cut tighten the setscrew for the stop and remove the tool by means of the crossfeed. While the lathe is running back, move the compound rest in several thousandths; and for the next cut, when the tool is clear of the work, return the crossfeed to its original position.

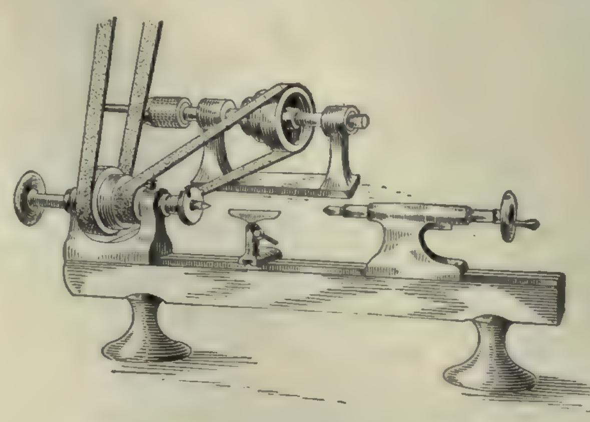
This corresponds, in effect, to moving the compound rest in and out at the beginning and end of the cut; but it obviates the necessity of remembering, and adding, a certain amount of each cut to obtain the setting for the succeeding cut, or of setting the tool by guess. The first of these two methods is very confusing, and with the latter a uniform depth of cut is difficult to maintain even after much practice. Albert J. Seibt.

Fort Wayne, Ind.

Filing and Lapping Heads

When a shop is running right up to its limit, it is often necessary for a workman to wait for a chance to get a lathe; and often it is only to do a little filing or lapping on some other job that does not require a lathe.

As a remedy for this condition a filing and lapping head is just the thing. Take any old head, a polishing



HEAD FOR FILING AND LAPPING

head or an emery-wheel stand—anything with a spindle to which a chuck may be fitted—and arrange the belt as shown in the accompanying sketch. This plan of belting on a machine where much filing is done is ideal, as it allows the workman to stand naturally without interfering with the belt, as is the case with the vertical belt.

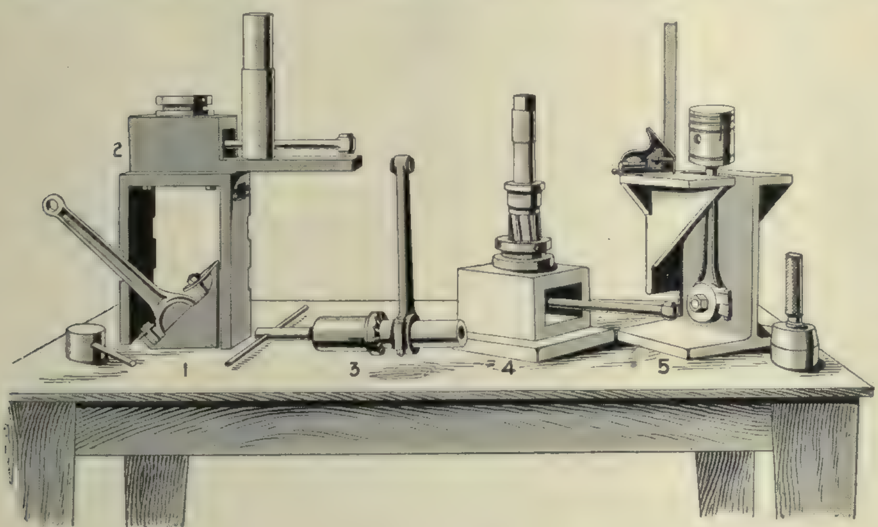
This head will be found a big help on all jobs where a slide rest and tailstock are not required.

Brooklyn, N. Y. W. J. Wells.

Assembling Connecting-Rods for V-Type Motors

The V-type of gasoline motor, which is becoming more popular both in automobile and aviation work, with two connecting-rods on each crank throw, introduces some conditions not met with in other multicylinder motors that have but one rod to each crank.

On account of the smaller bores commonly used in both eight- and twelve-cylinder motors the connecting-rod bearing at the crank end can be of much smaller area. This is usually secured by making the diameter of the crankpin as large as that of a four- or six-cylinder motor of the same piston displacement and by making the length of the individual connecting-rod bearing one-half of the usual single bearing less a few thousandths clearance between the two rods on one crankpin. In this way the ratio between the connecting-rod and the bearing length is much greater than with the single type of rod. Consequently, the accurate preparation of the bearing for scraping becomes an important operation in order to preserve as far as possible the correct alignment of the connecting-rod. The accompanying illustrations show how this is accomplished in one of the plants making twelve-cylinder motors.



FIGS. 1 TO 5. ASSEMBLING FIXTURES FOR CONNECTING-RODS

The connecting-rods come to the assembly bench direct from the machine inspection. After having the machine burrs removed, the bearings, which are bronze-backed die-cast babbitt shells, are attached to both the rod and the cap by means of two brass machine screws in each half-bearing. Before drilling for the screws, which is done in a jig, Fig. 1, the bearing shells are seated in the forging by means of a short mandrel with a stud on one side to drive against.

After the bearings are attached to both the rod and the cap, they are bolted together with liners between to replace the metal removed by the splitting saw. They are then brought to the same weight (within ¼ oz.) and arranged so that the weight of the two groups shall not vary to exceed ¼ oz.

After balancing, the rods are held in a fixture, Fig. 2, and a polished mandrel is forced through the bearing for the purpose of condensing the babbitt and seating the bearing firmly against the rod forging. A hand facing tool, Fig. 3, with a pilot clamped in the bearing, is used to bring the width of the bearing to a limit-gage fit, thus providing the proper clearance between the rods when assembled on the crankshaft.

The rods are next placed in a reaming jig, Fig. 4, and finish reamed with a piloted reamer to the crankpin diameter, after which they are readily fitted to the crankshaft by scraping slightly.

After being scraped to a bearing on the crankshaft, the rods go to the piston-assembly bench, where a broach is pushed through the piston-pin bushing and the pin is fitted in the rod. This is then passed along the bench to the piston assemblers, who attach the piston to the rod and anchor the pin in the piston by means of a special screw through the boss, locked by a cotter pin on the inside of the piston pin. The rods are next corrected for alignment by the use of a fixture, Fig. 5, with a horizontal stud near the bottom, around which the bearing is clamped. It is located sidewise by a washer and nut on the end of the stud. This stud is 0.001 in. larger and 0.005 in. longer than the bearing, so as to hold the rod true with the bearing and prevent throwing the top of the rod to one side or the other by clamping the side of the bearing. The top surface, or table, of the fixture acts as a surface plate on which a square is placed to gage the side of the piston, making it at right angles with the crankshaft. The surface plate bears graduations on each side of a center slot through which the rod passes. These graduations are used to gage the alignment of the piston so that the center of the piston shall be directly in line with the center of the connecting-rod bearing and at right angles with the center line of the crankshaft, when the clearance is equally divided between the piston-pin bushing in the rod and the bosses in the piston.

Indianapolis, Ind. HARRY C. SATTERTHWAITE.

Drawing a Deep Flanged Shell Without Annealing

The flanged shell shown in Fig. 1 is made in seven operations—one blanking, four drawing, one trimming and a final forming operation to turn up the edge on the flange. The material is 0.035-in. drawing steel, and the shell is finished without any annealing. The blanks are made on a rotary shearing machine. They are then run through the ordinary "push through" type of drawing die, making a straight shell 5.75 in. in diameter, 3 in. long.

For the second drawing operation the same type of die is used, but it has an inside blank holder to prevent the stock from wrinkling; and instead of pushing the shell through, it is drawn just far enough to leave a flange the size of the radius on the drawing edge of the die. This is the starting of the flange. The trimming operation follows in order to make the flange round. This was found to be necessary in order to obtain the required uniformity of pressure in the next drawing operation. The trimming is done with press tools, the punch being the lower mem-

ber and the die the upper. The piece is located centrally on the punch by means of a pilot the size of the inside diameter of the shell.

The third drawing operation reduces the shell from 5 in. to 4.250 in. in diameter. The die is of the same form, except that it has a cast-iron stripper plate to the under side of which is fastened a tool-steel ring that acts as a pressure plate. When the descending punch comes in contact with the stripper, it flattens out the flange on the face of the die as the punch completes the down stroke. The radius joining the flange and the body of the shell is now finish size. It required some experimenting

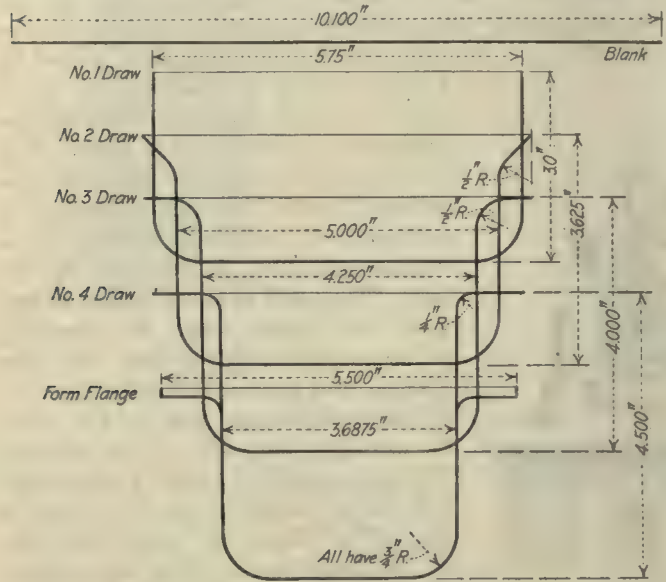


FIG. 1. THE FLANGED SHELL

to determine the correct time for the pressure plate to come into contact with the flange as the shell was being drawn, in order to exert enough pressure on the flange to keep it from wrinkling, yet not enough to cause it to roll over.

The fourth drawing operation reduces the shell from 4.250 to 3.6875 in. in diameter. In this draw it seems to require sufficient pressure to cause the flange to roll in order to prevent it from developing wrinkles. Then as the flange is flattened at the bottom of the stroke there is a circular crease on the flange due to the action of the metal being bent beyond a horizontal plane and straightened out again. This appears to be unavoidable; but if it can be avoided or overcome without the aid of a drop hammer, I would be pleased to know the remedy.

Owing to the fact that the flange is not strong enough to stand the stress of stripping, it has been found impractical under existing circumstances to turn up the edge on the flange in the finish drawing operation. It is therefore necessary to make a separate operation of this, the final one in the development of the piece.

Referring to Fig. 2, *A* is a cast-iron punch holder, bolted to the ram of a Toledo toggle press with 13-in. stroke; *B* is a jacking ring and *C* the punch. At *D* is the stripper plate, and *E* is a tool-steel pressure plate, the radius on the plate being made to conform with that on the dies so as to iron out the metal on the flange. A positive knockout *T* is operated by side rods screwed into the ram of the press. At *G* is the die, and at *H* the die shoe, which is bolted to the bed of the press. The duty of the two springs *U* is to keep the stripper *D* up on the punch and out of the way of the operator. The two rods *S* on the side serve as guide rods. They also hold the stripper plate *D* in place as the punch ascends, thus pulling the shell from the punch.

By trying out various diameters for the punches it was found that best results were obtained when the diam-

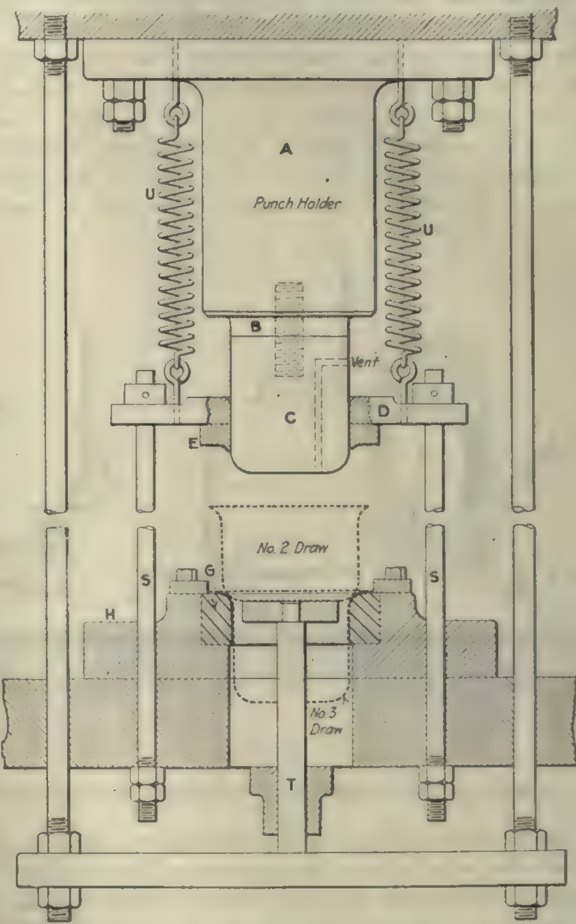


FIG. 2. THE ARRANGEMENT OF THE DIES

eter of the punch was from 0.010 to 0.012 in. smaller than the size determined by subtracting the double thickness of the stock from the inside diameter of the die.

The lubricant used was a compound to which was added about 20 per cent. of lard oil and a small quantity of sulphur. W. E. Chambose.

Ontario, Calif.

Business in the United States

The Federal Trade Commission has found that, leaving out of consideration the banking, railroad and public-utilities corporations and referring only to those that have to do with trade and industry, there were about 250,000 business corporations in the United States in the year 1914. The astonishing thing is that of this number 100,000 had no net income whatsoever, 90,000 made less than $5000 a year, and 60,000 made $5000 a year and over.

The total volume of business done by the 60,000 successful corporations was found to be as follows: 20,000 made sales of less than $100,000; 20,000 sold goods valued at from $100,000 to $250,000; 10,000 from $250,000 to $500,000; 5000 from $500,000 to $1,000,000; 4500 from $1,000,000 to $5,000,000, while only 462 corporations did a business greater than $5,000,000.

Discussion of Previous Question

Drafting Room Versus Shop

Mr. Horton's article on page 147 interested me, and he has presented the draftsman's side of the case with a clearness and conviction that could hardly be bettered. But he deals with the case of only one class of draftsman, the "quiet individual with a reticent manner," a true artist and gentleman—one who quite understands that he does not know it all and is grateful for help from anyone who really wishes to help him out.

There is another class, unfortunately. There are few machinists who have had extensive dealings with draftsmen, who have not at one time or another had "the nose snapped off them" when offering some advice. Perhaps the suggestion was long thought over and deferentially offered; and when turned down, the machinist has sworn, "Never again!"

A parallel to Mr. Horton's experience in the small shop comes to my mind, but is presented from the flat-footed machinist's side. The incident happened across the herring-pond. I had served five years of my time in various shops in Belfast, Ireland, when in my last year I returned to the one where I had served at first. It was a small weaving factory and dyeworks repair shop. I was a student in the Technical Institute at night and knew a little about machine drawing (a *very* little), so any drawing there was to do in the shop fell to me, in addition to looking after two winding rooms.

There was never much drawing to do; and what there was of it was not elaborate (fortunately for me), until one day the engineer took a notion that he would build his own winding frames. I knew I was not equal to the task of designing these machines, so promptly found an excess of work and persuaded "Ole Harry" to get a regular draftsman. He came, a young fellow of my own age or perhaps a year or two older, a product of the schools, with some experience in a shipyard, but he had never seen a textile machine before.

The drawings were almost finished when one day, as I was passing "Ole Harry's" office, where he and the draftsman were, I was hailed and ordered inside. "Ole Harry" threw a bundle of drawings on the table, "What d'ye think o' that, Jimmie?" After I had looked them over, "Fine," I said, "that should be a much better machine than our old ones." "Ole Harry" laughed. "Any suggestions?" he asked. "Well, yes," I said, "but this is Mr. White's machine; and when he checks his drawings, he'll probably think of anything I could say." I did not wish to butt in on his work, so picked up my tools and made for the door, but Harry stopped me and said, "Out with it; you know, or ought to know, quite a bit about our machines by now."

Taking up the drawings again, I pointed out one or two things which had come under my notice as bad points in the old machine and which were retained in the new one. I also suggested some improvements that I thought could be made in the drive, etc. The boss slapped his knee, "Great," he said, "I never thought of those things; see to it, Mr. White." "No," said White, "I certainly won't; what the h—— does that dirty-faced apprentice know about machine design?" I did not argue this point, but walked away, knowing something of manners.

Since that time, even when I have thought of something that would benefit machine, draftsman and employer, I have been very chary indeed of giving my advice, even when asked. I have never been fortunate enough to come across the other type of draftsman. So it is not only on misunderstanding that the strife between shop and drafting office is based; there are other underlying causes.

As a sequel to the incident related, the suggestions and improvements I had offered went into the new machine, although I never received any credit for them. That fact just touches on the fringe of another reason why machinists will not "come across" with their ideas and advice.

Chicago, Ill. JAMES TATE.

Positively Located Drill Jigs

The article by Leroy M. Curry, on page 913, Vol. 45, should command the attention of all who have to do with the design and construction of drill jigs. The advantages of a properly located drill jig cannot be overestimated. The operator feels that things are safe, and making things safe for the operator automatically increases the output.

Every designer of drill jigs should consider the feature of clamping them when in use, though this, of course, is not always possible. In many instances, however, drill jigs may be clamped without the elaboration of an indexing jig. A method of attaining the same end where two holes of the same size are to be drilled in the work is to lay out the holes in the jig parallel to the jig base and then provide a light shoe in which the jig slides along to the two positions. Correct location of the guide brushes is obtained very simply in this way, and stops in the shoe serve to limit the movement. The shoe may be clamped to the table.

This method of sliding from the one position to the other enables one to deal with a jig up to the full capacity of the drilling machine, whereas with a rotating jig it may easily happen that the rotation of the jig is prevented by the column of the machine. A further advantage of this method is that the jig need not be fastened to the shoe, but can be taken out for the more convenient insertion of the work. The whole jig may be soused in a pail of soda water for cleaning.

An easy and quick method of correctly positioning drill jigs that possesses many advantages is as follows: A substantial strip is bolted to the drilling-machine table and is provided with a taper hole in alignment with the drilling spindle. This taper hole accommodates a taper spigot on the drill jig, machined in exact alignment with the hole to be drilled. The writer recalls a

series of jigs designed some years ago, and still in service, which were fitted with these spigots. The ease and speed with which the jigs are positioned under the drill is remarkable. This method of positioning by spigots was devised to prevent the dulling of the drill points by their coming in contact with the hardened guide bushes; it also proved an effectual remedy for the pock-marking of the jig body around the guide bushes, due to the operator's hurry or carelessness.

It will be understood that in use the spigot attached to the jig merely positions the jig, the jig body resting on the strip; or where only single hole jigs are required the hole to mate with the spigot may be put in the table. For multiholed jigs, where the holes are all or most of them on the one surface, the strip bolted to the table is to be recommended, as then the strip can be cut away to clear the spigots not actually in use at any particular moment. Machinery steel, pack-hardened, was used for both the strip and the spigots. GEORGE W. SMITH.

London, England.

Counterbore with Disappearing Pilot

On page 35, Mr. Tompkins attacks the counterbore described by me on page 628, Vol. 45, and I agree the tool could have been described more accurately, but not in the space devoted to it.

In spite of Mr. Tompkins' assumptions this tool has been at work for over three years without the small pilot giving any trouble. It does not seize, nor bind, nor bend, nor are the results inaccurate. I did not discuss the accurate spacing of the pilot holes, as this was not relevant. JAN SPAANDER.

Brooklyn, N. Y.

Which Is the Better Way To Impart Information?

The article by W. D. Forbes, on page 1041, Vol. 45, and the discussion by W. S. Drew and W. S. Ayers in two later numbers struck me as being of peculiar interest. Though I agree in the main with both these latter gentlemen, I disagree as to the uses of the two methods of presentation. Like both of these men, I have had some teaching experience and have found that the story method is sometimes not only the best method, but really the only effective method of driving home the point to the boys. And this condition is not limited to the classroom. Very often I have found in dealing with the various foremen in the shops that, if I can illustrate the problem in a descriptive way, it gets them interested and sets them to thinking in a way that cannot be accomplished by a mere statement of fact.

But it makes a lot of difference whether the reader of the article is stealing half an hour out of a busy day to run through half a dozen trade papers to glean any pointers in his line or whether he is comfortably seated before his own fireplace. I remember that in the early days of my work in a machine shop, about 15 years ago, my *American Machinist* used to arrive on Saturday night. About the first thing I did after supper was to read the weekly installment of "Echoes from the Oil Country." I believe that, if I had the time today, I could find just as much interest in those articles as I used to in those days.

On the other hand, with the short, concise method of presentation, the busy man's eye catches the picture and reads little more than the heading. If the subject interests him, he gets an impression that is apt to come to his mind some day when a similar problem arises. The chances are that, if the same article had been presented in the second, or narrative, form, this man would not have noticed it at all.

But right here I want to differ with Mr. Forbes and say that the two presentations are not identical ideas framed in different terms. His first is a simple description of a method and nothing else. The second is something more. If it had been published without comment, most readers would have taken it as an argument that a new man in a strange shop must keep his eyes open and his brain working every minute to show the boss that he can produce the goods. The opening of the article led us to believe that this particular man had not yet shown the foreman that he was better than old Bill Smith, who was getting only 28c. an hour, but the description proved that he did not hesitate when a job requiring brains was put up to him. The final conclusion showed that he demonstrated his ability to do what the average machinist in that shop did not dare tackle. Thus, by means of 700 words instead of 70, Mr. Forbes gave us a moral lesson as well as showed us a new kink.

Perhaps the question may arise, "Why do we not write all our kinks that way?" Well, I can vouch that the average husky machinist does not want a moral lesson put before him every time he reads an article. So it looks to me that we will have to put it squarely up to the editor to give us just the number of descriptive moral lessons that he thinks the average of his readers can digest, and no more. G. S. B.

New Haven, Conn.

The Unending Struggle

John R. Godfrey's criticism on page 168 of the editorial printed on page 37, has caused no little amount of thinking on my part. Mr. Godfrey starts out in the times when we were given wild horses to tame. He also intimates that cows and sheep are gifts of Nature rather than the result of effort on the part of men. If he had to do some of the taming himself, he would know how much effort it took on the part of man.

From that age he slips down to a year or so ago. While it is true that flour and such commodities cost twice as much as they did a year ago, let us go back 20 years and see what they cost then. Let me prove to Mr. Godfrey that a day's work purchases more than ever before. During the winter of '96-'97 I was a hired man on a farm in the richest farming community in Wisconsin, working for the round sum of $10 per month. Today a hired man on a farm gets $10 per week, and in some cases more. Flour at that time ranged from 90c. to $1.20 per sack, while today it costs from $2.50 to $3 per sack; bottled milk in those days was 5c. a quart, today it is 8c. A machinist's wages in those days was from $1.25 to $1.50 per day; now they are from $3 to $5.

Labor-saving machinery never injured labor—it only makes it possible for the ever increasing population to be supplied with food, clothing and shelter. The greatest labor-saving machine ever invented was made 124 years

ago—that was the cotton gin, which did the same amount of work in a given length of time as 1000 slaves.

The improvements since then have only made it possible for us to wear more cotton and read more books, the latter because of the printing press. As for devising a machine to write editorials and get out a paper automatically, Mr. Godfrey, as well as anybody else, knows that no machine ever was or will be invented with a set of human brains. Thus the editor can still remain on his job.

I said before that labor-saving machinery never injured labor. At the age of 14 the very first wages I ever brought home were in the shape of a new wooden pump to save my widowed mother from drawing water with a windlass. In that case I wonder whose labor was injured?

A few days ago I was given orders to place a power traverse on a large boring machine which has heretofore been cranked by hand. Whose labor was injured in this case?

J. A. RAUGHT.

Janesville, Wis.

Does a Grinding Wheel Peen?

Mr. Macready, on page 125, presents an unusually interesting paper, for which he should have the sincere thanks of more than one reader.

Evidently, Mr. Macready has begun an interesting line of investigation. So assuming, I will venture to tell of some of my experiences with identical heat problems.

A grinding wheel operating under favorable conditions undoubtedly generates during the operation of removing metal an intense heat, even though the depth of the cut be very light.

This is evidenced by the glazing effect apparent on the face of the wheel; for does not this glazing result from the fine cutting points melting, rather than wearing away?

I am satisfied that the former is true; else, if the dulling is due to the wearing of the cutting points, why is it that a wheel, when its face has been grooved with a diamond, or nicked, will glaze much more slowly and heat the work less, although, in this instance, there is a less number of cutting points to do the work and, consequently, each point does more work than in a straight-faced wheel?

In a softer wheel it would appear that as the particles begin to melt and glaze, the contact with the work causes them to break away and new points are presented to the work, in their turn to be melted and broken away.

It is my opinion, therefore, that glazing is simply a melting of the wheel due to the intense heat caused by the cutting action of the wheel.

If the wheel is grooved, or nicked, across its face, it seems these grooves, etc., act as air passages through which cool air is driven by the speed of the wheel; and this, probably, prevents the wheel particles from melting and acts also as a coolant on the work.

This is a point, I think, that should indicate the presence of a great degree of heat at the point of contact of the wheel and the work.

As Mr. Macready states, the heat must be localized, and follows the wheel contact.

In the case of light cuts it is conceivable that outside air currents set in motion by the wheel must rapidly cool the work, except where the wheel is operating.

Another thing I would mention is the possible effect of the wheel upon the grain of the metal being ground.

We all know that in certain machining operations, principally turning and planing, it will be very difficult at times to obtain the desired degree of finish; the tool, however well ground, leaves a rough surface; yet, when the piece is moved around and the cut started from the opposite end, a clean and smooth finish is easily obtained.

Now, a grinding wheel removes metal through the action of cutting. This can be shown by experiments in grinding steel of varying degrees of hardness; for in grinding highly carbonized steel the metal is removed in the form of minute chips, which to the eye appear as dust.

In grinding soft steel, then, the metal removed appears not as a dust, but as a fine, wooly mass—like fine metallic wool.

If the grinder reaches down and tries to pick up a handful of what at first appears to be dust, this "wool" will be found in quantity.

"Like causes produce like results," but this may in a way be qualified when we are considering grinding wheels and their action and lathe and planer tools and their action. Because of the different construction of cutting agents, the action of which is similar, "like results" may be manifest, though apparently in a different form. This I will presently take up.

It is possible that the buckling produced by a grinding wheel may be due to a condition analogous to the rough surface produced by the lathe tool operating under certain conditions; for, in turning, no matter how sharp a tool may be, the rough surface can be remedied only by running the cut from the opposite direction. A lathe tool has but one point, while a grinding wheel has many; but it is possible that the buckling of a thin piece of metal is produced by grinding against the grain of the metal.

It is understood the piece is on a magnetic chuck and held down evenly all over, producing a balance. As the grinding proceeds, this balance can be affected by the temperature of the piece which, of course, becomes warmer at the center while the outer parts remain cooler. Through the expansion of the center, and while the cooler and less expanding outer parts are held firmly by the chuck, the tendency of the center would be to rise with the pull of the grinding wheel.

Yet, of this condition another case is possible. Suppose, for example, a thin piece of hardened steel is so placed on the magnetic chuck that one or both ends are off the fields; now, it is certain these ends are not held by the magnetism of the chuck and so the piece is out of balance to start with, although this may not—probably will not—be noticed at first and later on by the results only. As the center becomes heated and expansion begins, the center is no longer confined between firmly secured ends; and instead of yielding to the upward pulling influence of the wheel, it is permitted to move from the wheel, through the ends being loose, and the influence of the magnetism draws the center downward and from the wheel and is rather pushed by the latter, causing the ends to move outward and because of the downward pull at the center, upward. Possibly this may have somewhat to do with the upward curling of the ends that Mr. Macready speaks of.

That pieces so distorted will not resume their original shape upon cooling is to be expected, for many suggestions of this are frequently met with in the hardening room.

Again, if the grain of the piece being ground is running with the wheel—that is, if the wheel is not operating against the grain of the metal—a condition could be produced similar to the ends being loose, especially as the wheel becomes a little dull or glazed.

In this instance the balance of the piece could be disturbed by the push of the wheel and the downward pull of the chuck. If the ends were not held securely enough to resist this action, they would be forced upward and the center downward, through the two manifestations of force —the lateral expansion of the center and the downward pull of the chuck. On the other hand, if the ends were firm enough to resist this force, the expansion must be in one direction only—upward.

In my own practice I have found it expedient to place one or two sheets of paper on the magnetic chuck under the work, to act as a nonconductor of heat—preventing the heat generated from entering the chuck. (The result of this will be discussed presently.) I also groove the face of the grinding wheel with a diamond, to provide air passages, as I explained in a former article.

This grooving enables the wheel particles to break away very readily and obtains the shortest possible duration of heat.

In a consideration of the foregoing, still another phase is possible wherein we have to do with the heat factor to the exclusion of all else.

If a flat, thin piece of hardened steel is placed upon a magnetic chuck, and care is taken to see that the piece is held securely at the center and at both ends, it is reasonable to deduce as follows: The wheel passes over the surface, producing a moving line of heat—great heat. Now, as previously explained, this heat will be greatest and of longest duration at the center of the piece. The heat at the center will penetrate the small slab of steel and be absorbed, to an extent, by the chuck; and this heat of the magnetic chuck will not be dissipated as rapidly as will the heat absorbed by the piece of hardened steel, because of the larger mass of the chuck.

However, before any heat is received by the chuck at the beginning of grinding the surface of the piece of hardened steel at the center, it is warmer than any other member.

Logically, this would produce expansion at the center, and because of the cooler and securely held ends, the movement of the center must be upward, since at this period the heat is greatest at the center of the upper surface of the piece.

But, as the piece becomes cool the upper surface cools first and more rapidly than the surface next the magnetic chuck, due to the absorbed and retained heat of the chuck, and the lower surface becomes the warmer in proportion to the cooling of the upper surface.

This, I deduce, would result in an expansion of the lower surface, causing a pressure against the ends, chiefly on the lower side, or the side next the chuck, for the upper side has been cooled and therefore contracted.

If the ends are held securely, this would cause a concave in the center; if the ends are not sufficiently secured to resist this pressure, it would cause the ends to curl upward, presumably.

In the case of a large block, or cube, this same effect could be obtained, I believe, through the heat absorbed by the center of the block itself and retained by it below the surface.

The writer has made a few tests, using a hardened steel disk 4 in. in diameter and $\frac{1}{8}$ in. thick.

When this piece was chucked in a cylindrical grinder and ground dry to a thickness of $\frac{1}{16}$ in., an examination showed no buckling.

In this case a dished wheel was used and its periphery extended to the center of the disk.

An attempt to perform the same operation on the surface grinder was attended with considerable difficulties, due to buckling and warping.

From this I am of the opinion that heat may be present but so controlled as to minimize, or indeed to eliminate, all trouble such as mentioned above.

I am further of the opinion that a source of trouble, if not the trouble, is our present methods of chucking and securing work generally, to the platen of the surface grinder.

As for comparing surface-grinder work with cylindrical work, the writer can show that internal heat will produce the same results—buckling—in proportion to the extent to which the work of the cylindrical machine approaches the condition of the work on the surface grinder—that is, a state of rest.

That period of rest may be very minute and still be sufficient to permit the heat to concentrate on one side, thus disturbing the balance of the piece; in such work the heat may be controlled by motion of the work being ground.

Herein I raise no question of design. What troubles me most is bolts, clamps, vises, magnetic chucks and all the rest of the equipment of the surface grinder that provides no control of the heat generated nor permits it to be concentrated at some predetermined point.

As for grinding wheels without heat, I would as soon expect to see wheels without speed; for it is the speed that produces the heat, not the wheel.

A piece of iron, if it falls far enough, will generate sufficient heat to melt itself merely through its friction with the air, produced by its velocity.

In precision grinding the temperature of the room should be kept as nearly uniform as possible, and all unnecessary handling of the work should be carefully avoided until the grinding is completed and the work has had time to season thoroughly.

The foregoing considers some of the experiments I have been able to make and some of the conclusions at which I have arrived respecting certain phases of grinding.

Like Mr. Macready, I should be very glad to hear more of this matter through these pages.

Day by day, more and more work of all kinds is sized and finished by grinding; and as the lathe, miller and shaper become more and more mere roughing-out machines, it may well be to our advantage to investigate more thoroughly the many complex problems that are to be met with in grinding. J. B. MURPHY.

Plainfield, N. J.

Critical Speeds of Rotors Resting on Three Bearings—Errata

On page 193, Fig. 4, the figures on the scale of square inches should read 0, 1, 2 instead of 0, 2, 4. On page 194, Fig. 9, the scale readings for pounds should be 0, 2000, 4000, 6000 instead of 0, 1000, 2000, 3000, as given.

Editorials

Making United States Munitions

In this issue the reader who is interested in munition making will find a complete description of the manufacture of the United States three-inch common shrapnel. The process described is that practiced at the Frankford arsenal, and the operations have been followed with the same detail that characterize those on the Springfield rifle now being published.

The reasons for publishing this material at this time are self-evident. Educational orders for munitions of this kind have been provided for by appropriation of Congress, and in line with this first step those who are not familiar with the United States field-artillery ammunition will have an opportunity herewith to become acquainted with our most common types of defensive shells. The threat of war, whose distant but ominous rumbling is heard by all patriotic Americans, will perhaps lose some of its formidableness with the spread of technical information such as is found on pages 353 to 377 of this issue. Fortified with the knowledge of how the Frankford arsenal goes about its work, American shop owners will feel better prepared to turn from foreign to American ammunition production and without the loss of time that would occur were they compelled otherwise to search as individuals for this information.

The most common size of shells produced at the Frankford arsenal is the three-inch. Subdivided into its two most prominent and widely used types, we find the three-inch common shrapnel, such as is described herewith, and the three-inch common steel shell (high-explosive), the description of which will follow in an alternate issue. Based on the process employed for the manufacture of these shells of three-inch size and the help of detailed drawings and specifications that will shortly be published, the reader will be given an introduction to field-artillery shells of larger size—namely, 3.8, 4.7 and 6. Cartridge cases will be handled in the same manner in a succeeding alternate issue, full details being presented for the manufacture of the three-inch size and detailed drawings and a list of operations being given for the larger sizes.

The attention of the reader is called to that portion of the first article which deals with the manufacture of shrapnel balls, also to that portion of the second article which deals with the making and loading of night tracers, which are used to illuminate the flying shell at night and act as a guide in artillery-fire observation.

Another interesting feature which has received very little if any previous published description is that of loading the common steel shell (high-explosive) with "T. N. T." This dangerous operation is carried out in bombproofs and under a pressure of many thousand pounds to the square inch.

Those who have been manufacturing foreign ammunition will find no hardship in turning to the simpler operations and less rigid requirements of American shells. When we speak of less rigid requirements, it does not imply that the accuracy of the American shells has been in any way jeopardized. In fact, an examination of limits and specifications would not reveal any particular difference between the physical requirements of the more prominent countries. This distinction comes in rather in the psychology of inspection, which will be found to react instinctively to our advantage with practical American inspectors. A large number of such inspectors have become trained through experience on foreign munition work during the last two years; and we therefore will not be forced to suffer from the scarcity of skilled inspectors, which resulted in much difference of opinion and unnecessary expense during the early days of European manufacturing in this country.

The Anti-Metric Institute

The pros and cons of the metric system have been freely discussed by the correspondents of the *American Machinist* during the past few weeks. Another turn is now given to the matter by the announcement of the final organization of a new society—the American Institute of Weights and Measures.

This organization has two general purposes, as shown by its constitution. One is to strengthen and improve the English system of weights and measures as used in the United States; the other is to fight all efforts to do away with this system. The institute is really an anti-metric society.

However, it has come into being not merely to fight against the pro-metric propagandists who wish to make the metric system exclusive and compulsory in our country, but also to improve the present system. This fact is a source of gratification. Too many units and standards are used in buying and selling commodities. The existence of two quarts of different sizes—the dry and the wet—is one example. The lack of uniformity in state laws specifying how many cubic inches or pounds constitute a bushel in the sale of common products is another. The opportunity for constructive work in this direction is tremendous, and it is practically untouched.

The institute can also very properly and with profit undertake a study of methods and means for making exact measurements. The demand for greater accuracy in machine-shop products is growing more and more insistent. Our knowledge of ways and means and our devices for making refined measurements have not kept pace with the requirements for accuracy in production. We need better methods and simple instruments that can be used with ease and certainty.

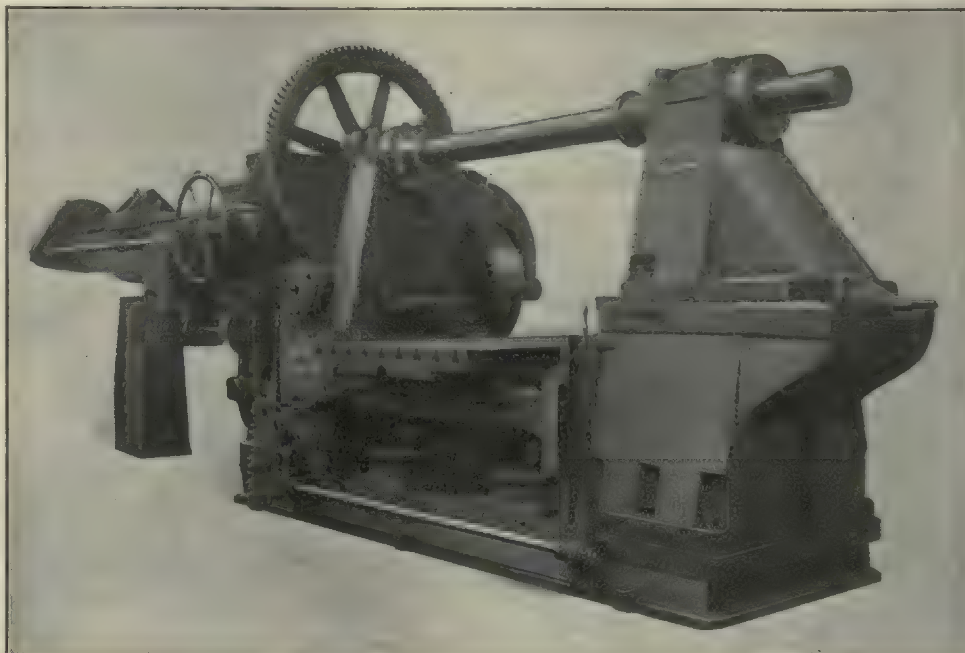
With skillful guidance the institute can be of direct service to the industry and trade of the country. That it will have far-sighted leadership and ample funds to carry on its work is assured by the men who constitute its first group of officers. The name of every one is well known in American business affairs.

The American Machinist wishes for the institute a long and useful career.

Shop Equipment News

Locomotive-Cylinder and Valve-Chamber Boring Machine

A machine for boring at one setting, both the cylinder and the cylindrical valve chamber on castings intended for locomotive work is illustrated herewith. The machine is one of the recent products of the Newton Machine Tool Works, Inc., Philadelphia, Penn. The spindle of the machine is 7 in. in diameter and it has a feed of 12 in. either by gear or handwheel drive. Power rapid traverse is provided for both directions. The spindle and spindle sleeve are made to rotate in unison by double splines and full-length keys. The sleeve turns in capped bearings on either side of the driving worm. The worm wheel is fitted with a roller thrust bearing and is submerged in oil. An attachment is also provided for facing the cylinder heads, which operation may be accomplished either while the cylinder is being bored or at a separate time. The work table has a full bearing on the saddle, and adjustments are made by means of a taper shoe. The drive is so arranged that the power-rapid-traverse feature of the spindle may be utilized whether or not the spindle is rotating. Six changes of feed are obtained by means of lever-operated gears. The feed and rapid traverse are by means of a screw equipped with roller thrust bearings.

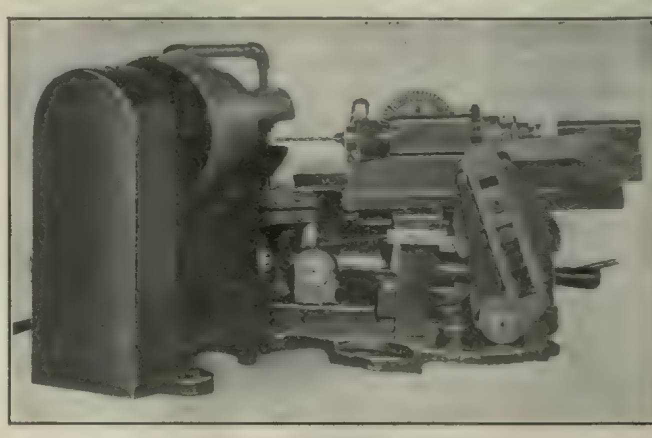


BORING AND FACING MACHINE FOR OPERATING ON LOCOMOTIVE CYLINDERS AND VALVE CHAMBERS AT ONE SETTING

Minimum distance center of spindle to top of work table, 39 in.; maximum, 51 in.; work table, 54x72 in.; with hand cross-adjustment of 30 in.; maximum distance between ends of facing heads, 60 in.; spindle speeds, 3 to 9 r.p.m.; feeds, 0.0637 to 1.019 in. per revolution; weight, approximately 70,000 lb.; floor space, 31 ft. 6 in. by 9 ft. 6 in.; motor recommended, 20 hp., with speed of from 400 to 1200 r.p.m.

Drill-Fluting Machine

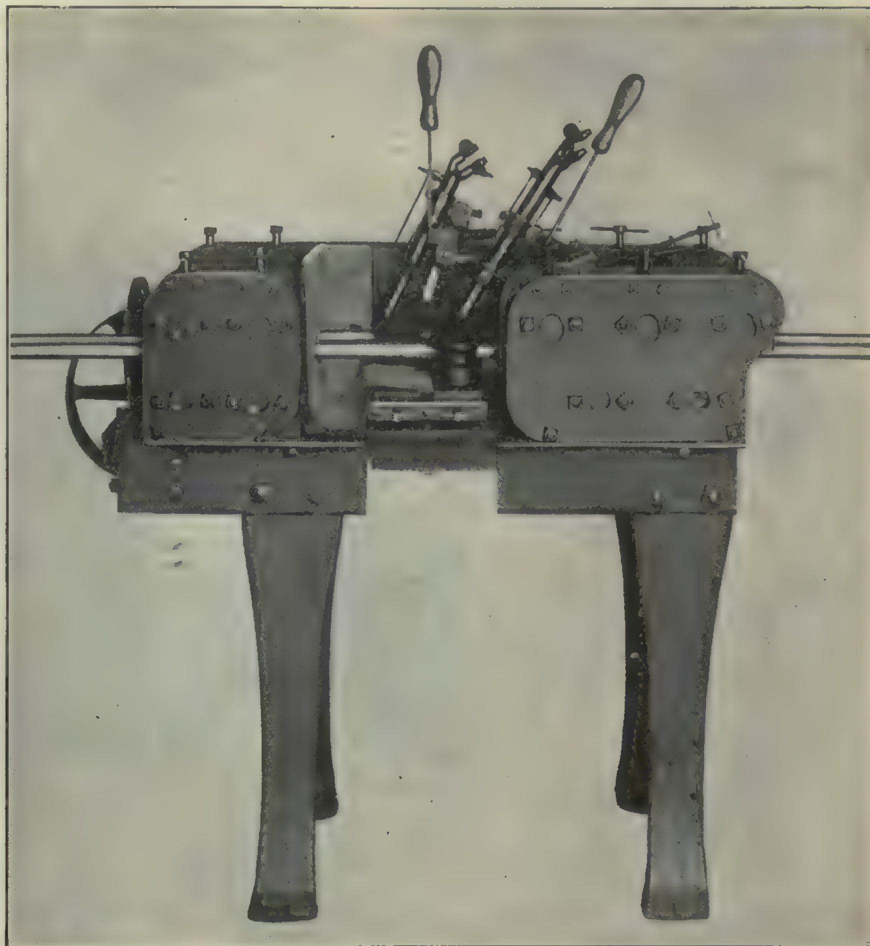
The drill-fluting machine shown is one that has recently made its appearance on the market. The angle between the drill blank to be fluted and the cutter spindle is adjustable, and any desired ratio of speed between the two shafts is secured by means of a train of gears. A high and low speed is provided, the purpose being to give a higher speed movement to the blank when the cutter is not working. The rotation of the drill blank is secured by means of a gear drive involving both spur and bevel gears. By means of a graduated segment, an adjustable angular slide and an adjustable roller mounted on the bevel gear on the carriage slide, any desired spiral or any desired rate of increase in the lead of the spiral may be obtained. The rotation of the blank during its backward travel is stopped by means of a combination of a friction plate, clutches and trip dogs. Adjustable trip dogs on the periphery of the crank wheel are used to shift the speed of the feed. The carriage slide is completely adjustable as to position and length of movement. A 2 to 1 pair of gears driven from the crank wheel act as a stop for the feed mechanism after the drill has been fluted. A device is incorporated by means of which the carriage is given a practically constant rate of motion while the cut is being made. This feature is accomplished by placing the fulcrum of the lever arm out of line with the line travel of the slide in this arm. The Bickford Machine Co., Greenfield, Mass., is the maker.



DRILL-FLUTING MACHINE

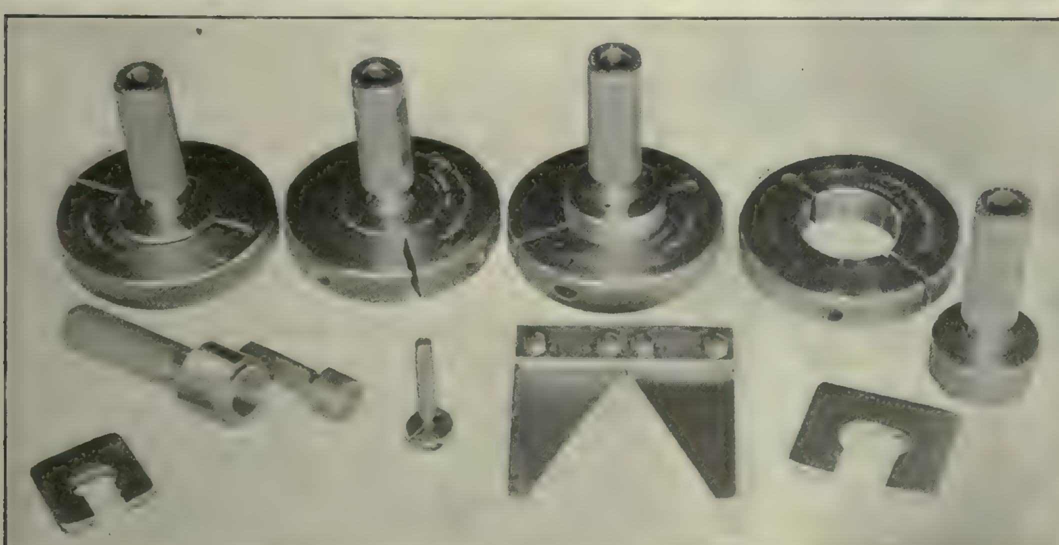
Tube Seam-Welding Machine

The welding machine illustrated here is made by the Thermalene Co., Chicago Heights, Ill., and welds two tubes at once. Thermalene gas is used, generated in one of the company's make of generators. One operator handles two welding machines, which take two tubes each. The machine is built to weld tubing 1¼ in. in diameter, 14 gage, at a speed of from 28 to 34 in. per min. without preheating. With a preheater the speed can be increased to about 42 to 50 in. per min. The torches are water cooled and simple in construction. With 8 lb. pressure of thermalene and 10 lb. pressure of oxygen the estimated cost per foot of tubing welded is 1.1c. for gas and oxygen. The thermalene gas mentioned was described in detail in a former issue, and consists of a combination formed by mixing vaporized crude oil and acetylene gas, to which oxygen is added for welding and cutting purposes. The comparatively small amount of oxygen needed gives very satisfactory results in welding work and produces a strong non-brittle weld. Aside from making generators of various sizes for the production of thermalene gas and the burners or torches for cutting and welding, the company also designs and builds on order, automatic welding machines of all kinds, of which the one shown is merely an example. A number of their machines have been in successful use in large pipe- and tube-making plants for some time. A number of these machines are being used without preheaters, for various reasons, but where preheaters are used the welding speed can be almost doubled. The company's plant is well equipped to promptly handle orders for both machines and supplies of every description in its own particular line of work.


TUBE SEAM-WELDING MACHINE

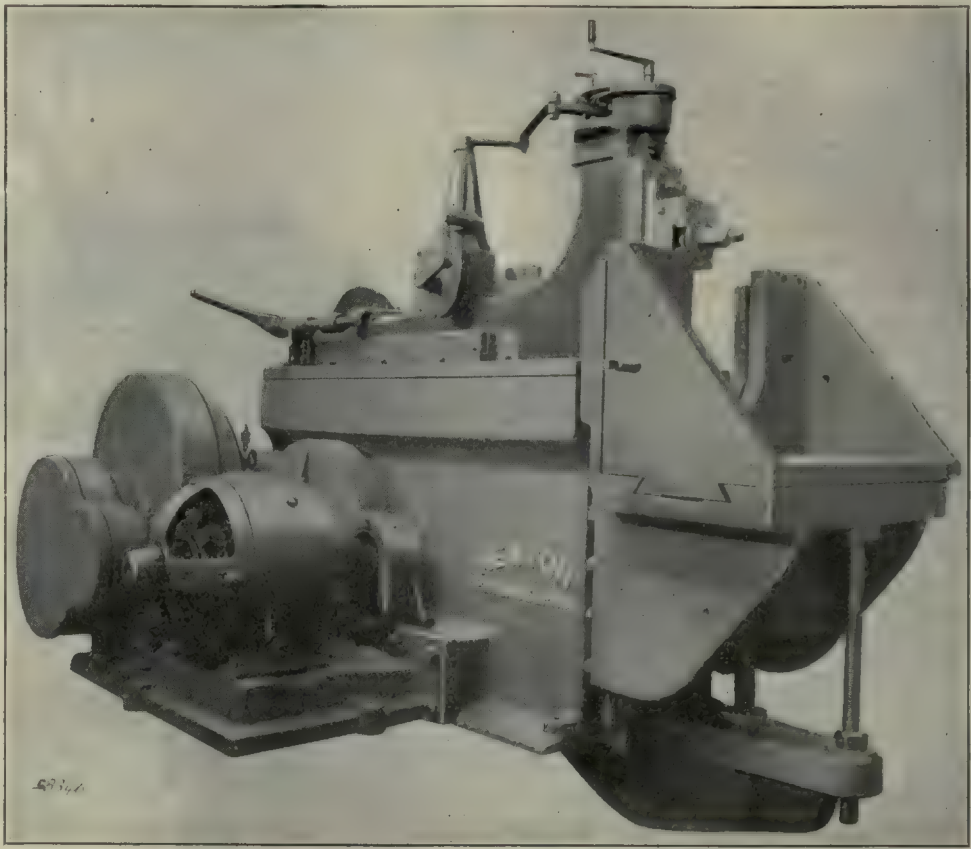
Precision Gages

The Superior Machine and Engineering Co., Detroit, Mich., is now making a line of precision gages that includes thread gages, snap gages, ring and plug gages, angle gages and practically anything of this character that may be ordered. The mechanical heads of this concern have had long experience with the largest makers of precision tools in the United States and are applying their knowledge to making tools that are right in every particular. This is especially true in regard to thread gages of both the plug and ring type, which every real mechanic knows are extremely difficult to produce accurately and in duplicate. Not only must the original workmanship be of the best, but the treatment of the steel used must be such as to give maximum wearing qualities in all cases. The company possesses ample means for extremely accurate measurement.


AN ASSORTMENT OF VARIOUS KINDS OF PRECISION GAGES

Shaping Machine for Locomotive Boxes

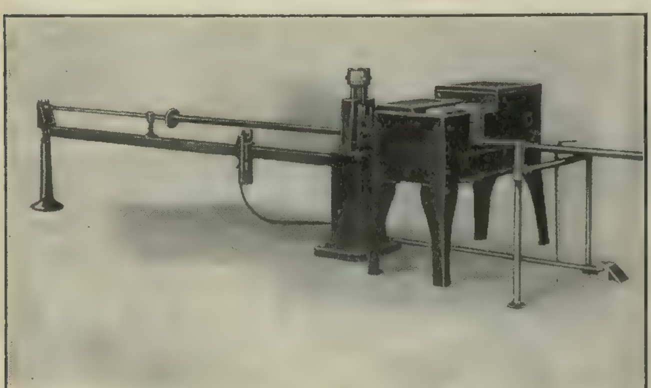
The machine shown in the illustration is one that has recently been built for shaping operations upon locomotive boxes. It is of box-type construction, the knee being equipped with hand elevation of the angular blade to which the boxes are bolted while being operated upon. For the purpose of making fine adjustments on the position of the box being machined a slight amount of cross adjustment of the angular blade to which the boxes are bolted is provided for. In operating upon locomotive boxes of the type for which this machine has been designed it has been found convenient to place the boxes in a horizontal position in order that the markings to be worked to may be more easily seen. This is one of the conditions met by this shaper. The drive is through a connecting-rod and Whitworth quick-return-motion mechanism, and the stroke of the ram is 30 in. The vertical feed is accomplished by means of a pawl engaging with teeth in an incline. This method accurately insures that a definite and predetermined amount of feed be given at each stroke of the ram. The machine weighs approximately 30,000 lb. without the motor, which should be of 15 hp. with a speed of from 400 to 1200 r.p.m. The machine has been built by the Newton Machine Tool Works, Inc., Philadelphia, Penn.



LARGE SHAPING MACHINE FOR WORK ON LOCOMOTIVE BOXES

Boiler-Tube Reclaiming Machine

The illustration shows a device that has recently been placed on the market for the purpose of reclaiming boiler tubes. It is primarily designed for use in railroad shops and permits the utilization of boiler tubes which would otherwise be scrapped. The equipment consists of a pneumatic welding machine, an oil furnace, suitable racks and a mandrel on which the tube is placed while operations are being carried on. In operation the tube is heated and belled out and the safe end or shorter tube is inserted. These are then passed over the mandrel until the point to be welded is properly located in the furnace. When ready to weld, the tube is shoved forward through the furnace until the point under the welding dies is reached, when a stop previously set on the mandrel automatically starts the pneumatic hammer. When the end pressure is taken off the tube the air supply is cut off and the hammer stops. The tube is again placed in the proper position in the furnace in order to heat it for the completing operations. The machine has capacity for from 3- to 6-in. tubes and is the product of Joseph T. Ryerson & Son., Chicago, Ill.

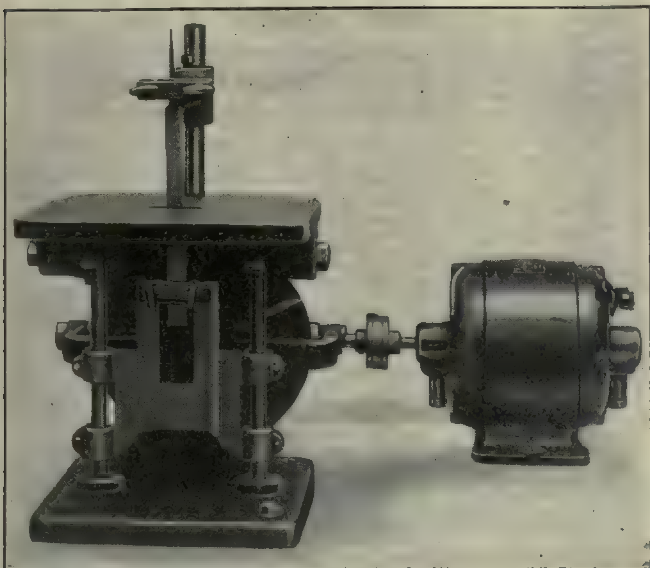


BOILER-TUBE RECLAIMING MACHINE

Filing Machine

The Holmes Manufacturing Co., Shelton, Conn., has placed on the market a machine designed especially for the purpose of punch and die forming. One of the features of the machine is that plain files may be used, making it unnecessary to carry a supply made with special shanks. Where it is required to file down to a shoulder, a short file may be held in the upper support, which is made extra heavy for this purpose. The machine is driven from an electric motor through a friction disk and wheel by means of which the speed may be varied from 200 to 800 strokes per minute. An Oldham coupling is provided between the motor and the friction wheel shafts. The four bearings are adjustable for wear and the stroke may be varied from 0 to 1¾ in. The table is 8 in. square and may be tilted from 0 to 15 deg. The over-

hanging arm for holding the upper end of the file may be removed and the file held by the under support. Complete with wood base and motor the machine weighs 35 lb., which allows it to be taken to the work where this is large or cumbersome. One of the chief advantages of this



PUNCH AND DIE-FILING MACHINE

machine is that with the clamp used, which will grip the file at any point, the file may be broken off from time to time as it wears, thus making it possible to use up all of the cutting surface. This is a feature that is not present where files with special shanks are used.

Polishing Instead of Filing Pulleys

By Elmer W. Leach

Small shops and factories are quite likely to underestimate the value of a polishing department. Many plants still cling to the old method of filing flat or crown-faced pulleys of small size, shaft collars and similar pieces. Much flat or round work requires a smoother surface than can be put on by any lathe tool; and it is for work of this kind that the polishing wheel is invaluable.

Before polishing had entirely replaced filing in the lathe, in the manufacturing plant where I am employed, I observed the time a machinist spent in turning and filing 4-in. pulleys having a 1½-in. face. After machining the face, he shifted the speed of the lathe to one high enough for filing, and proceeded to file the face of the pulley. When this was done, he changed the speed back to the proper speed for turning. The time required for the filing and the two changes of speed averaged 2 min. for each pulley.

Later, when the polisher was given charge of finishing all pulley faces, this job was done in a much different way. The polishing wheel employed was made of hard canvas covered with 90-grit emery. The pulley was placed on a short piece of shafting, with a loose collar on each side of it. The polisher then grasped the work by the collars and pressed it against the wheel. When the pulley revolved too fast, the speed was slackened by bringing the collars together against it. Sometimes the polisher wears a heavy leather apron and uses that as a brake. Each night just before closing time the wheels are dipped in hot glue and rolled in pans of emery of various grits. This gives the men a clean set of wheels each morning.

The boss says he will never return to the old method, and showed me two time cards that proved the superiority of the polishing method. According to one, a hundred 6-in. pulleys having a 2¼-in. face were polished in 45 min., and the other recorded a job in which two hundred 4-in. pulleys having a 1½-in. face were polished in 1 hr. 15 min. These pulleys have a much better surface than those which had been filed; and the machinist need not be so particular with his lathe work, as a polishing wheel will quickly smooth up a surface that would be a big job for a file. Pulleys are but one of many articles whose cost has been reduced in this shop as a result of the installation of a small polishing department.

First 18x96-In. Norton Plain Grinder Still in Use

The first plain grinder of the 18x96-in. size made by the Norton Grinding Co. is still running in the shop where it was bought and installed 16 years ago. The illustration shows the machine, and the following letter from G. W. Church, superintendent of the saw department of R. Hoe & Co., tells how this grinder happened to be purchased and the work it was used for:

Replying to your verbal request for some data regarding the first large-cylinder Norton grinder: This machine was ordered by the firm of R. Hoe & Co., of New York, about the latter part of December, 1900, or early in January, 1901.

In the early part of 1900 I became convinced of the necessity of finishing certain rollers and cylinders, used in rotary printing presses, in a more accurate manner than we were

FIRST LARGE NORTON CYLINDRICAL GRINDER

able to do on an engine lathe, and after some preliminary investigation by the late Mr. Hoe he decided to give the order as above. The machine was delivered to us in 1901, and I, having charge of the department in which it was installed, tested it out on the work for which it was designed. Charles E. Norton came on and was with me several days, trying out different grades of grinding wheels. The machine was put in operation and has been running continuously since.

New Publications

Cost Accounting and Burden Application—By Clinton H. Scovell. Three hundred and twenty-eight 5 x 7¾-in. pages; indexed; cloth bound. Published by D. Appleton & Co., New York City. Price, $2.

So much has been written on cost accounting that a new book in this field must justify itself by new material, a fresh viewpoint or improved method of treatment. The volume under review does not seem to have any one of these three desirable characteristics. It examines the elements of cost, defines some principles and describes some methods in respect to the determination and application of overhead expense, or manufacturing burden. It is entirely unillustrated and can hardly serve the interests of anyone except the man who wishes to gain a general knowledge of what factory cost accounting consists of and how overhead expense is determined and apportioned. All this ground has been covered many times in other works.

However, there is one saving feature in this book, and that is Chapter VII, "Interest Charged To Cost." The 39 pages that it covers, together with the 14 pages of the first appendix, give an excellent presentation of the reasons why interest on capital and money invested in materials and stocks should be charged as an item of manufacturing cost. On page 96 occurs this sentence, "All objection to including interest on investment in cost must disappear, however, when one considers the fundamental economic theory involved, for most authorities agree conclusively that interest and profits are essentially different in principle." And again, on page 98, "The effect which the inclusion of interest has on the accomplishment of the other aims of cost accounting indicates conclusively that it should be included as a manufacturing cost." These two quotations show how vigorously the author upholds the opinion that interest should be one of the items of cost. Anyone who is at all hazy on this particular point will be repaid by study of this one chapter and the appendix that touches upon the same subject.

Manufacturing Costs and Accounts. By A. Hamilton Church. Four hundred and fifty-two 6 x 9-in. pages; 140 illustrations; indexed; cloth bound. Published by McGraw-Hill Book Co., New York City. Price, $5.

Reviewed by Dexter S. Kimball*

This book, as its title indicates, is something more than a treatise on the theory of costs; it aims to explain the fundamental theory of accounting, by which the facts of cost accounting are recorded and interpreted. It aims also to show the cost accountant the relation of his work to the general accounts and to furnish to students an introduction to the basic principles on which all manufacturing accounting must rest. It deals as much, therefore, with basic accounting theory as with basic cost theory, though the discussion of the latter is quite full. It was to be expected that any book by this author, who has contributed so much to the discussion of cost finding, would be worth while, and this expectation is fully realized.

The book consists of three parts—namely, General Outline of Manufacturing Accounts; Cost Accounting; Factory Reports and Returns. Part I consists of 13 chapters, as follows: Purchasing, Production, Marketing; The Mechanism of Accounting; The Mechanism of Cost Accounting; Mechanism for Connecting Cost with Product; Costing on Method A; Costing on Method B; Costing on Method C; The Final Stage of Costs; Waste and Spoilage, Scrap, Byproducts; Auxiliary Equipment—Designs, Patterns, Molds, Jigs, etc.; Sales and Selling Expense; Summarizing the Results of a Business Period; Recapitulation.

This part, it will be seen, is a discussion of the primary principles of cost finding and of the mechanism by which costs are connected with product. This discussion is not as full as that given in some other treatises, but it is full enough to be clear. The author outlines in this section three important methods of charging up direct labor and expense: (A) Direct labor and expenses are merged and charged to unit quantity of product on a time basis. (B) Direct labor is charged to unit quantity on a time basis. Expense is averaged and charged as a percentage on direct wages or on the time taken by direct labor (hourly burden or percentage method). (C) Direct labor is charged to unit quantity, and expense is similarly charged by means of a machine rate, both on a time basis (scientific machine-rate method).

Chapters 5, 6 and 7 are devoted to brief discussions of the general mechanism of cost finding under these three respective methods of distribution. In each case the relation between the sources of cost, the cost-finding machinery and the final cost record are clearly shown by diagrams. These chapters serve as a basis for a more complete discussion of the subject later on. A brief discussion is also made in this section of the way in which costs are summarized and of the proper disposition of selling expense.

*Professor of Machine Design and Industrial Engineering, Sibley College, Cornell University.

The second section of the book contains 24 chapters bearing the following titles: The General Diagram; Purchase Orders; Recording Purchase Expenditures; Purchases Not Immediately Chargeable—Stores; Stores (Continued); Continuous Inventory; Purchases Not Immediately Chargeable—Buildings and Plants; Rents, Taxes, Insurance, etc.; Time and Pay; Works Expense and Administrative Expense; General View of the Foregoing Operations; Orders—Service or Standing Orders; Orders—Production Orders; Cost Sheets and Burden; Costing; Departments; Costing on Method A (Department Hour-cost Method); Costing on Method B (Hourly Burden or Percentage Plan); Costing on Method C (Scientific Machine-Rate Plan); Costing on Method D (Determining the Machine Rate); Costing on Method E (Control of Factors); Collecting Departmental Costs; Final Remarks on Costing; The Inclusion of Interest in Cost.

In this section the author extends the elementary principles laid down in Section I, and shows the entire mechanism of cost accounting by means of a general diagram. This general plan is then applied to cost finding by means of the three methods of distribution (A, B. and C) explained in a preliminary way in Section I. Chapters 19, 20 and 21 are devoted to a discussion of Mr. Church's well-known plan of allocating expense by means of a scientific machine rate, so called, and a supplementary rate. The use of "production centers," the clerical machinery for allocating expense to them and the precautions that must be taken to insure accuracy under this method are discussed, and the principal blanks and forms needed are illustrated. The remaining chapters of the section, as can be seen, are devoted to more or less detailed discussions of certain elements of manufacturing expense and the proper methods of disposing of them in the costs.

The third section consists of four chapters: The Nature of Reports and Returns; Reports and Returns for the Foreman; Reports and Returns for the Superintendent; Reports and Returns for the Executive.

These chapters consist of material originally published as a series of articles in the "American Machinist," in September, 1915, and have been revised and extended for this book. They include a general discussion of the nature of reports and returns and some suggested reports that may be of use to the several executive officials. This particular feature of cost finding is most important, and Mr. Church's discussion, while brief, is good and to the point.

While the book is written largely from the standpoint of the accountant, it is perhaps for this reason the best statement of the relation of cost finding to the general accounts that has yet appeared. The discussion is clear, and the book is not filled up with blanks and forms that are meaningless or special; only such blanks and forms as are necessary and sufficient to illuminate the text have been inserted. The discussion, furthermore, is well balanced, the author having wisely refrained from pursuing any phase of the subject to an extreme. Even the subject of production centers, in which the author is particularly interested, since it is largely his own conception, has been treated concisely. In fact, some items are treated perhaps too concisely, as for instance the subject of depreciation. Conciseness is, however, a virtue in book writing. The book contains very little on the subject of cost prediction, which is rapidly becoming a most important feature of all industrial management. Of course, the methods of finding the material necessary for cost prediction are fully discussed, but the book would have been bettered by specific reference to this phase of the application of cost records.

The book, as has been noted, has been written largely from the viewpoint of the accountant, and the diagrams and forms presented are those that pertain largely to the accounting side of cost finding. Nevertheless, the manager and shop executive will find much of interest and profit in its pages, and no library on cost finding or industrial management will be complete without it. It is a little advanced for college students, especially those who have not had a course in accounting, though in the hands of a good teacher it would be very serviceable. It is somewhat large also for a college text, since in general only the basic principles of cost finding can be and should be taught in college. On the whole, however, it is a very praiseworthy production and is a decided addition to the literature of the subject.

Personals

C. K. Lassiter has been appointed vice-president of the American Locomotive Co. in charge of manufacturing.

John A. B. Patterson has retired from active service with the Standard Gauge Steel Co., but still retains his place on the board of directors.

Spencer Weart has been elected president of the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J., and **G. O. Smalley** has been elected treasurer.

C. C. Cleland has been appointed sales manager of the Reliance Gauge Column Co., Cleveland, Ohio, in place of F. Roberts, whose connection with the company has been severed.

Gen. George W. Goethals has opened an office at 43 Exchange Place, New York City, where he will engage in a general consulting practice in civil, electrical, mechanical and hydraulic engineering.

E. B. Merriam, assistant engineer of the switchboard department of the General Electric Co., has been transferred and now heads the industrial service department which has recently been organized at the Schenectady plant of the company.

Trade Catalogs

Lathes and Screw Machines. Universal Machinery Co., Milwaukee, Wis. Bulletin with illustrations and calendar. Pp. 12; 4¼x8 in.

How To Measure Screw Threads. Greenfield Tap and Die Corporation, Greenfield, Mass. Bulletin; pp. 16; 6x9 in.; illustrated. This booklet deals with the subject of the inspection of screw threads and is the first of a series which is to be published by this company.

Business Items

The Carpenter Steel Co., Hartford, Conn., has closed a contract for the erection of a new building for office and storehouse purposes.

The Modern Tool Co., of Erie, Penn., has moved its Detroit office to 1223 Dime Bank Building. The office will be in charge of H. T. White.

The Hoenign Machine Shop, East Liverpool, Ohio, has been sold and will hereafter be operated under the name of Bucher, Smith & Co. The new owners are F. W. Poland, B. H. Bucher, H. V. Smith and A. J. Bostock.

Canadian S K F Co., Limited, has been organized under Dominion charter for the manufacture and sale of S K F Self-Aligning Ball Bearings in Canada. All correspondence should be directed to Toronto, in which city headquarters have been established at 47 King Street, West.

Catalogs Wanted

A. Pagney-Dumas, 8 Rue Pigalle, Paris, France, would like to hear from manufacturers of leather and shoe machinery and briquetting machines. Is also desirous of representing American builders of shaping, milling, drilling and other machine tools.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

Heat-Treating Plant of the New Process Gear Corporation—I

By E. A. Suverkrop

SYNOPSIS—The first installment of a description of the heat-treating, annealing, cementation, hardening, tempering, testing, sand blasting and final inspection of gears made in a factory covering half a million square feet of floor area, where over 10,000 gears, pinions, crosses, etc., pass through the carbonizing furnaces each day.

Owing to the methods employed in making them, drop forgings lack uniformity of hardness and toughness. Not only is this true from piece to piece, but, for example, in the case of ring-gear forgings there is often a dearth of uniformity of hardness throughout a single forging, caused by this lack of even treatment in manufacture. Lack of equal heating while forging will cause a gear to be hard on one side and soft on the other. Again, some forgings are finished at a single heat, while others of the same object and material are subjected to several heats before they are completed. With such treatment it is not to be wondered at that there is in the structure of the product a lack of uniformity that evinces itself in varying densities and hardnesses.

In the machine shop, to get the best results from men and machines, it is obligatory that the material be of as nearly uniform hardness as possible. Obviously, a cutting speed that is suitable for properly annealed stock would invite disaster if employed on unannealed forgings. On the ordinary lathe, when a single hard piece is encountered, the machine is slowed down by the operator. But in this shop many automatic machines are used in the production of the various kinds of automobile gears. The operator of such a machine merely places the rough forging and removes the finished work. The setting of the tools and the speed of the machine are no concern of his. The tool setter sets the tools, and the hardness and toughness of the forgings determine the speed at which the machine is run. The operator can of course start and

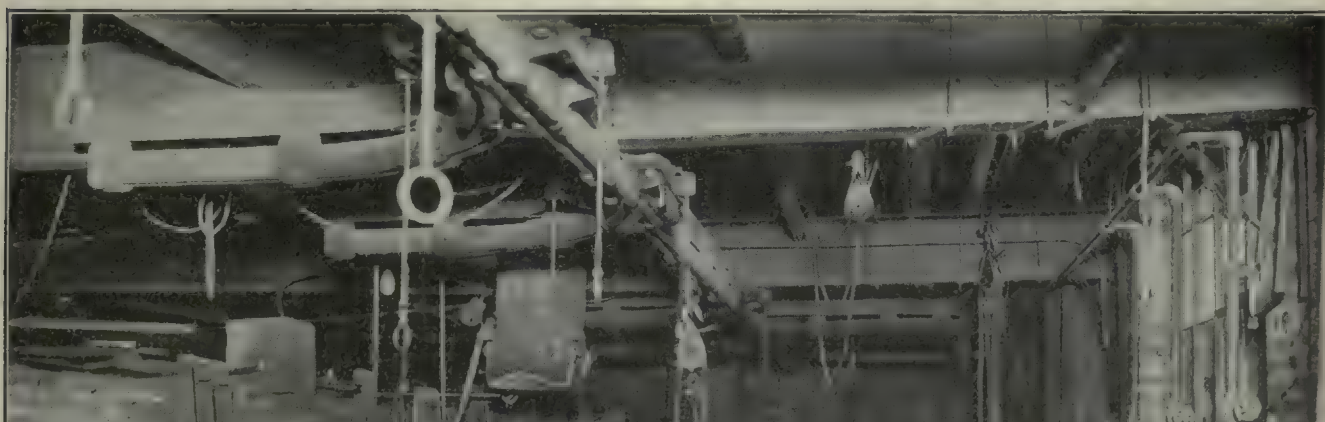


FIG. 1. PART OF THE HEAT-TREATING DEPARTMENT

stop the machine, but these are merely features assuring the safety of the tools, machine, work and so forth.

Granted then that an automatic machine should be run at an efficient speed, it is obviously necessary that the material to be worked by it must also be in an "efficient" condition; that is, it must be as free cutting as it can be made without detracting from its suitability for the work it will ultimately be called upon to perform. As previously stated, there is no such uniformity in commercial forgings, and to attain it all such forgings must be subjected to heat-treatment.

At the works of the New Process Gear Corporation, Syracuse, N. Y., the old carbonizing department is now devoted in its entirety to annealing and heat-treating all forgings and other material in the rough, on reception. The drop forgings are received in cars on a spur line of track that runs directly into the yard. Electric trucks propelled by storage batteries carry the forgings in tote boxes to the storage bins at the end of the heat-treating department, a small part of which is shown in Fig. 1. Each ring forging for a gear, as it is unloaded from the tote boxes, is visually inspected. It is then thrown, with a twist of the wrist, upon a flat steel plate. The method of throwing it down causes it to rotate on its axis, and while thus rotating any that are bent are readily detected. These are returned to the forge and straightened.

The preliminary operation in heat-treating ring forgings is to give them the "high heat." This is considerably above the critical point of the steel and results in a complete change of structure of the steel throughout the forging. For this operation the rings are taken from the bins and placed in annealing pots, some of which are shown in Fig. 2. They are made of unannealed malleable cast iron.

Two sizes of pots are used—12 and 14 in. in inside diameter. The 14-in. pots accommodate the larger rings, 10 in. in diameter, and the 12-in. pots the smaller rings and other small forgings. Square pots are also used for other pieces, such as stem pinions and the like. All pots have two ears at the top for handling them while hot. Special apparatus is provided for this purpose.

Each of the round pots holds eight or nine rings, which are piled one on top of the other. When full, the pot is covered with a loose lid of the same material as the pot. The lids, however, are not luted in place.

The pots are next charged into the coke fired furnaces *A*, Fig. 1, of which there are seven in this department, large enough to hold 10 of the 14-in. pots or 12 of the 12-in. ones. Natural draft only is used, the air entering under the grates of the fireboxes *B* from openings below, both at the back and the front. As previously stated, the pots and their contents are brought to the high heat to correct faulty structure due to possible previous mistreatment of the steel in forging.

For openhearth steel this temperature is around 1650 deg. F., and for nickel steel it is in the neighborhood of 1550 deg. F. Having attained the heat, the pots and their contents are held at this temperature for half an hour, after which they are drawn by the aid of the tool *C* and the hoist *D*. The contents are quenched (depending on the results required, or the steel being treated, or both) either in oil or water, in the tanks visible at the right.

For the second, or low, heat, or "draw," the treatment varies somewhat, depending on the steel and also on the temperature of the atmosphere. In the summer the pots are repacked in precisely the same manner as for the high heat and charged into the furnaces. They are then brought up to or slightly below the critical point of the steel, depending on the machine operations they are to undergo.

Steel containing about 3.5 per cent. nickel and 18 to 20 points of carbon, which is to be turned only and not broached, is heated to approximately 1250 deg. F. If the work is to be broached, the temperature to give the required results is about 1450 deg. F. Openhearth steel containing about 18 to 20 points carbon is also heated to about 1450 deg. F. Some of the work, as for instance the

FIG. 2. POTS FILLED WITH SAND TO RETARD COOLING THE CONTENTS

FIG. 3. PICKLING TANK FILLED WITH VARIOUS TYPES OF FORGINGS

side pinions of differentials, is not subjected to a second treatment, but in the initial heat is raised to 1600 deg. F. and quenched.

Without exact knowledge of the composition of the steel, exact treating temperatures cannot be given. With a knowledge of analysis of the steel, the qualities requisite to facilitate the various machine operations and insure subsequent efficiency can, however, be readily imparted to the steel by varying the temperature to which it is heated and by altering the method of quenching. Thus work that is to be broached is heated to the AC1 point, that which is to be turned, but not broached, to the AC3 point.

Having reached the heat desired, the pots are held at this temperature for an hour, drawn from the furnace and allowed to cool slowly to 800 deg. F., after which it is safe to remove the forgings from the pots and cool them off in water, as no structural change takes place when they

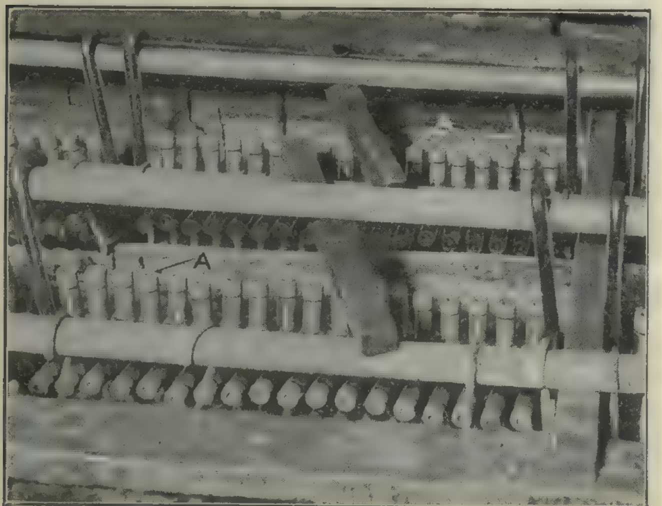


FIG. 4. COPPER PLATING THE ENDS OF CROSSES

are quenched at a temperature as low as this. In winter time, when the weather is cold, the procedure is of necessity somewhat different.

Ignoring other conditions, hardness in steel is caused by rapid cooling from, or above, the critical point to a temperature of about 800 deg. F. The rapidity with which this cooling takes place, other conditions being equal, governs the hardness; that is to say, the quicker the drop in temperature the harder the steel, and vice versa. For this reason, in order to retard cooling when performing the drawing operation in cold weather, it is customary in some plants to allow the furnaces to cool slowly with the pots still in them until a temperature of about 800 deg. F. is reached, when the pots are drawn and the contents taken out and quenched. Obviously, by this method there is a great waste of heat and time, and also of fuel necessary to bring the furnaces up to heat again. In the plant under discussion the process pursued in winter is as follows:

Before charging the pots for the second heat their bottoms are covered with dry silica sand to a depth of about 1½ in. The rings are then placed in the pots one on top of the other and the covers put on, but not luted. The pots are then charged into the furnaces and brought up to the desired temperature. When the heating period is concluded, the pots are withdrawn, the covers removed and the pots filled to the top with dry silica sand or, in other words, to about 2 in. over the top ring. The pots are then run out to the cooling floor, as shown in Fig. 2, and allowed to cool to 800 deg. F.

The sand delays the cooling, so that it takes about the same length of time as in the summer to reach 800 deg. F.—say about 7 hr. Formerly, the temperature was tested with a thermometer; but the men handling this work soon

FIG. 5. PACKING DEPARTMENT

learned that, when they could hold the bare palm of the hand on the outside of the pot, the inside was approximately at the prescribed heat.

The forgings, after heat-treating, are trucked to the pickle house. Here the work is loaded into the tanks, as shown in Fig. 3, and pickled in a solution of water and "Edis" pickling compound in the proportion of 1 bbl. of compound to 200 gal. of water. Steam is then let into the bottom of the tanks through perforated pipes. The duration of the pickling operation varies with the amount of scale to be removed and takes anywhere from 2 to 4 hr. Sulphuric acid has been used for this work, but the Edis compound gives equal results at less than

a third of the cost with sulphuric acid. When the pickling has proceeded far enough to loosen the scale, the tank is drained and the forgings are subjected to two washings with clear hot water.

Pickling removes practically all the scale; that which is left is in the form of a loose film, which is readily removed in the tumbling operation that follows and is carried on in the same department. The tumbling barrels are of iron, and cast-iron stars are utilized to assist in the removal of the scale from inaccessible parts of the forgings. While pickling can hardly be termed a part of the heat-treating operation, it removes the scale formed in that operation and for that reason is considered pertinent to the process.

In the same building that houses the heat-treating department is the copper-plating department. While this also may be considered as apart from the heat-treating of forgings, it is in reality very closely allied to the casehardening of the parts, for the reason that the parts which are to be locally casehardened only are in this department plated before going to the cementation operation. In Fig. 4 one of the copper-plating tanks is shown. A number of crosses *A* will be observed in it. They are hung by their central holes on horizontal rods. The cross-ends for about ½ in. are required to be soft. Sufficient thickness of copper to prevent penetration of the carbon in the cementation process can be deposited on the cross-ends in about 15 min. A series of ends having thus been plated, the operator turns the crosses by hand to expose the next row of ends to the plating action.

Just as it is necessary to insulate steel from the action of the carbonizing operation, so also is it necessary to insulate it from the action of the plating solution. Certain pieces, such as small pinions, are required to have the bore soft while the teeth are hard. Rubber collars are pulled over these, which hug them tightly and prevent the solution in the galvanic bath from gaining access to the teeth while the bore is exposed for copper plating.

It will of course be understood that all work handled in this department has already been machined. Some other types of work that must be prepared for local hardening are daubed with fire-resisting paint or paste. This is done in that part of the new casehardening plant devoted to the packing of the hardening pots. The cement used here for this purpose is known by the trade name of "Adamant" cement. It looks very much like common yellow clay; in fact, yellow clay mixed with water to the consistency of molasses will make a satisfactory resist for local casehardening. All work that is coated with fire paint should be thoroughly dried before it is packed in the hardening pots.

The casehardening compound used at this plant is a mixture of charcoal and charred leather. In size, the granules of which it is composed are about equal to buckwheat coal. For packing the pots, old, or burnt, compound and new, or unburnt, casehardening material are mixed and used in the proportion of three parts of the old to one of the new.

All parts to be casehardened are marked in conformity with an elaborate system of symbols indicating the heat number, number of furnace where treated, hour, day, month and year and any other feature of which it is desirable to keep track, so that at any future time the symbols and records will give an exhaustive history of the piece.

In Fig. 5 is shown a part of the pot-packing department. The trucks *A* accommodate three pots *B*, as shown. The trucks with three pots on them are first run over to the piles of newly cut gears, and the operator piles six rings against each pot, as shown at *C*. The truck is then rolled to a position convenient to the chutes *D*, which bring down the casehardening compound from the mixing room on the fourth floor. Eight men can pack simultaneously at the packing bench. A scoopful of compound is first dumped into the bottom of each pot. The size of the scoop is such that it will give a depth of about 1½ in. of compound for the bottom ring to rest on. Another scoopful is then dumped on top of the ring, another ring placed, and so on till the last ring is in position, when the pot is filled to the level of the seat for the lid and smoothed off. Such a pot is shown at *E*, while at *B* is shown a pot in which the last gear ring has been placed, but which

FIG. 6. LUTED POTS AND FURNACE TOOLS

has not been filled with compound. Between the rings a thickness of compound of about ¾ in. is allowed, and on top of the last ring about 2 in. is placed.

After being filled as described, the trucks are run out of the way, to have the lids placed and luted on. However, before placing the lids, three pots of each furnace charge are selected to receive test pieces. These are pieces of ⅜-in. round steel rod rolled flat on opposite sides to a thickness of about $\frac{5}{16}$ in. and cut about 1¾ in. long. They are attached to wire, so as to be readily found and removed when wanted. They are thrust down into the centers of three of the pots. One of them is placed in a pot in the second row from the back of the furnace, while the other two are placed in pots that will be in the front row in the furnace and easily accessible. The pots so selected are distinguishable from the others by having varying numbers of balls of fireclay on their lids.

These "test-piece pots" are readily seen in Fig. 6. The one at *A*, with the three balls, will be placed in the second row from the back of the furnace, while the ones with one and two balls (at *B* and *C*) will go in the front row. The steel used for the test pieces is of special analysis and known affinity for carbon.

To digress for a moment: Other conditions being equal, a piece of steel of small section will carbonize more quickly than a large piece; and while the steel used for the test

pieces is small in comparison to the work, its composition and affinity for carbon are known, and besides this it is located in the center of the pot and consequently where it will reach the cementation heat last and will begin to absorb carbon last.

The duration of the heat is 9 hr. The coke-fired furnaces take about 3 hr. to bring the pots to the temperature where cementation begins, and from this time on till the eighth hour is reached the pots are not molested. At the eighth hour one of the test-piece pots at the front is removed from the furnace, with the tool shown at *D;* the lid is lifted and slid to the side, with the tool shown at *E*. With the same tool the test piece is hooked out by its attached wire and dropped into a bucket of cold water. It is then gripped in the vise, the two flat opposite sides giving a firm hold, and broken to ascertain the depth of case. If the proper depth of case has been attained (which frequently occurs even at the eighth hour), the pots are removed and run out to the cooling dock to cool slowly.

In any event the test piece indicates, to the man in charge, the comparative thickness of case that can be expected on the work. At the end of the ninth hour the pots are removed and run out to the cooling dock, where they remain till they are cold. At the end of the cooling period the other pots with the test pieces are opened, and the test pieces are removed without disturbing the rest of the contents. Afer being heated to the hardening temperature the test pieces are quenched and broken. Should they show, which they sometimes do, that the proper depth of case has not been obtained, the opened pots are again luted up and the whole charge is returned to the furnace for further treatment.

[*To Be Continued*]

The Mirth of a Nation—A Small-Shop Tragedy

By John H. Van Deventer

SYNOPSIS—The evils of unwise legislation frequently are not realized until after the laws have been enacted. In this article what would happen to the machine-shop man under a compulsory metric system, is graphically impressed upon the reader.

Scene 1. Convention of metric propagandists at Washington, D. C., to celebrate the approaching passage of the Metric Measure Bill providing for the compulsory and exclusive use of the metric system throughout the United States.

Dr. Fatton, concluding his speech: . . . . and now, fellow scientists and co-workers, we who for long years have fought and bled in the cause of the centimeter, liter and kilogram are about to gaze upon the dawn of a new and glorious era. [Applause.] Ere the bright sun of another day casts its metric beams through yonder windows, laws will be passed that will place our beloved country on a par with the great industrial and scientific nations of the world—Bolivia, Brazil, Chile, China, Colombia, Costa Rica, Mexico and Spain. No longer need the youth of our land spend arduous and wasted years in absorbing the illogical relations between the inch, foot and yard. The very names of these antiquated and horrible units grate upon our enlightened ears, reminding us of *inch*worms, *foot*pads and *bone*yards. Henceforth, these fortunate young minds will be soothed by the beautiful inter-relations and co-relations of units, such as the co-relation which states that 3.28083 ft. equals 1 m. [Loud applause.] Henceforth, the man who is 6 ft. tall need not labor and sweat to determine his height in inches. He will have the exquisite satisfaction of knowing his height to be 1.8288 m., and the profound joy which comes from the advantage of being able to convert and express this in millimeters, centimeters or decimeters merely by shifting a decimal point—the joy which a Rockefeller or a Morgan now possesses in his ability to express his wealth at will in eagles, dollars, dimes or pennies. [Thunderous applause.] And let the misguided opponents of progress who would now stand in the way of this great scientific reform and block the wheels of civilization—our antagonists—beware, for this law will carry with it dire penalties that will be rigidly enforced against the stiff-necked and unruly who may adhere to the old order of things. Our prisons and penitentiaries yawn for them, and fines will be—[Enter messenger in haste, with message, which he hands to Dr. Fatton, who reads it with much emotion.] My beloved hearers, I can say no more—I am too full for utterance—the bill has passed! [Overwhelming applause, and waving of handkerchiefs.]

[Curtain]

Scene 2. Police court at Ogosh, Wis., Justice Hardblock presiding. Time, one month later.

Justice: Next case to the bar. Officer, repeat the charge.

Officer: Speeding an automobile, yer honner.

Justice: How fast was the prisoner going at the time of the offense?

Officer: All av' 40 mi. an hour, yer honner.

Justice (rapping with gavel): Careful, officer, or I shall commit you for contempt. It is no longer lawful to use the word mile. How fast was he going by the metric system?

Officer: Faith, yer honner, I didn't see him go bye thot at all, at all—it was Paddy Doyle's saloon he waz passin' at sich a speed.

Justice: How fast was he going in meters or millimeters, you blockhead?

Officer, scratching his head: Will, sor, at laste 25 mm. an hour, an dommed if I cud make it one less!

Justice, severely: Ahem! A most reckless and criminal speed, dangerous to the life and limb of the public. Prisoner, what have you to say for yourself before sentence is imposed?

Prisoner: I'll swear that my speedometer did not register over 15 mi. an hour, your honor!

Justice: The evidence of an instrument reading in miles is no longer accepted in courts of law, and besides it is a criminal offense to have one of them in your pos-

session. I fine you $50 for overspeeding, and suspend sentence on your having the English-measure speedometer in your possession, conditional that you buy a metric one tomorrow.

Prisoner: Sweep out the cell, Judge, I had to mortgage the farm to buy the flivver. I'll have plenty of company in jail if every bus owner is compelled to buy a new speedometer to suit the metric law. What kind of graft is this, anyway—

Justice, interrupting: Officer, remove the prisoner. Clerk of the court, make out commitment paper for 60 days at hard labor.

[Curtain]

Scene 3. Jones' machine shop and foundry, Catchacold, Mich. Time, three months later. Curtain rises on Billy Jones and Tom Hardy at work on a steam-pipe break that has shut down the plant. Shop clerk enters through doorway marked "Stockroom."

Clerk: Not another piece of 2½-in. left in the place, Mr. Jones! We used the last piece on Old Man Evan's gasoline-pump suction pipe. I called up the Azax Supply Co., and all they can sell us is metric size—60-mm. is the nearest, with five threads to the centimeter.

Jones, excitedly: Blank! Blank!! Blank the metric system anyway! I'd like to see the lobsters that wished it on us sweatin' over this here job. You'd have thought from their talk that this country was goin' to be heaven with the metric system, but as near as I can make out it's going to resemble the other place! Call up the Azax Co. again and see if they have adapter fittings to take 2½-in. and 60 what-you-may-call-its.

Clerk: I asked them that and they said no; the fitting people can't get taps because the tap makers are swamped with three years' advance business on metric sizes.

Jones: God bless good old Dr. Fatton! Call up Professor Boyd and ask him to figure out the blamed dimensions for us in inches, so we can make a master tap and a die from that.

Clerk: We can't do that, sir; Professor Boyd has been fined $500 for accommodating Jim Hodge in a similar way on a special-size reamer. I guess he's converted to the metric system now, or will be when he gets paid up. No use to ask him.

Jones: Well, we'll do the same as everybody else is doing, then, and make a new standard of our own. Get a piece of the 60-dingus pipe, measure it up in English and make a tap and die as near to Briggs good old standard as you can. I don't imagine many of us will keep out of bankruptcy until the metric system is fully introduced anyway, if this is an example of it.

[Curtain]

Scene 4. Interior of John Saunders' cottage. Time, six months later. Curtain rises on Mrs. Saunders and little Jimmy waiting the return of father from the shop.

Mrs. S.: I wonder what's come over your father lately, Jimmy; he hasn't been the same man for the last six months. Seems sort of worried and depressed like. Here's his dinner gettin' cold again; I do hope there's nothing happened to him at the shop.

Jimmy: Mebbe its somethin' to do with the metric swistem, Ma.

Mrs. S.: I wouldn't be surprised, with the trouble its makin' for all of us. Here for 20 years I've ben buying your pa's undershirts for him, size 42, and last week when I asked for that same size they gave me some that wouldn't cover a two-year old baby. Seems that he takes size 135 now, and the price in proportion. I asked the girl in the dress-goods department how many yards it would take to make up the dress pattern I saw in last Sunday's paper, and she said, "Hush! Do you want to be arrested?" She showed me a fellow walking up and down the aisle wearing big glasses and a red badge and said he was a metric inspector lookin' for violations of the law. Well, well, it's a funny world, but here comes your father, Jimmy, at last. [Enter John Saunders, downcast and smelling of whisky. He bangs his dinner pail down on the table and throws himself into a chair.]

Mrs. S.: Why, John, you've been drinking!

Saunders: Well, ain't it enough to drive a man to drink? Here I've been workin' hard for the past year for a raise and now my pay has been cut 10 per cent. to help pay for the burden of puttin' in this blamed metric system. Tool makers are the only people that get good money nowadays; there ain't much for us machine operators to do and won't be until all of the factories get their old jigs and fixtures made over into metric sizes. Most of 'em has to be thrown out anyway. I can't blame the boss; he's raised the prices of everything as much as people'll stand, and it's a wonder if he don't get broke with all goin' out and nothin' comin' in. Funny part of it is that nobody wanted the metric system anyway; customers didn't want it, bosses didn't want it, and God knows the men didn't want it. Just a few scientific politicians in Washington wanted it, and they put it over on us while we were asleep. Talk about this country being a democracy, when a thing like that can be put across without the popular vote! I'm going to look up a job in Russia.

Mrs. S.: Eat your supper, John, and you'll feel a little better. I was afraid you was laid off altogether, and then I'd have two of you hanging round the house. Jimmy won't be able to go to school for six months yet until they get all of the schoolbooks written over in the metric system. Then we'll have to pay extra taxes for the new books, I suppose. Well, it's always the poor that have to pay for such things, and I suppose we'll live through it. We'll cut out the butter except on Sundays and make our old clothes do this year and eat meat twice a week and get Jimmy a job as messenger boy and try to keep up the payments on the house.

[Curtain]

Scene 5. President's office, the Cleveladelphia Manufacturing Co., an old, established and highly reputable concern making a varied line of machinery that has been widely marketed in all civilized countries. Curtain rises on the president of the company studying the financial statement for the preceding year. He presses a button, and the chief accountant enters with detailed statistics.

President: Mr. Jepson, we face a serious problem. Our manufacturing and selling expense this year exceeded our net sales by $236,785.68. This is not counting what is included in the additional blanket fund of $600,000 that we spread over the coming four years to provide for the outlay necessary to purchase metric gages, measuring devices, jigs, fixtures, changes to existing machine tools, etc., made necessary through adopting the metric system. We estimated that this outlay would absorb the additional expense of this change, but it appears to me that we did not look far enough into the problem. What

percentage of our business has been repair parts, taking the preceding five years as representative?

Accountant, consulting data and figuring rapidly: Sixty-four per cent. Mr. Stockton.

President: How has the total volume of this repair business increased during these five years?

Accountant: From $468,421.76 for the year five years from date to $845,846.91 for the preceding year.

President: In other words, the volume of this business has practically doubled, which is to be expected from our long time in business and our increase in new business. We may expect under normal conditions that this percentage will continue and even increase. Now, what percentage of last year's repair shipments was for machines in service 10 years or more?

Accountant: Eighty-three per cent.

President: Good in one way, Mr. Jepson, but ominous in view of the compulsory adoption of the metric system in this country. Our customers abroad are not going to throw away usable machines because those at the head of affairs over here have sold their country's industrial birthright for a mess of metric pottage. We shall have to continue filling orders for these parts for at least 15 years; and while we may call the measurements millimeters instead of inches in order to keep out of jail, the sizes will be English and not metric. On the other hand, our new machines must be metric and not English. Hence, for the next 15 years I foresee the maintenance of a double standard in our shops, with double expense, double the liability for error and endless confusion. We will not dare to permanently retire one of our old tools, jigs or fixtures; in addition we must maintain an equally elaborate set of the new standard. Two sizes of every piece will be constantly present in our shop, necessitating double supervision and the splitting of lots, with its diminished-profits accompaniment. We must carry two stocks instead of one or else suffer serious delays in shipment, having already established a minimum safe stock list from previous experience. We must double our drawings and designs without one single duplication, which means a double expense for maintenance aside from first cost. In fact, to make the same net annual profit, we must practically double the capacity of our plant and reduce our overhead at least 25 per cent. from its present figures. They say the next generation will gain by the adoption of this metric myth, Mr. Jepson, but I fear it will not be the heirs or followers of those who in this generation through hard work and honest dealing have established or built up worthy enterprises. I seem to foresee strange industrial wolves tearing at the fabric of our country's commercial wealth, built up so carefully during the past century—wolves eager to fill themselves with meat and caring not what becomes of the stricken carcass from which the life blood has been sucked. By the way, Jepson, what is the latest news about International Consolidated?

Jepson: It is strangely difficult to get wind of their doings, Mr. Stockton; but I heard it rumored this noon that our competitors, the Climax Co., have sold out to them at a ridiculous figure.

President: That is all, Mr. Jepson; you may go. [Aside.] Already the wolves are howling in the distance!

[Curtain]

Scene 6. Board room of the International Consolidated, New York City. Time, two years later. Curtain rises on the 16 directors and guiding spirits seated about the mahogany table, smoking perfectos and fingering diamond fobs. A large number of them appear to be foreigners, and the remainder are recognized as unscrupulous wolves of the financial district. The chairman of the board, Howard U. Skinnem, rises to address the gathering.

Skinnem: Gentlemen, we may congratulate ourselves on a most successful period. The past six months leave nothing to be desired by the most expectant among us. We have not hidden our talents in a napkin; we have used them, and they have produced tenfold. Those of us who six months ago were worth a million are now worth ten. Nothing that I can say to you will speak more eloquently of our progress than the report of our secretary, Mr. O. I. Bleedem, who will now take the floor. [Grunts of satisfaction.]

Bleedem: I have to report, gentlemen, that during the preceding period of six months 1233 manufacturing plants went into bankruptcy. Of these, we acquired the 207 which were important enough to interest us, at a total expenditure of less than half the physical inventory. In addition to this, we obtained through other methods, of which Mr. Bludgeon is in charge and with which you are familiar, 74 plants representing an annual going business of $478,000,000 at an expenditure directly on them of a little less than one-quarter of that sum. Among these, you will be delighted to hear, is the Cleveladelphia Manufacturing Co., which has fought us tooth and nail during the last two years. The itemized list of receipts and expenditures you will find on the printed sheet in front of each one of you. It will be unnecessary for me to repeat these figures, but I will be pleased to answer questions relating to any individual items.

Chairman of Board: Mr. Abel Grinder wishes to address a question to you, Mr. Bleedem.

Mr. Grinder: I notice a considerable fund that has been expended in the conversion of various minor legislators and public officials to the metric system and to spreading a sentiment for its adoption prior to the enforcement of the law. I also notice various funds paid to our secret-service bureaus to determine and bring to prosecution violations of the metric law. But it appears to me that you must have overlooked one large item, Mr. Bleedem, for I see no figures of disbursements to the eminent scientists who so enthusiastically aided us in securing metric legislation.

Mr. Bleedem: Set your mind at rest on this point, Mr. Grinder. The most effective aid of these gentlemen cost us nothing and was in fact unwitting on their part. They were simply riding a hobby, and a scientist riding a hobby is deaf, dumb and blind. We simply fed the horse, kept the course clear, and they won the race.

[Curtain]

Scene 7. Private dining room in a large New York hotel catering to millionaires and diplomats of foreign extraction. Time, two hours after the close of the International Consolidated directors' meeting. Seated about the table are a number of the directors of the Consolidated, but it is conspicuous that no Americans are among them. An elaborate banquet is being held in celebration of some event eminently pleasing.

First Director, rising with his wine glass in hand: Gentlemen, I will propose a toast, "Our homeland!" [All rise enthusiastically and drain their glasses.] In another

six months, my friends, all will be ready. This hated country, so proud in its industrial might, will lie as helpless as did Samson to the Philistines. Already we are in control of the best of its industries—those which have survived the uprooting cataclysm of a universal change in standards. The remainder we will throttle at our will. And who then will compete with our homeland?

Second Director: These statesmen in this country—how ridiculous it has been to hear them preach national defense, to see them build forts and battleships! And yet how easily they permitted us to conquer them at one blow—the passage of our metric bill. We have conquered America without firing a gun, and henceforth the Americans will be our industrial vassals. I drink to the diplomacy of the homeland, which has brought about the suicide of our enemy, thus giving us a bloodless victory!

[Curtain]

Grinding in Theory and Practice

By Robin Duff

When a man thinks he has discovered some new and interesting facts regarding grain, grade, speeds and feeds, either through practice or by observation, and then looks back over his references, he usually finds some general statement that covers the case. A repetition of this experience leads him to believe that although the subject is almost new there is nothing *really new* about it. Each article on the subject is full of generalities that may mean a lot when analyzed, but only to a person of experience. One of these general rules of conduct in grinding can cover a wide range of meaning. To write anything on grinding-wheel action is a sort of plagiarism, because the thing had been said or printed somewhere before.

Yet the farther along you go and the more experience you gain in grinding the more convinced you become that the subject can only be dealt with in generalities. Each operator himself must learn to determine in which direction to work if the wheel becomes glazed, or loaded, or shows chatter marks in the work, or transfers scratches to the piece, or does not give a warrantable production, or a combination of these things, and several others.

Personal Experience Counts

You can teach him to run the machine, you can give him a list of wheels that may possibly fit any ordinary case, and you can teach him such rules as "decreasing work-speed makes the wheel act as though it were harder," etc., but you cannot tell him specifically that a piece of work of a known material, of a given diameter and a certain amount of stock to remove, requires a wheel of a positive grain and grade, a work-speed of a certain peripheral feet per minute, a definite depth of cut and an exact traverse speed. He must learn these things through personal experience. To attempt to teach him to grind is like trying to teach him to play a harmonica—you can show him how to twist his tongue and how to blow. The rest is easy when he knows how.

Grinding conditions in themselves are so distinct from other machining operations, and the combination of altering variables is so confusing, that the whole subject has been practically left out of the realm of mathematical calculation. Even the changes in the composition of grinding wheels have been left to the suggestions of practical application rather than to anything mathematical. The fact that problems have been solved by the medium of sight, sound and touch has limited to a marked degree all efforts in which these human elements are the boundaries. Yet the results attained have been wonderful, and nothing derogatory can be said of the masterful minds that are working daily to achieve things in the grinding-wheel industry.

The Chip per Tooth Theory

A friend of mine was one of the first to accept and apply the theory that the thickness of the chip per tooth in milling is a deciding factor in determining the number of teeth in a cutter; and from this the proper speeds and feeds. He also reasoned that the same chip per tooth theory might also hold good in grinding, for determining the number of cutting abrasives in a wheel and also the feeds and speeds. In this way he thought that the operation of grinding might be made more scientific. He was quite enthusiastic over his discovery.

I let him rave, because I knew he would come out at the same door he entered. But, nevertheless, his reasoning sounded fairly good, on the surface. I had previously had the same hallucination myself.

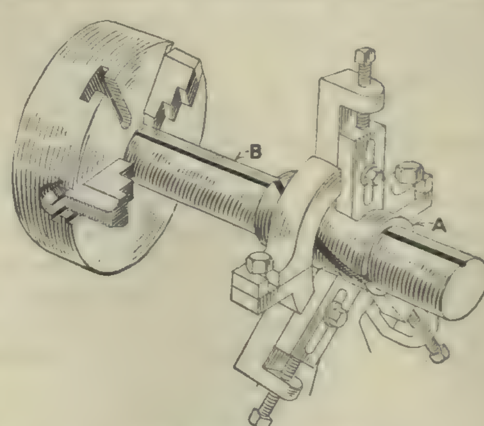
He went into all the points that have to do with grinding and worked them out in theory so you could give definite speeds, feeds, wheel, depth of cut and all the rest. He finally gave up trying to convince me, but in the back part of his head he is holding his idea in reserve, and some day he is going to go through a lot of foolish tests. I know the symptoms because I have done some foolish things myself in the grinding line.

Running Keywayed Work in the Steadyrest

By Walter Gabriel

The following method was used with great success when running the keywayed piston of a subpress die in the lathe steadyrest:

The bushing *A* was bored out 0.002 in. smaller than the outside diameter of the piston *B;* then the outside



THE SPLIT BUSHING

was turned 0.250 in. larger than the hole, leaving a wall 0.125 in. thick. The bushing was then cut to 1⅛ in. in width.

After the bushing was slotted through, at an angle of 45 deg., it was sprung onto the piston and provided a satisfactory bearing for the steadyrest.

Using the Electric Welder on Parts for Automobiles

By Robert Mawson

SYNOPSIS—Spot-welding operations on automobile parts including the battery box, floor plate, muffler cone, fender and some carburetor parts. The times required to perform the various operations are given and the thickness of the steel welded.

In the manufacture of automobile parts the spot welder is being employed to advantage by the Reo Motor Car

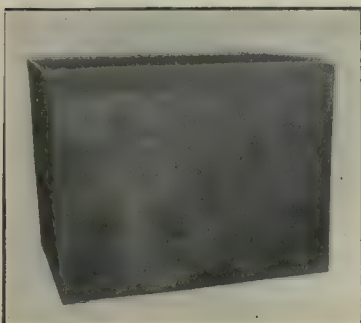


Fig. 1

Fig. 2

FIGS. 1 AND 2. THE BATTERY BOX BEFORE AND AFTER BEING SPOT WELDED

Co., Lansing, Mich. Winfield and Detroit electric spot welders are used.

In Fig. 1 is shown a battery box that has been formed to shape prior to the spot-welding operation. This box is made from 0.031 in. (No. 22 gage) steel. The four hangers are then welded onto the battery box as shown in Fig. 2. In this operation 16 spot welds are made and the time required is 1 min.

Welding Brackets on Floor Plates

Two brackets are spot welded onto the floor plates during the process of manufacture. The plate is first blanked and punched to shape and the brackets blanked

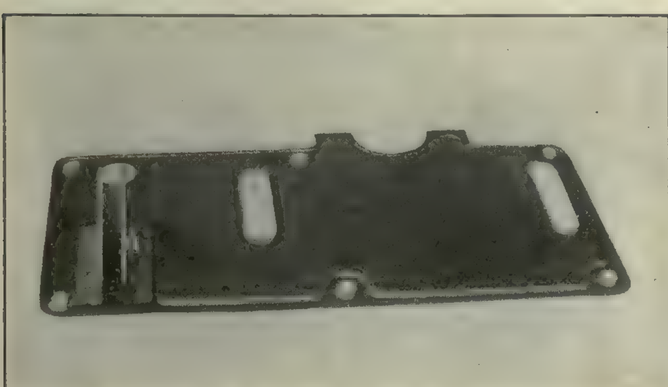


FIG. 3. WELDED BRACKETS ON FLOOR PLATES

and formed at an angle. The first bracket *A* is then attached to the floor plate with three spot welds, one edge being brought against the beading as shown. A distance gage is then placed against the welded bracket.

The second bracket is then put against the other face of the gage and welded to the floor plate with three spot welds. The floor plates and brackets are made from 0.109 in. (No. 12 gage) steel. The time required to weld on the two brackets is 1 min. (See Fig. 3.)

In Fig. 4 are shown three of the parts used in the construction of the muffler. At *A* is shown the muffler pipe, which is made from 0.0375 in. (No. 20 gage) steel. This part is made with a lap joint, as shown, and 18 spot welds are used to fasten the joint in position. The aver-

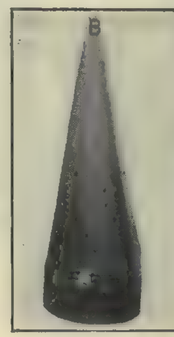


Fig. 5

Fig. 6

FIGS. 5 AND 6. SPOT WELDING AS USED ON A MUFFLER CONE AND ON A FENDER

age time required is 2 min. A muffler band is shown at *B*. After the piece has been rolled to shape, the joint is made with three spot welds. This band is made from 0.031 in. (No. 22 gage) steel. The time required for the spot-welding operation on the muffler is ¼ min.

The part *C*, Fig. 4, is the muffler exhaust pipe. The operation performed on this is welding the flange to the pipe. The flange is made with a short pipe at right angles to the flange base, which fits inside the pipe *C*. The two pipes are then spot welded, thus fastening the flange to the pipe. The flange and the pipe are made from 0.050 in. (No. 18 gage) steel. The time required to unite the two parts by the spot-welding operation is about 2 min.

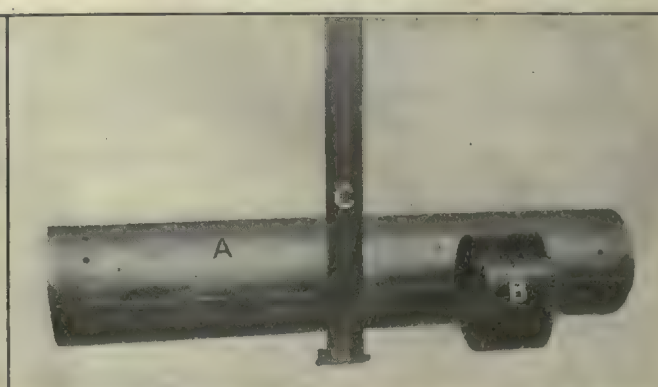


FIG. 4. WELDED MUFFLER PARTS

When manufacturing the muffler cone, Fig. 5, the sheets are first cut to length, perforated and formed into shape. The upper part is then slid into the lower and the two are united by means of spot welds at *A*. As

shown the cone end B has been closed by spot welding. The cone is made from 0.0375 in. (No. 20 gage) steel and in producing the finished part shown 40 spot welds are used. The time required is ¾ min.

The spot welder is also being used to advantage in the manufacture of fenders. In Fig. 6 is shown a fender after the welding operation. The bracket iron A is welded on the fender; the end B, after it has been bent over, is also spot welded. The skirt C is also attached by means of spot welding. The fender is made from 0.0375 in. (No. 20 gage) steel and about 30 spot welds are used in its construction. The time necessary to make these welds is ¾ min.

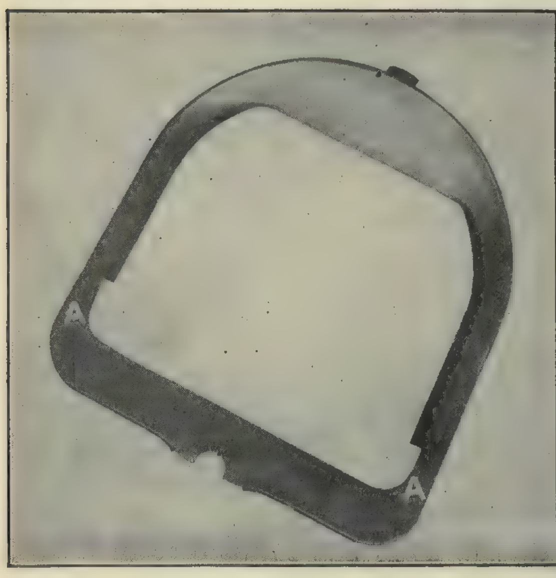


FIG. 7. THE SPOT-WELDED RADIATOR CASING

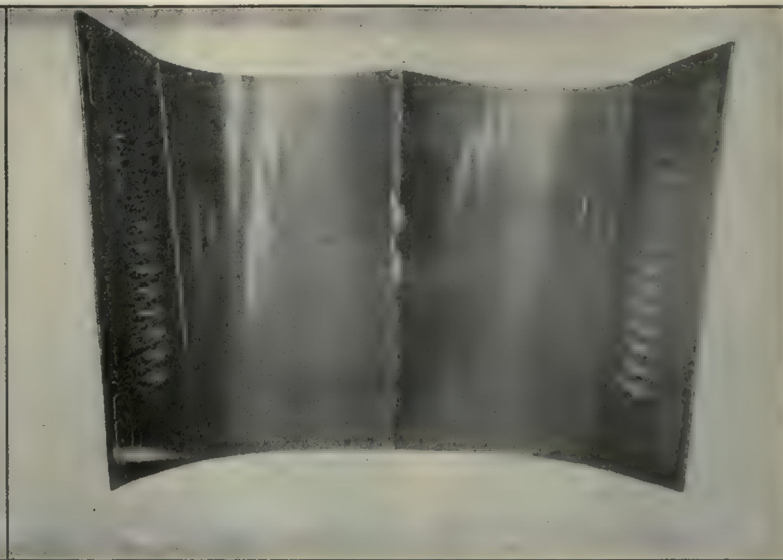


FIG. 8. SPOT WELDING ON THE HOOD

In Fig. 7 is shown one of the radiator casings, which is made in two parts and then united by means of welding. The thickness of the metal is 0.0375 in. (No. 20 gage) and four welds are made along the joints A. The average time required to weld one of these radiator casings is 2 min.

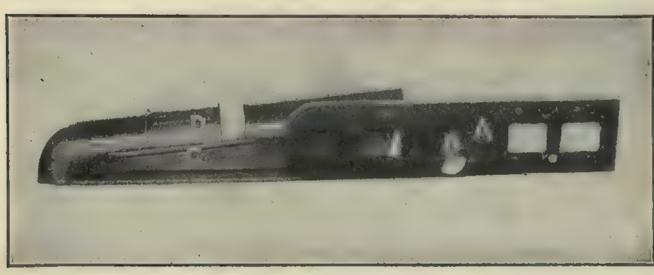


FIG. 9. WELDED CARBURETOR SLEEVE AND BOTTOM

When attaching the hinges to the hood the spot welder is used instead of rivets. The result is a much neater product in appearance, and the operation is performed more quickly. The hood is made of 0.0375 in. (No. 20 gage) steel and eight spot welds are used. The time required is 2 min.

One of the hoods, after the hinges have been welded on and the four parts fastened together with the hinge pins, is shown in Fig. 8.

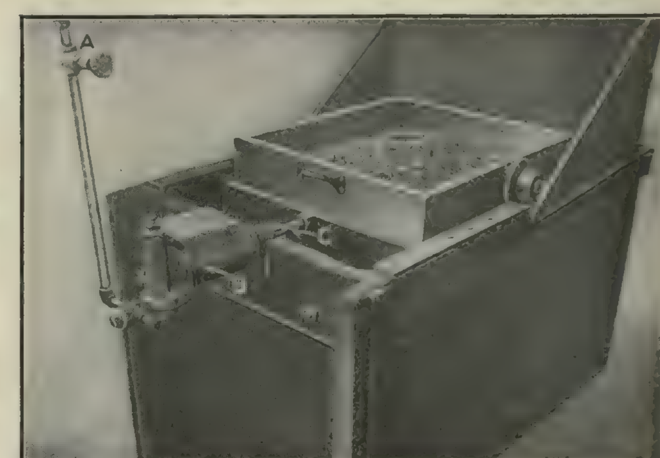
A carburetor sleeve bottom is shown in Fig. 9 at A. The short pipe B is attached to the bottom by means of spot welding. The short pipe is made with a flange which comes against the face of the sleeve bottom, thus enabling the short pipe to be held in place as the two surfaces are united by spot-welding operation. To the left of the sleeve bottom is shown a carburetor sleeve on which the slide guide C is spot welded. One of these guides is welded on each side of the carburetor sleeve, so the slide D may be moved to any desired position. These two parts—sleeve and bottom—are made from 0.0375 in. (No. 20 gage) steel. Twenty-two spots are used in the welding operations to produce the parts as shown. For the spot-welding operation approximately 4 min. are required.

A Handy Chip Separator

By A. Towler

The illustration shows a chip separator that has been built, and is now in use, in the factory of the Wheeler-Schebler Carburetor Co., Inc., Indianapolis, Ind.

In this device the chips are placed in the wooden box, which is provided with a mesh-wire bottom. Compressed



THE CHIP SEPARATOR IN POSITION

air is admitted at 60-lb. pressure through the pipe A to the air cylinder B. This cylinder is 2½ in. in diameter and has a 4-in. stroke. The plunger is attached to the box by means of a rod, as shown at C. The air forces the box back and forth, thus shaking out the chips.

Organizing a Time-Study Department*

By Dwight V. Merrick†

SYNOPSIS—Outline of the work of a time-study department and a typical organization. The best time-study man is one who has had considerable shop experience. Methods are shown for keeping track of the work in a time-study department.

In order that time-study work represent real value to a manufacturer, it should be handled in a systematic manner and should be carried out by a distinct department. No greater mistake can be made than to treat time study as of relatively minor importance or as something to be done when there is nothing more pressing on hand. Time study, when carried on in a haphazard manner, as opportunity offers, is a sheer waste of money and is far more likely to do harm than good. The manufacturer who does not intend to give the time-study department of his organization his full and cordial support and allow it to devote itself to its work in a manner that will enable it to achieve worth-while results had better let time study alone.

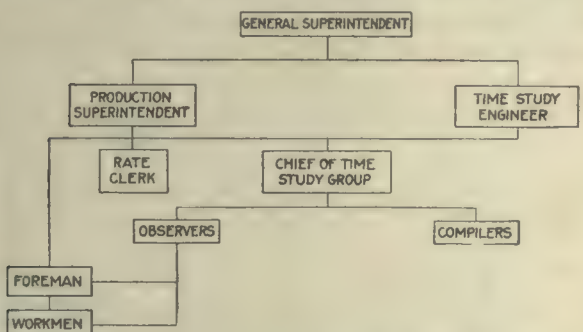


FIG. 1. THE ORGANIZATION OF A TIME-STUDY DEPARTMENT

When contemplating the establishment of time study, the manufacturer should make up his mind that the man or men who will handle this work shall give their entire attention to it. The smallest shop will have enough time-study work to keep one man busy at least six months, in making studies and analyzing them, preparing instruction cards, setting rates, checking his studies and instruction cards by means of production studies and indicating improvements in methods and tools that the time studies will reveal to be necessary.

The results and economies that will be attained from the studies will warrant this one man devoting his entire time to them, unhampered by any other duties of production or otherwise. In larger shops, the variety and volume of work may easily require the services of a large number of men, in which case it will be profitable to effect a departmental organization. The organization of such a department will be described in detail a little later.

The work of a time-study department, whether it consists of one man or forty, comprises: (1) The taking of machine-, hand-tool or operation time studies; (2) the analysis of these studies and the fixing of minimum times; (3) the determination of delay allowances for the several classes of work; (4) the setting of piece rates or tasks from the time studies; (5) the preparation of instruction cards, showing how the work can be accomplished within the time as determined by the time studies; (6) the making of production studies to verify the time studies, or to discover errors in procedure on the part of the operators, or improper performance of the machines; (7) the discussion with the production or manufacturing department of improvements in tools and fixtures and of shop practice, that the time studies may show to be advisable.

Before beginning the time studies, a careful survey of the work of the establishment should be made to determine the character that the time study should assume; that is, whether the time-study department should devote itself to operation studies or to machine- and hand-tool studies, as defined in the first article, page 221, or to a combination of the two. In general, if the product of the factory consists of standard interchangeable parts, produced by a series of repetitive machine or hand operations, operation studies will be indicated as most desirable. For example, typewriter and small-arms manufacture lend themselves admirably to operation studies. On the other hand, if the product is of a variable character, few jobs being the same, machine studies will probably be productive of the most profitable results. Within this latter class will fall most machine-tool work, hoisting and conveying machinery, steam engines, etc., and heavy work in general. If a portion of the product is standard and the remainder variable, it may prove profitable to begin with operation studies on the standard portion of the product. From these operation studies there will probably be available many machine data, which can later be supplemented by the necessary machine- and hand-tool studies to give complete information regarding all the work that the factory will be called upon to do. The primary rule to be followed is that that work should be started first which will make the largest hole in the job. It is essential that the time-study department be made to pay for itself at the earliest practicable moment.

21301 CAM SHAFT BEARING CAP GROUP E25AA									
1	2	3	4	5	6	7	8	9	10
11/6/16 11/7/16	11/7/16 11/8/16	11/8/16							

FIG. 2. WORK CARD FOR ASSIGNING STUDIES TO THE OBSERVERS

*Copyright, 1917, by Edward W. Clark, 3rd, executor of the Estate of F. W. Taylor.

†Consulting engineer, New York City.

Note—This article is the third by the same author dealing with the general subject of "Time Study for Machine Tools." Other articles of this series appeared on pages 177, 221 and 269.

The time study should be under the direction of an engineer who has had considerable experience in this work. In the small shops, this engineer may be the entire department and will take and analyze his own observations. In the larger shops, he will make comparatively few observations but will devote his energies to the training and directing of the work of time-study men, who will take the studies, analyze them and draw up instruction cards therefrom. The studies should all be approved by the engineer, whose experience will enable him to judge of their accuracy and to decide upon the justice of the rates set from them. The function of the engineer will also include the determination of the character of the studies—namely, operation or machine—and the laying out of the schedule of studies so that they will be productive of profitable results in the shortest time.

Another function of the time-study engineer is the revision of methods that the time study may show to be advisable. For instance, to select a rather obvious case, on a boring mill one head may be used for rough turning on an outside diameter while the other head is taking a rough facing cut on the upper surface of the work. In such cases, it will frequently be found that the workman will set both tools before starting either cut. It is feasible to first set the tool and start the cut on the outside diameter, and then without stopping the machine to set the tool and start the facing cut. Time studies of the two methods will show a considerable saving of time, due to the elimination of the second set of items of tool-handling time. The saving is, of course, evident without time studies, but the example illustrates the principle involved.

The Best Time-Study Man

The best time-study man, other things being equal, is one who is skilled in the trade that he is observing. It requires a comparatively short time to train an intelligent man to take observations according to the methods previously set forth. It does require, however, considerable judgment and experience for the observer to know whether or not the operator is using the best methods and doing work at his best average speed. Time studies taken under any other conditions are worthless. College-trained men with shop experience, as a rule, make excellent time-study men. Good mechanics, possessed of an analytical mind and a willingness and ability to study, are also first-class material. Such men, after a year or two of time study, are fitted to take responsible positions in the production department, since their time-study experience will give them the most thorough knowledge of methods, rates and possibilities of the shop. The time-study engineer has few functions that are more important than the selection and training of these time-study observers.

In the shop where the time-study engineer is the entire time-study department, he should at the earliest practicable moment decide upon and begin the training of his successor. The thoroughly competent time-study engineer is too valuable and should be too high-priced a man to be kept constantly at the taking and analyzing of observations. If he is to be a permanent part of the factory organization, he should soon be graduated to a position of larger responsibility. If he is only temporary, and therefore more expensive, he should be enabled to organize the time-study work and train men to carry it on, so that he can be relieved and the expense of the work reduced as soon as possible.

The following is a description of the time-study organization of a factory employing several thousand hands and involving both wood and metal working. The department is under the direction of an engineer who gives his attention exclusively to it. He reports directly to the general superintendent and issues his instructions to the shop as to methods and rates through the production superintendents in charge of the several departments. An assistant, or time-study supervisor, reporting to the engineer, is in direct charge of the time-study observers and computers and is provided with a stenographer to assist him. The engineer decides, in consultation with the production superintendents, the studies that are to be taken and in conjunction with his assistant determines the sequence in which the work shall be carried out. The assistant assigns the studies to the several observers, and the computation of them to the computer, and after analysis fixes upon the minimum selected times and the allowances as shown by the studies. He also, in conjunction with the engineer, determines finally the standard method for each job and draws up the instruction card, which is then prepared by the stenographer for issue to the shop.

The observer, having taken the studies assigned to him, turns his observation sheets over to the computer, who takes differences and ascertains the individual time for each element of the study. The studies are then returned to the observer who eliminates the abnormal items and

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PART PROGRESS SHEET

1 SHEET — NO. 1

SHOP ______ DATE ______ 191__

PART 21801 CAM SHAFT BEARING CAP GROUP E25AA

SIZE OF LOT 200

Time Observation Taken DATE	Time Observation Worked Up DATE	Instruction Card Prepared DATE	Instruction Card In Operation DATE		Operation No.		Location	Mach. No.				Remarks
					1	Assem. Bushing to Cap	D3M	315V				
					2	Drill for Pins and Oil holes	D3M	108				
					3	Pin Bushing and Ream	D3M	313V				
					4	Face and Turn Cap	D81M	21S				

FIG. 3. THE PART PROGRESS SHEET WHICH FORMS THE RECORD OF TIME STUDIES ON A SINGLE PART

hands the studies once more to the computer to determine averages, deviations and minimum selected times.

This work being completed, the observer then makes up the summary sheet that forms the basis of instruction cards. In making up this summary, unnecessary elements and false moves on the part of the workman that appear in the time study are eliminated, and the standard practice for the particular operation under study is formulated. Operations performed on a group of pieces are prorated to the individual piece at this time.

The summary as completed by the observer shows the selected minimum, or ideal, time of the operation. The time-study supervisor then takes the study in hand and checks it to make sure that deviations and minimum times are correct and that the standard of practice as laid down by the summary cannot be improved. Having satisfied himself as to these points, the supervisor adds the allowance for machine and personal delays, etc., and fixes a rate for the job. Next he causes the study of the operation to be repeated for a few cycles to assure himself of the correctness of all the previous work. This checking is quite practical in connection with operation studies. It cannot always be done, however, in machine- or hand-tool studies. In such cases, studies may have to be checked after rates set from them are in operation, and at times it may be necessary to make corrections in the studies. Verification of the study having been made, the supervisor passes the study to the time-study engineer for approval. Upon its approval by the engineer and also by the production superintendent of the department in which the study was taken, the summary is sent to the stenographer, who copies it in the form of an instruction card for the shop.

Keeping Track of the Work

In the time-study department we are examining, the work is laid out and assigned to the men by means of a planning box, or bulletin board, similar to that used for operators' job cards in the shop. The planning box consists of several groups of card pockets, three pockets to the group. These pockets are labeled respectively, "Jobs Ahead," "Observations Being Taken," "Observations Being Worked Up." One group of pockets is allotted to each man in the department, and in it, in the appropriate pocket, are placed the work cards of the various jobs assigned to him, these being transferred from pocket to pocket as the work progresses through the various stages.

In the "Jobs Ahead" pocket are placed the cards calling for studies of the operations on the different parts of the product. These cards are arranged in the pocket in the sequence in which the studies are desired, and by reference to them the time-study observer can tell exactly what work he is expected to do next. When he proceeds to take a study, he transfers the card from the "Jobs Ahead" pocket to the "Observations Being Taken" pocket. When the observations are completed, and the study is being worked up, the card is transferred to the third pocket, showing to the one in charge of the work that the study has been taken and that the computations are under way.

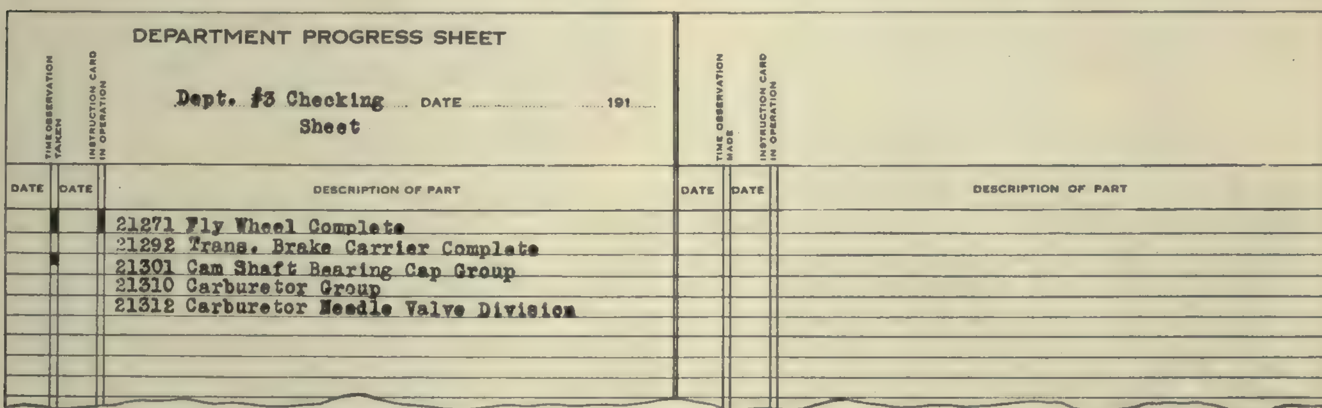
Use of the Records

The work cards are ruled as shown in Fig. 2. The information given by the card comprises the name of the part, the shop in which it is machined and the numbers of the operations, arranged in the sequence in which they take place. Reference to the progress sheets will inform the observer which of the operations on the part called for by any particular card are ready for time study. The observer fills in with pencil half of the space between the double lines at the top of the space immediately below the operation number when he begins the study, and transfers the card to the "Observations Being Taken" pocket. (See operation 4, Fig. 2.) When the observations are completed, he fills in the remainder of the space between the upper double lines and writes the date below it. (See operation 3.)

Similarly, when the studies are being computed, the space between the lower set of double lines is half filled at the beginning of the work (see operation 2), and completely filled in and the date written in when the computation is finished. (See operation 1.)

At the end of the day all the cards representing jobs that were worked on during the day are deposited in a "Jobs Today" box. They are collected from this by the stenographer and the progress of the work checked on the progress sheet, after which they are redistributed to the planning box, thus assigning the work for the following day.

The part progress sheet that covers the work of the time-study observers and computers is shown in Fig. 3. One of these sheets is allotted to each part, and the various operations on that part are listed as shown. When a study is assigned to an observer on a particular operation, the space opposite that operation and between the


DEPARTMENT PROGRESS SHEET

Dept. #3 Checking Sheet DATE .... 191....

Time Observation Taken: Date	Instruction Card in Operation: Date	Description of Part	Time Observation Made: Date	Instruction Card in Operation: Date	Description of Part
		21271 Fly Wheel Complete			
		21292 Trans. Brake Carrier Complete			
		21301 Cam Shaft Bearing Cap Group			
		21310 Carburetor Group			
		21312 Carburetor Needle Valve Division			

FIG. 4. RECORD OF TIME STUDY IN AN ENTIRE DEPARTMENT

double check lines entitled "Time Observations Taken" is filled halfway down in pencil. When the study has been completed, the remainder of the space opposite that operation is filled. Similarly, when observations are assigned for computation, the fact is indicated by a half-check, which is completed when the computations are finished. The preparation of the instruction card and its putting in force are similarly noted on the part progress sheet, being entered in the proper spaces in each case.

These entries are made on the part progress sheet by the stenographer, who obtains her information from the cards that are filed in the planning board. The progress sheets enable the condition of the time-study work on any particular part of the company's product to be determined at a glance. If all the operations on any part have been time-studied and instruction cards therefrom put in force in the shop, the several check columns on the part progress sheet will be filled with solid black lines. If part of the operations have been studied, a white space left in the check column will indicate instantly which operations remain to be studied. Half-check marks show that a study on an operation has been started but not yet completed.

The Department Progress Sheet

Fig. 4 illustrates a somewhat similar progress sheet, used to keep track of the time-study work of a shop department. One or more such sheets are used for a single department. In the column entitled "Description of Part" are listed the names or symbols of the several parts manufactured in that department, each of which has a separate part progress sheet, Fig. 3. As the time study is completed on any part, as shown by the check marks on the part progress sheet, the corresponding checking is made opposite that part on the department progress sheet. Thus reference to Fig. 4 indicates that department No. 3 manufactures five parts, and of these the time study is complete on part No. 21,271, has been started on part No. 21,301, and that nothing has been done in regard to the three remaining parts.

In the shop under consideration, the majority of the time studies are operation studies, and instruction cards for the shop are prepared directly from the summary sheets. If the nature of the product was such that machine studies would have been better suited to the requirements of the establishment, the procedure followed in the time-study department would be somewhat different. The work would be laid out as before by the time-study engineer and the observations made and computed in the same fashion. The part progress sheet instead of indicating operations on a portion of the product, would list the elementary operations that would be possible upon standard machine tools, such as a lathe, planer or boring mill. Studies would be made and checked on the part progress sheet exactly as would be the case were the studies operation studies.

Data derived from the studies, however, would be tabulated and filed according to the machine and to the class of work, and the instruction cards would be prepared from these tabulated data. It is in the writing of the instruction cards that the most radical change from the organization above described would take place. The time-study organization would necessarily be increased by the addition of an expert mechanic in the case of machine shops, who would possess to a high degree the ability to analyze drawings and to determine from them the best method of procedure in making the part called for by the drawing. The function of this man would be to reduce to writing his analysis of the method of doing the work, subdividing his instructions into as fine details as in his judgment would be considered necessary. The method having been laid out, the time required for the performance of each of the elements of the operation as indicated would be selected from the tabulated data and set opposite the respective elements. After totaling these items, the necessary allowances would be added and a rough instruction card then passed to the stenographer for preparation for the shop.

Hiring Men Away from Other Shops

By J. P. Brophy*

What kind of business do you call it when you send one of your good mechanics to educate the purchaser of your machines and, when your expert returns home, learn that he has been offered a position by the company you favored?

After educating him at considerable expense to the point of being an expert, you are forced to increase his wages beyond what he can earn—for you, at least—to keep him in your employ. The best way to treat such a case is to let him do as he pleases. I do not blame the man so much as I do the customer who fails to inform you that he would like your man's services, if you could possibly spare him, etc. Common business courtesy demands this kind of treatment among business people.

Reverse the case and see what happens. One of the men in your employ, holding a job of consequence—perhaps a foreman—informs you that he is leaving without giving any notice. You are furious at an act of this kind, but this foreman is an angel in comparison with the company that is guilty of stealing one of your employees.

Are we businessmen in this country becoming so unscrupulous that we will damage one another just for a few dollars? What seems to be the matter with our so-called fair-dealing men, if they entertain the impression that such an act is justifiable? It is certainly demoralizing from a business standpoint when your employee returns and, without even consulting you, unhesitatingly spreads the news that he has been offered another job at higher wages with a concern to which he has just been sent for the purpose of setting up a machine, or some other similar work.

Sending one of your experts to assist in educating those who have to operate your machines is generally embodied in the contract. You send one of your best men, and you are not sure whether or not your customer will offer this man a position. This is exasperating, because it often happens that men have to be sent to the same place more than once, because incompetent help are operating the machines. In doing your customer a favor in such an instance you are likely to be doing yourself an injury.

Is it reasonable or honorable for your employee, while away from home, to accept a job, if one is offered him, without consulting you? Does the company where your expert is demonstrating, which ignores your existence and induces your employee to enter its services, deserve condemnation?

*General manager, Cleveland Automatic Machine Co.

Blanking, Piercing and Forming Tools for a Typewriter Part

By Frank A. Stanley

SYNOPSIS—These tools form three angular lugs on a long blank, cut away the greater portion of the interior of the blank, bend the work to an arc of a circle and fold down the three lugs to a right angle, at the same time striking up two beads, or shallow ribs, the entire length of the piece to stiffen it against accidental deflection in surface.

The press tools shown herewith are used by the Noiseless Typewriter Co., Middletown, Conn., in the manufacture of a sheet-metal part known as the universal bar. This part is 9⅜ in. long and is bent up to a quarter circle of 5⅜-in. radius, as shown in Fig. 1. It has three lugs or arms projecting from the lower edge, which are offset in the blanks and then bent around at right angles to the body of the bar itself. It is made from sheet-steel stock 0.040 in. thick, and one piece is required for each typewriter.

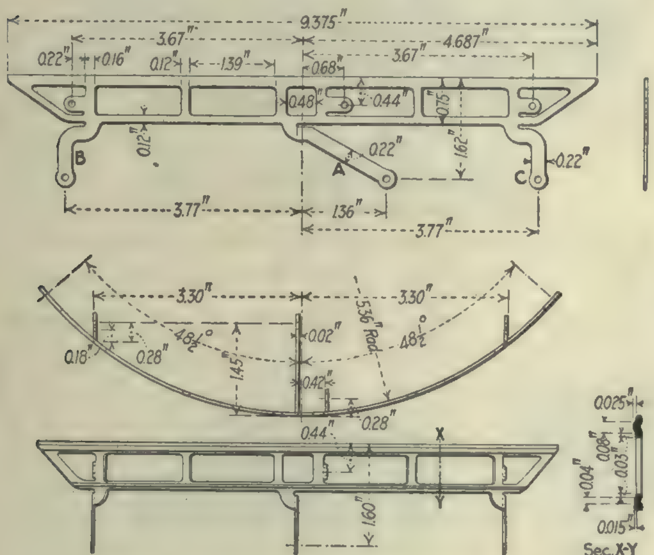


FIG. 1. DETAILS OF UNIVERSAL BAR

Figs. 2 and 3 illustrate the blanking tools used in the production of these sheet-metal parts. The die is of simple construction, and the punch is of a form requiring little explanation in detail. However, the length in proportion to the width of the projecting portions that form the lugs on the blanks is such that a considerable degree of care and judgment was necessary in machining and hardening these tools in order to prevent a degree of deformation which would make the punch work improperly in the die. Both punch and die are mounted upon heavy blocks, the bolster for the die being of the standard form and dimensions utilized in this factory for a good share of the press tools.

The proportions of the die proper will be seen in Fig. 2, which shows the layout as indicated by the opening in the stripper and also the width of the stock guide slot in the under side of the stripper. The dotted lines in the top of the plate show that the width of the guide is sufficient to admit stock wide enough for two rows of blanks, so that the material is reversed for the second passage through the press and there is very little waste along the edges of the strip of stock or between the projecting lugs.

The second die, Fig. 4, is used for punching out the seven openings. In this process a greater portion of the material is cut away. The work is shown at the front of the die. It will be noticed that there are also six round pierced holes in the lugs. As a matter of fact, this piercing operation is performed in a subsequent process, the blank being shown here in this condition to indicate its appearance before twisting of the lugs occurs.

These dies, like the blanking tools shown, are simple in construction, although they have been laid out and finished with great care to assure satisfactory operation under the punch press. In working material of this thickness, where such narrow portions of the stock are left as are indicated in the illustration, it is important that the material shall have no opportunity for creeping under

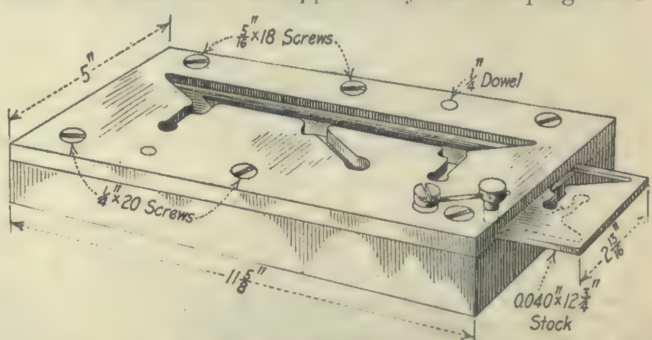


FIG. 2. THE SLOTTING DIE

the punching action of the tools. Otherwise, the edges become deformed, the inner openings formed by punching out the stock become twisted, and the job is generally unsatisfactory.

Piercing Six Holes at Once

Referring to Fig. 5, the press tools at the left perform the operation of piercing the six holes in the blank. Here, a sectional construction is used, as indicated. The work is nested under the stripper plate, against suitable end stops and back stops, and is thus retained against movement during the downstroke of the punch. The latter has a block that is provided with corner posts, thus making a pillar-die construction. As will be seen, the small piercing punches are all carried in sockets sufficiently large to assure stability of the punches and prevent their deflection under the action of piercing this 0.040-in. piece of stock. Each of the punch members, as shown, is fastened securely to the block by fillister-head screws and an adequate number of dowels, while the holders for the piercing punches are located outside of the punches proper in holes laid out, accurately indicated and bored in correct positions on the faceplate of a lathe.

The tools at the center in Fig. 5 are for forming the blank up to an arc of a circle and bending down the middle lug or arm nearly halfway to its right-angle position to the body of the blank proper. For this operation

the work is nested against a stop at one end. The punch in descending with its curved lower contact face forms the blank down into the curved seat on the top of the die, the projecting hub or pilot at the middle of the punch engaging with the square opening at the middle of the length of the work, thus preventing the work from traveling either or deflected in action. The stiffening ribs, although shallow, are sufficiently deep to add materially to the strength of the parts and greatly increase the resistance to any forces tending to open the arc out toward a straight line or to twist the curved portion about its major axis. The use of ribs in this way forms a convenient method of

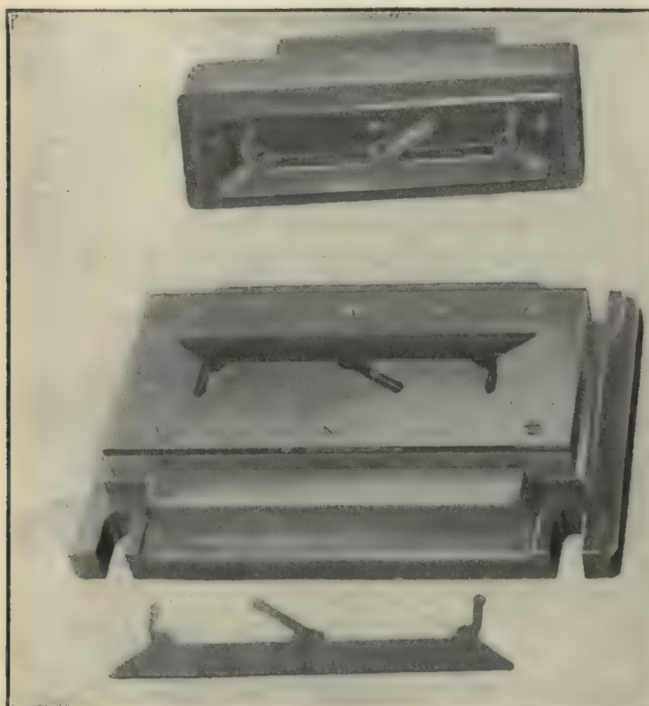


FIG. 3. THE BLANKING TOOLS

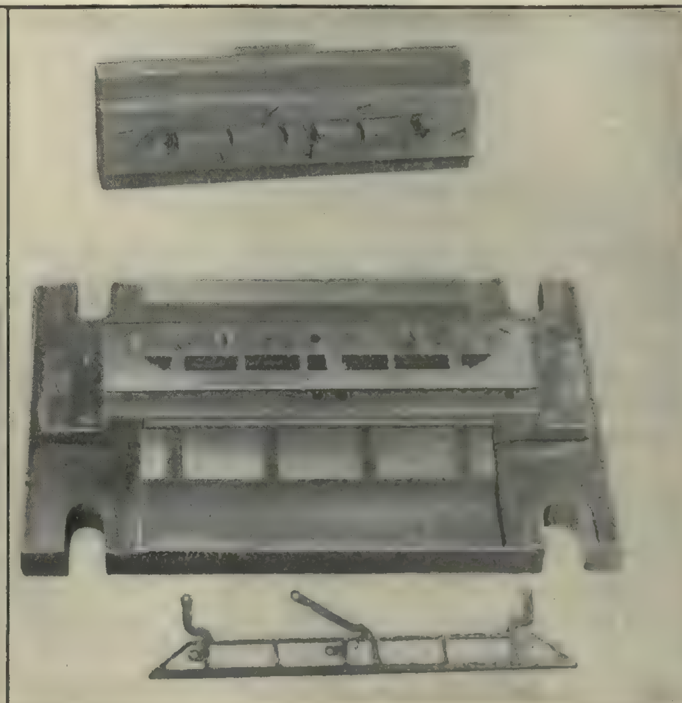


FIG. 4. THE DIE FOR SECOND OPERATION ON BLANKS

FIG. 5. DIES FOR FORMING UNIVERSAL BAR

to the right or the left. Looking closely at Fig. 5, it will be seen that there are stop lugs at both the back and the front of the die to make of the latter a suitable nest in which the straight blank will rest securely during the downstroke of the press, under which it is transformed into the curved article.

At this same setting the two grooves, or beads, running longitudinally the full length of the work are formed up to stiffen the job so that, when bent to the arc of the circle, there will be little likelihood of its being twisted strengthening sheet-metal work without increasing the weight and adds practically nothing to the cost of manufacture, as the forming of the grooves, which also form the beads, or ribs, on the opposite side, is done at the same stroke of the press as the body of the piece is bent to the arc of the circle and the central lug bent halfway down.

The tools at the right, Fig. 5, are the most interesting of the group in this view, and details of them will be seen in Fig. 6. It will be noticed that here the work is nested upon the convex face of the lower die, and on this die block

it rests between a pair of pins at the back and two adjustable stop screws at the front. Midway of the width of the die will be seen a vertical offset portion *F* that forms the bending corner over which the middle lug *A*, Fig. 1, is bent around to a true right angle to the tangent line to the universal bar. The lugs at either end, *B* and *C*, Fig. 1, are bent down to a position parallel to the central lug *A* by the two punch members attached at the right- and left-hand sides of the punch block.

Referring again to Fig. 5, it will be seen that the concave block *F* is arranged to act as a pressure pad to hold the blank temporarily during the descent of the press ram, while the punch members *D*, *E* and *G* fold down the three ears or lugs to the right-angle position. The movement necessary after the pressure block seizes the work is about 3/8 in., and this is allowed for by the com-

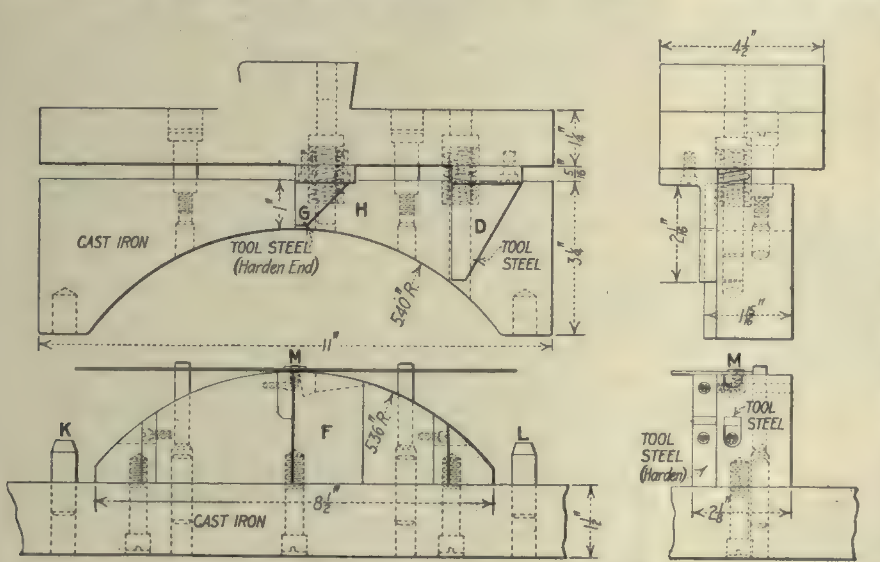


FIG. 6. FORMING DIE FOR UNIVERSAL BAR

pression springs seated between the block *H* and the main punch block, as shown in Fig. 6.

It should be noticed that on the downstroke of the press the first thing that happens is for this pressure pad *H* to drop over the pilot pins *KL*, so that here again a subpress form of action is obtained in that at the moment of operating upon the blank the punch and die are piloted and guided together by the pillars, or pins, at either end.

The two punch members *D* and *E*, only one of which is shown in Fig. 6, but both of which are clearly visible in Fig. 5, are in the form of angles with stiff uprights and bases, the latter having two substantial screws and a pair of dowels, by which each part is secured to the punch block.

Similarly, the central bending punch *G*, Fig. 6, is made with a right-angle base and secured by a pair of screws and dowels. This construction enables the part to be fitted up to the work conveniently and to be replaced in case any part should wear out or give way.

The position of the work endwise upon the lower blank when nested for the downward stroke of the press is positively secured against possible end thrust in either direction, due to the lateral pressure of the bending punches *D* and *E* by the pilot *M*. Upon the upstroke of the press the work is prevented from lifting with the die, due to the binding pressure between the inner faces of the bending punches *D* and *E* by a shedder operating between these punches and acting downward upon the work and holding it upon the convex upper base of the lower die.

Notes from the Backwoods—A Systematic Reaction

By W. Osborne

Jack and Aaron enjoyed going to the Foundrymen's Convention at Cleveland, and they valued the privilege of visiting some of the uptodate foundries that were thrown open to those attending the convention.

The salesmen who were there on behalf of the various foundry supply houses also took a kindly interest in Jack and Aaron and were careful to see that they were shown the latest and best models of improved foundry machinery. One of the machines that was new to them was the jarring molding machine, or so-called bumper. When it is shown that a machine can do in a minute what it has taken an hour to do in another way, and can do it better, it is no longer a question of whether one should get it or not. It is a question of whether one is going to be the first at it, and get the cream by being first, or whether one is going to wait and be forced to be progressive or go out of business. Part of this Jack and Aaron could see for themselves, and part of it they were helped to see. Such a machine was equivalent to an addition to the foundry without the necessity of putting up any more buildings, and it increased the output the same as if more molders were put on, and without adding to the pay roll. Are you surprised that Jack and Aaron went home with their heads full of plans for a larger and better business and that they left an order for one of the latest bumpers? The first thing that worried them after they got home was where to locate the new machine. It was a large machine, and it had to be set on a foundation that made it a permanent fixture once it was up. The boys were surprised to find how much the installation of a machine of that size could interfere with the present running of the shop, in any place that it could be set. They finally decided on a spot, but they both had a feeling that after it was too late to make a change they would wish they had chosen some other place. They talked over every available situation in which the machine could be set up, and always felt that they would be dissatisfied with any one of them. It ended by their choosing the least unsatisfactory.

Finally, the machine was received and set up, and it certainly did seem as if it took up a lot more room in this foundry than it did in the foundry where they had seen one at work.

The first patterns to be used on the machine were simple ones with flat backs, and they worked very well except that they showed that the air compressor was not large enough.

While the boys were preparing some split patterns for the machine, they made a trade of their air compressor for a larger one. When things were in running shape, it was found that there was not power enough to drive the larger compressor. After worrying along for some time trying to get out of trouble by speeding up their

gas engine, they bought a larger one, and when it came they found that they would have to enlarge their power house.

A representative of the firm that made the bumper called on them to find out why they did not want another, and he discovered that they were not getting the results they could get with proper effort.

He pointed out to them that their flask equipment was entirely too limited. To make a bumper pay, castings must be made in quantity; and, besides, flask and pattern equipment must be furnished to handle things. And a hand crane was out of the question.

The New Crane, Core Ovens and Cupola

A traveling crane was so clearly indicated that it had to go in, runway and all, and that had to be followed by an additional coreroom and new core ovens. And to use up nearly the capacity of the bumper and the new core facilities an addition had to be built to the foundry. It could hardly be expected that the little old cupola would now be big enough, so a large one was installed and with it an uptodate blower and a motor to run it.

All these things, and many other things not mentioned that naturally go with them, cost money. Jack and Aaron began to feel that they had a large proposition on their hands, and one that took a knowledge and experience they did not have. Their banker had begun to get uneasy. He had faith in their honesty and in their ability as workmen, but he could see that the proposition was getting out of the workman class. It was getting into the capitalistic class.

Organizing the Stock Company

He suggested that a stock company be organized, and said that he could get some men to take stock. It surprised the boys to see how many men had bought the stock and paid money for it when the company was organized. System that was all right when two boys were running a little foundry would not do at all for the needs of a corporation. Stockholders must be kept informed of the state of the business because of their investments in it. Officers must be kept informed so that they could properly manage it. Bankers must be kept informed if money was to be safely lent.

A thorough, uptodate system was put in, and it is working nicely. The company has grown to be one that the local newspaper points to with pride. The yearly statements are pleasing to the stockholders who put their money into it as an investment.

You may consider the results from the standpoint of Jack and Aaron, if you care to do so, and you can draw your own conclusions. They get fair returns from the stock they own, but they do not own a controlling interest. The system runs the business. Jack and Aaron are useful and necessary cogs in the machine, but not indispensable ones. There are numerous other useful and necessary cogs, and each cog must tend to its own function and not interfere in any way with the function of another cog. Even the cog that is known as the president is strictly confined by the system to a limited range of action. Should any cog fail to work properly, the system at once calls attention to the fact.

Perhaps it is unnecessary to say that it is not certain that a bumper will always produce the reactions this one started. In any case draw your own conclusions.

American Export Methods as Viewed by a Chilean Firm

In a letter to the consulate at Antofagasta a firm of Chilean importers makes the following criticisms of American export methods:

1. There is a lack of cheap freights and regular and frequent steamship connections. Vessels carrying the American flag could easily find paying return freights with nitrate cargoes.

2. The means for consigning shipping documents and discount of banking values are unsatisfactory. North American conditions of sale are, generally: Irrevocable credit in United States banks in favor of the manufacturer or exporter, deposited at the time of placing the order; 25 per cent. with order, balance against documents; cash against documents at port of shipment; or in special cases when the firm is well known, 30 days after receipt of documents consigned to a bank or steamship agent in this country. European conditions used to be 30, 60, or 90 days' sight drafts accepted on presentation of documents after arrival of goods at port of destination. The establishment of branches of American banking institutions would help North American exporters to obtain a better idea of the financial standing of customers in South America, and hence to offer more favorable terms.

3. Deliveries are long and uncertain.

4. Goods forwarded to South America have proved on some occasions to be inferior to quality offered. South American markets have been looked upon as not sound by the majority of North American exporters, and this disinterestedness has made it possible for some unscrupulous exporters to send to this country goods inferior in quality to the kind offered. These cases have been frequent enough to spread the idea that North American manufacturers cannot be relied upon. These circumstances have left the field open to European import in South America. Liberal selling terms, a knowledge of the requirements and financial capacities of their customers obtained by means of their selling or banking agents, and a quick adaptation to customs and needs of the trade have given European manufacturers a chance to penetrate these markets, excluding all other competitors.

5. Prices are usually higher than European. We do not refer to the actual prices corresponding to abnormal markets, but to those given to us before the outbreak of war. We understand that North American products are higher in price, owing to higher salaries, interest rates and freights.

6. There are no standing quotations. Another factor due to the war and the consequent uncertainty of markets is the practice adopted by American firms to quote prices "subject to change without notice." This is certainly a wise policy for their own security, but it leaves the importer without a basis upon which to work out his calculations of cost. At least a certain period should be allowed during which quotations are held firm.

7. Careless packing and marking and incomplete details on shipping documents are common.

8. There is a wrong idea in the United States that the Americans from the South are not "up to business" in the way the Americans from the North understand it. It is not rightly appreciated that local business routine differs in some instances from a North American point of view, and this should always be borne in mind.

United States Munitions*

The Springfield Model 1903 Service Rifle

Floor Plate—II; Floor-Plate Catch, Magazine Spring, Cutoff and Follower

SYNOPSIS—These are all the parts which go to make up the magazine and, while small, perform very important functions in connection with the breech mechanism. Some of the profiling operations on the floor plate are rather delicate.

One of the interesting features of the design of the floor plate is the way in which the catch which holds it in place is released by simply inserting the ball end of a cartridge in the recess shown in Figs. 1316 and 1317. The leaf on the catch comes through the opening milled in operation 14, Fig. 1338, and is easily operated by the cartridge point.

The undercutting for the end of the magazine spring in Figs. 1333 and 1334 is of special interest as the profiling cutter is but 0.44 in. in diameter and only 0.035 in. thick. The method of gaging this is to have two buttons or disks on the end of a plug. The one for measuring the depth of the slot also acts as the minimum width gage while the width gage gives the minimum for the depth. This tells the inspector which dimension is incorrect.

FIG. 1316

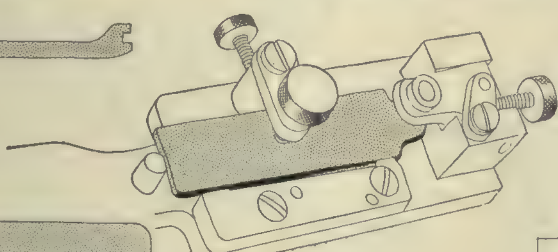


FIG. 1317

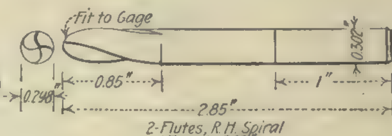


FIG. 1318

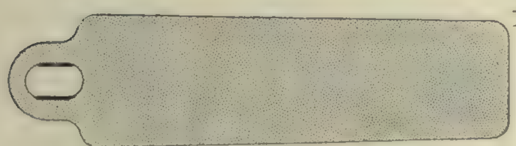


FIG. 1320

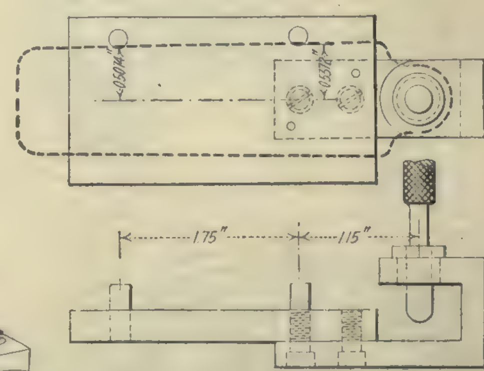


FIG. 1319

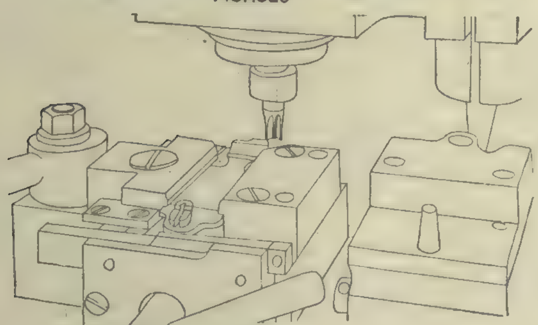


FIG. 1323

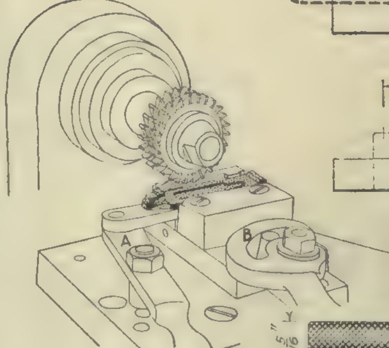


FIG. 1321

FIG. 1318

FIG. 1316, 1317, 1318, 1319 OP. 6
FIG. 1320, 1321, OP. 7
FIG. 1322, 1323, 1324, 1325, OP. 8

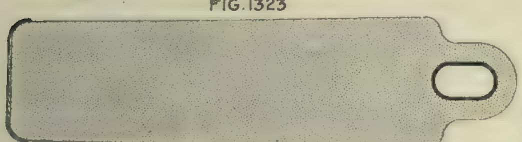


FIG. 1322

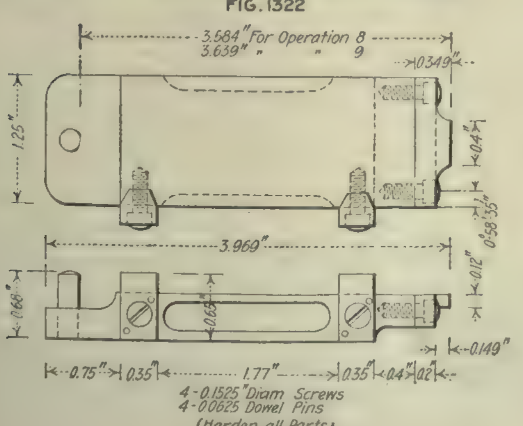
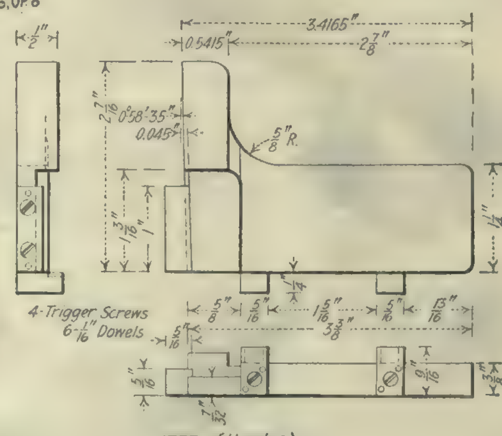


FIG 1325



STEEL (Harden)
FIG. 1324

OPERATION 6. DRILLING AND REAMING DISASSEMBLING HOLE

Transformation—Fig. 1316. Machine Used—Dwight-Slate 16-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1317. Tool-Holding Devices—Drill chuck. Cutting Tools—Drill, Fig. 1318; shoulder drill and forming drill. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed.

2.75 in. diam., 0.3 in. thick. Number of Cuts—One. Cut Data—300 r.p.m.; hand feed. Coolant—Compound, ¼-in stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Snap for width. Production—125 per hr.

OPERATION 7½. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening. Apparatus and Equipment Used—Hammer, lead block and straight-edge. Production—175 per hr.

FIG. 1326

OPERATION 9

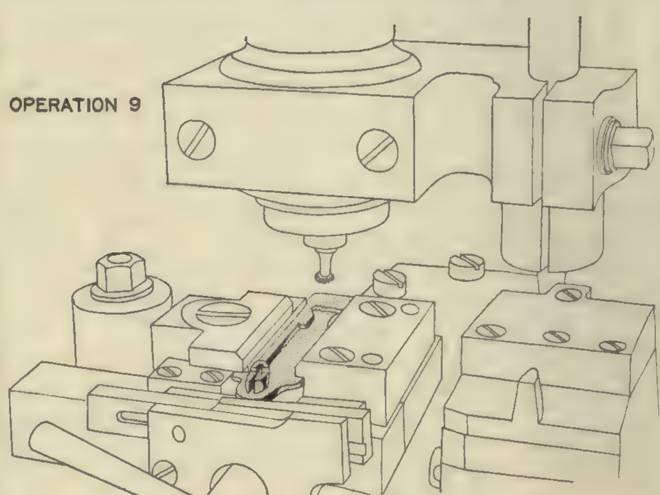


FIG. 1327

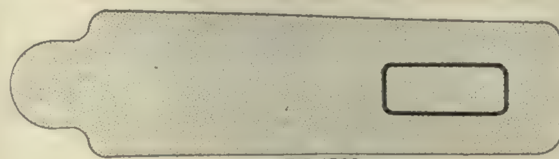


FIG. 1328

OPERATION 10

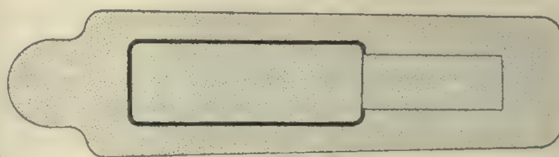


FIG. 1329

OPERATION 10½

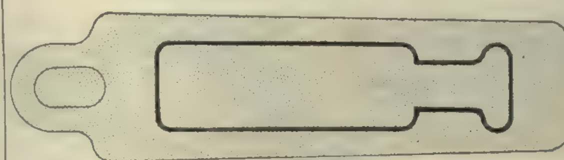
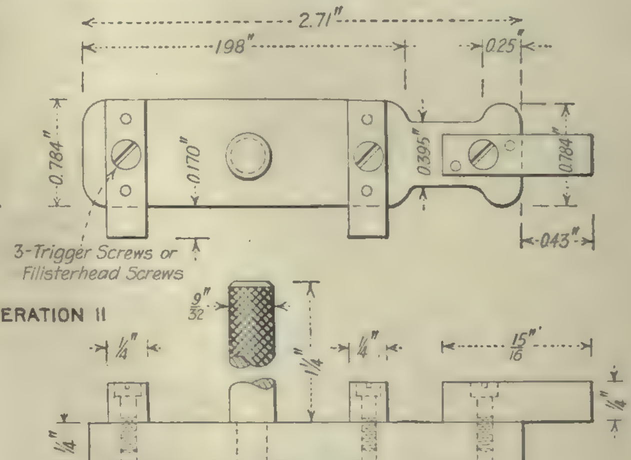


FIG. 1330



OPERATION 11

FIG. 1332

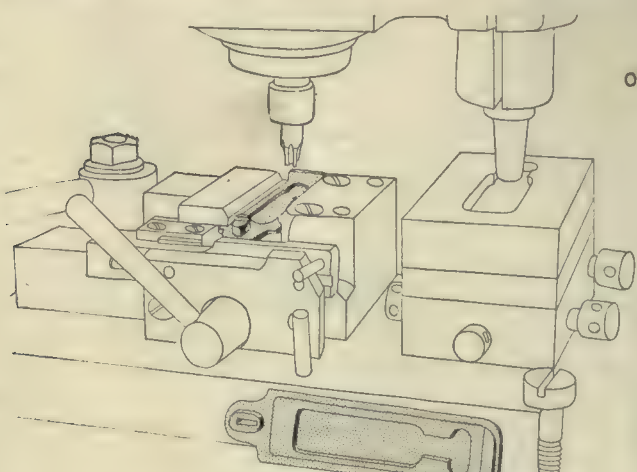


FIG. 1331

FIG. 1333

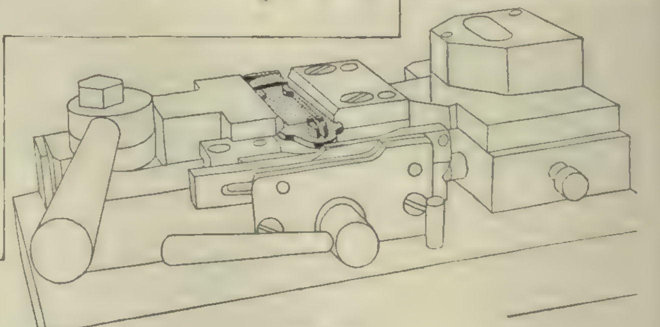


FIG. 1334

OPERATION 12

Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—Two roughers and one finisher, good for 250 pieces. Gages—Form and location, Fig. 1319. Production—75 per hr.

OPERATION 7. HAND-MILLING STRADDLE CUT LENGTHWISE ON LUG

Transformation—Fig. 1319. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held by vise jaws; pushed up against top by lever A; clamped by cam B, Fig. 1321. Tool-Holding Devices—Standard arbor. Cutting Tools—Pair of straddle mills,

OPERATION 8. PROFILING LUG AND TENON

Transformation—Fig. 1322. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Pushed up to stop; clamped with vise jaws, Fig. 1323. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter, 0.40 in. diam., 6 right-hand teeth, 0.32 in. long. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1324, length from lug to end; Fig. 1325, length from disassembling hole. Also for width and length of lug, and for contour of lug. Production—50 per hr.

OPERATION 8½. BURRING OPERATION 8

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 8. Apparatus and Equipment Used—File. Production—600 per hr.

OPERATION 9. PROFILING UNDERCUTS ON LUG AND TENON

Transformation—Fig. 1326. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held in vise jaws; pushed up to stop at top by cam, Fig. 1327; notice profiling forms. Tool-Holding Devices—Taper shank. Cutting Tools—Two small milling cutters, one for tenon on front end, the other for tenon on lug. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—One for front tenon; one for width of slots; one for position of undercut; and one for width of undercut on lug. Production—40 per hr. slot. Production—75 pieces per hr. Note—Work held against upper face by cam.

OPERATION 13. MILLING BOTTOM LENGTHWISE

Transformation—Fig. 1335. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held lengthwise, clamped on lug at rear, Fig. 1336. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutter, 2.70 in. diameter, 1.25 in. wide, face hollow with 1.795 in. radius, 24 straight teeth. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Form of bottom, Fig. 1337. Production—20 per hr. Note—Two at a time.

OPERATION 13½. BURRING OPERATION 13

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 13. Apparatus and Equipment Used—File. Production—450 per hr.

FIG. 1335

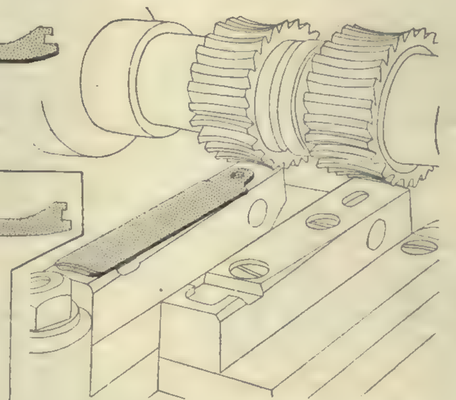
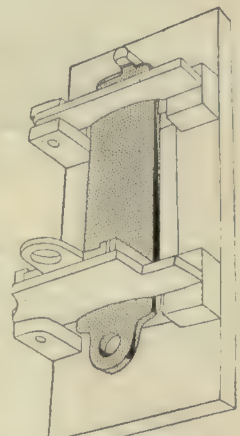


FIG. 1336



OPERATION 13 FIG. 1337

FIG. 1338

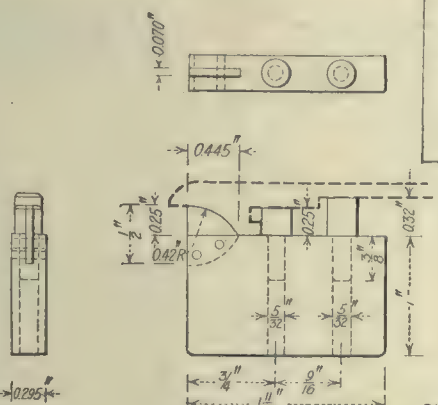


FIG. 1340

OPERATION 14

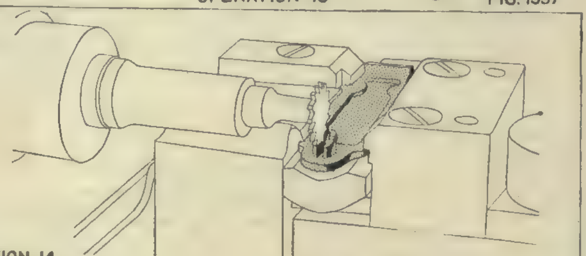


FIG. 1339

OPERATION 9½. FILING LUGS TO MATCH PROFILING AND MILLING CUTS

Number of Operators—One. Description of Operation—Blending cuts together. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATIONS 10 AND 10½. HAND-MILLING FOR FRONT AND REAR END OF MAGAZINE-SPRING RECESS

Transformation—Figs. 1328 and 1329. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; work pushed to stop (see operation 14). Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter 2.1875 in. diam. and 0.365 in. wide for operation 10, and one 2.68 in. diam. and 0.6 in. wide, with radius of 0.05 in. on corners for operation 10½. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—300 pieces. Gages—Depth and width. Production—125 pieces per hr. Note—Same fixture as operation 14; operations 10 and 10½ use same machine and fixture with a change of cutters.

OPERATION 11. PROFILING MAGAZINE-SPRING RECESS TO FORM AND DEPTH

Transformation—Fig. 1330. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; stop at end, Fig. 1331. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutters for spring recess. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—200 pieces. Gages—Form, Fig. 1332. Production—35 per hr.

OPERATION 11½. BURRING OPERATION 11

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 11. Apparatus and Equipment Used—File. Production—900 per hr.

OPERATION 12. PROFILING UNDERCUTS FOR MAGAZINE-SPRING SEAT

Transformation—Fig. 1333. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—By cam-operated vise jaws; pushed to stop at rear end, Fig. 1334; also carries profiling form. Tool-Holding Devices—Taper shank. Cutting Tools—Small undercut milling cutter, 0.44 in. diameter, 0.035 in. thick. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Width and depth of

OPERATION 14. HAND-MILLING FLOOR-PLATE CATCH SLOT IN REAR LUG

Transformation—Fig. 1338. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held by vise jaws; work pushed to stop and up against top, Fig. 1339. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, for undercutting, 0.84 in. diameter, 0.07 in. thick, 14 teeth. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 1340. Production—125 pieces per hr.

OPERATION 14½. FINISH STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening to finish lead block. Apparatus and Equipment Used—Hammer, straight-edge copper hammer. Gages—Straight-edge. Production—80 pieces per hr.

OPERATION 20. FILING, GENERAL

Number of Operators—One. Description of Operation—Filing and finishing. Apparatus and Equipment Used—Files. Gages—One for gaging top; a second for front and rear tenons to gage; and a duplicate of guard to see how plate fits. Production—20 per hr.

OPERATION 21. POLISHING

Number of Operators—One. Description of Operation—Polishing outside surfaces of floor plate. Apparatus and Equipment Used—Polishing jack and wheel. Production—35 per hr.

OPERATION 22. FILING, CORNERING

Number of Operators—One. Description of Operation—Filing and general cornering. Apparatus and Equipment Used—Files. Production—125 per hr.

OPERATION 23. BLUING

Number of Operators—One. Description of Operation—Same as all other bluing operations on other parts.

FLOOR-PLATE PIN OPERATION

Machine Used—Hartford automatic. Number of Machines per Operator—Five. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—Box tool in turret; cutoff crossfeed carriage. Cutting Tools—Box tool and formed cutting-off tool. Number of Cuts—Two. Cut Data. 1500 r.p.m.; ¼-in. feed. Coolant—Cutting oil, ⅜-in. stream. Average Life of Tool Between Grindings—3,000 pieces. Gages—For length; round end; and diameter. Production—180 pieces per hr.

The Floor-Plate Catch

The floor-plate catch hinges on the floor-plate pin and is operated by a small spring known as the floor-plate spindle. The function of the floor-plate catch is to retain the floor plate in its seat.

While a small piece it is all the more difficult to handle on that account, but the special fixtures shown herewith enable it to be machined at a good production rate. As with many other parts these are handled two at a time, as in Fig. 1351, where both the top and bottom are milled.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal heated to 850 deg. C. (1,562 deg. F.); left overnight to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnaces; oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then in the pickling solution, which consists of 1 part sulphuric acid to 9 parts water; left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, pickling tanks, hand hoist.

OPERATION C. TRIMMING

Machine Used—Perkins No. 19 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Setscrew in shoe. Stripping Mechanism—Work punched through die. Average Life of Punches and Dies—15,000 pieces. Production—650 per hr.

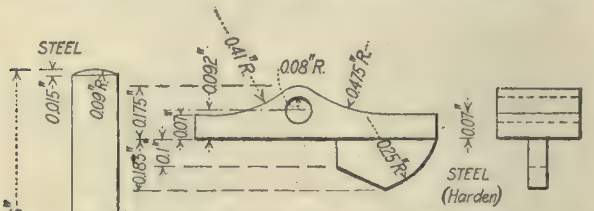


FIG. 1341

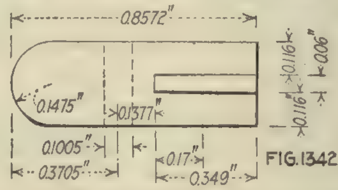


FIG. 1342

FIG. 1343

OPERATION A

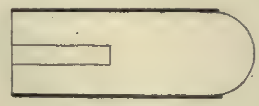
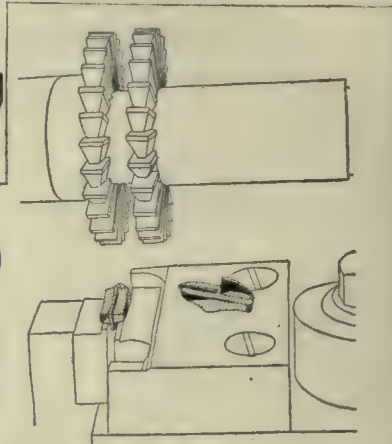


FIG. 1344



OP. 1 FIG. 1345

OPERATION 3

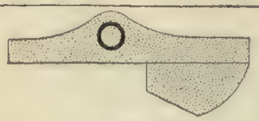


FIG. 1346

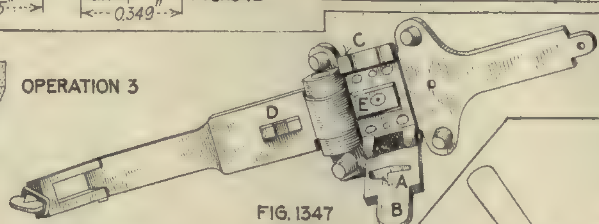


FIG. 1347

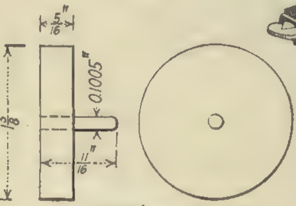


FIG. 1348

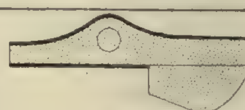


FIG. 1349

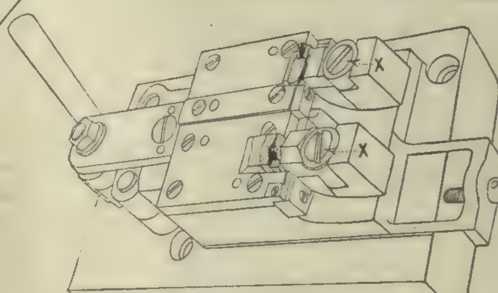


FIG. 1350

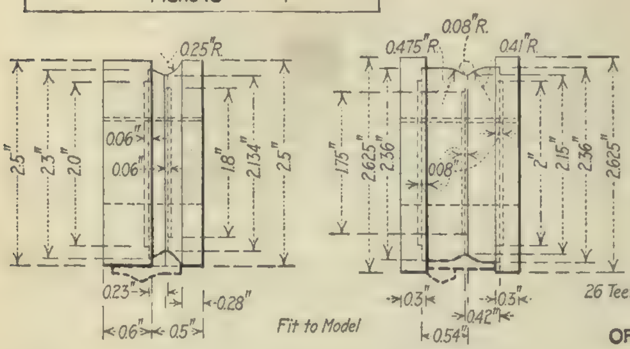
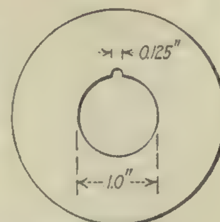


FIG. 1351



OPERATION 5 & 6

FIG. 1352

OPERATIONS ON FLOOR-PLATE CATCH

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
1	Straddle-milling both sides
3	Drilling pin hole
4	Reaming pin hole
5	Milling top
AA	Removing burrs left by operation 5
6	Milling bottom
BB	Removing burrs left by operation 6
7	Milling tongue straddle
CC	Removing burrs left by operation 7
8	Hand-milling rear end
DD	Removing burrs from pin hole
10	Countersinking, reaming pin hole (10 and 11 grouped)
11	Rotary filing upper corners and circle of tongue
9	Filing front end (in jig) and general cornering
12	Case hardening

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1343. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—160 per hr.

OPERATION 1. STRADDLE-MILLING BOTH SIDES

Transformation—Fig. 1344. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Special vise jaws, Fig. 1345. Tool-Holding Devices—Standard arbor. Cutting Tools—Two 3x5/16-in. side-milling cutters. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Thickness.

OPERATION 3. DRILLING PIN HOLE

Transformation—Fig. 1346. Machine Used—Woodward single-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1347; A shows jig open, B with one holding leaf closed. Tool-Holding Devices—Drill chuck. Cutting Tools—No. 40 drill. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—200 pieces. Production—90 pieces per hr.

OPERATION 4. REAMING PIN HOLE

Machine Used—Woodward single-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Held by pins; steel block. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer, round end, 0.1005 in. diameter.

Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1348, diameter of hole and squareness of hole with body. Production—450 pieces per hr.

OPERATIONS 5 AND 6. MILLING TOP AND BOTTOM

Transformation—Fig. 1349. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on pins; clamped by jaws; Fig. 1350 shows piece in left jaws X for milling top; the other jaws for milling bottom. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1351. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1352. Production—40 pieces per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operations 5 and 6.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 6. Apparatus and Equipment Used—File. Production—300 pieces per hr.

OPERATION 7. MILLING TONGUE STRADDLE

Transformation—Fig. 1353. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Three. Work-Holding Devices—Held on pin; clamped by vise jaws, Fig. 1354. Tool-Holding Devices—Standard arbor. Cutting Tools—Straddle milling cutters 2.50 in. diameter, 0.375 in. wide, 26 teeth. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width and location of tongue, Fig. 1355. Production—40 pieces per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7.

OPERATION 8. HAND-MILLING REAR END

Transformation—Fig. 1356. Machine Used—Goes on any hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held upright on pin; clamped by jaws, Fig. 1357. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters, Fig. 1358. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Form of end, Fig. 1359. Production—300 pieces per hr.

OPERATION DD. REMOVING BURRS FROM PIN HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around pin hole. Apparatus and Equipment Used—Speed lathe and reamer. Production—400 per hr.

OPERATION 10. COUNTERSINKING, REAMING PIN HOLE

Number of Operators—One. Description of Operation—Rounding corners of pin hole and reaming. Apparatus and Equipment Used—Speed lathe, countersink and reamer. Production—1,000 pieces per hr.

OPERATION 11. ROTARY FILING UPPER CORNERS AND CIRCLE OF TONGUE

Number of Operators—One. Description of Operation—Rotary filing corners and circle of tongue. Apparatus and Equipment Used—Rotary file. Production—175 per hr.

OPERATION 9. FILING FRONT END (IN JIG) AND GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing (in jig) front end. Apparatus and Equipment Used—Jig and file. Production—70 pieces per hr.

OPERATION 12. CASEHARDENING

Number of Operators—One. Description of Operation—Packed in whole new bone, heated to 750 deg. C. (1,382 deg. F.) for 2½ hr., quenched in oil. Apparatus and Equipment Used—Same equipment as for other casehardening.

The Magazine Spring

The magazine spring is of somewhat peculiar construction, so made as to have a long range of action with a comparatively light tension at all points. The small end slides into the undercut on the follower, and the large end fits the undercuts in the floor plate in a similar manner.

This spring is somewhat peculiar in its ease and uniformity of action, as well as its freedom from breakage in spite of being doubled back on itself. The roughing of the corners over a pin, as in Fig. 1367, accounts for much of this, and although the apparatus is simple in design it does the work admirably. The dies for bending the spring into its *M* shape are also of special interest. Fig. 1364 shows the dies open and a spring laid on them just as it leaves the die, while Fig. 1365 shows the dies closed. These show the way in which the bending forms are made in sections and fastened to the proper sliding shoes. This makes them easily renewable for wear, as well as adjustable for position. The operation of these dies is very easy and rapid, the blank strip being laid in between the dies and against stops to insure correct bending.

The final shaping of the ends in Fig. 1372 is the last touch which seems to be necessary to make the spring just right. The bending dies do not seem to be able to get just the proper set to have the spring hold firmly and fit easily under the lugs in the floor plate and follower.

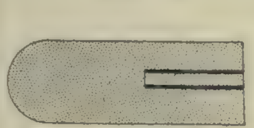


FIG. 1353

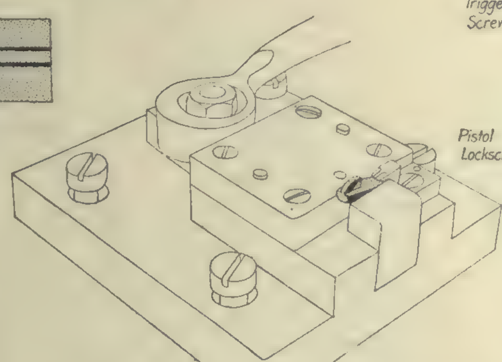


FIG. 1354

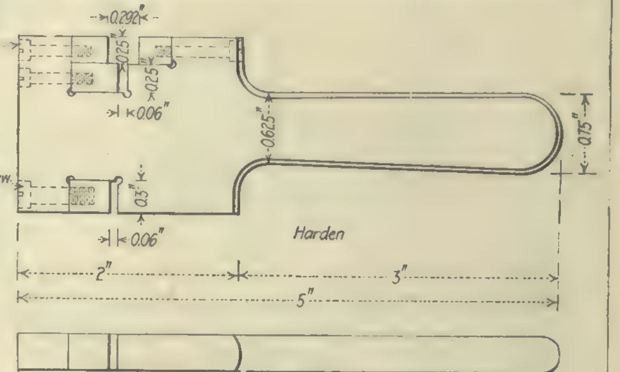


FIG. 1355

OPERATION 7

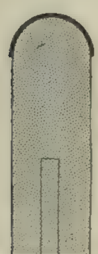


FIG. 1356

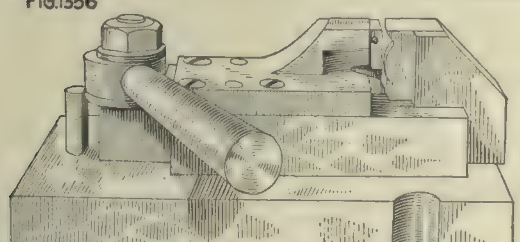


FIG. 1357

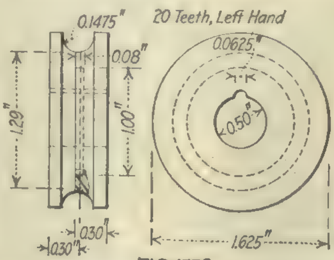


FIG. 1358

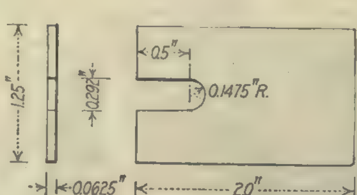


FIG. 1359

OPERATION 8

OPERATIONS ON MAGAZINE SPRING

Operation
- A Blanking from sheet cast steel
- I Burring operation A
- B First bending
- C Second bending to form eyes
- D Cutting off spring to finish shape
- E Third bending to finish shape
- F Hardening
- G Tempering
- H Correcting shape

OPERATION A. BLANKING FROM SHEET CAST STEEL

Transformation—Fig. 1361. Machine Used—Perkins No. 19 press. Number of Operators per Machine—One. Punches and Punch Holders—Round-shank pivot holder. Dies and Die

OPERATION C. SECOND BENDING TO FORM EYES

Transformation—Fig. 1366. Number of Operators—One. Description of Operation—Forming eyes to shape with bench fixture, Fig. 1367; bend of spring is placed over the pin, and the block is swung down; then a light hammer blow sets the spring over the pin and forms the eye. Apparatus and Equipment Used—Fig. 1367 fixture. Production—350 per hr.

OPERATION D. CUTTING OFF SPRING TO FINISH SHAPE

Transformation—Fig. 1368. Machine Used—Old Perkins press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank; punch and dies are centered by two pins at each end, Fig. 1369; spring is set with bend against a stop; a knife cuts the end against the lower blade. Dies and Die Holders—Screwed to plate and bed

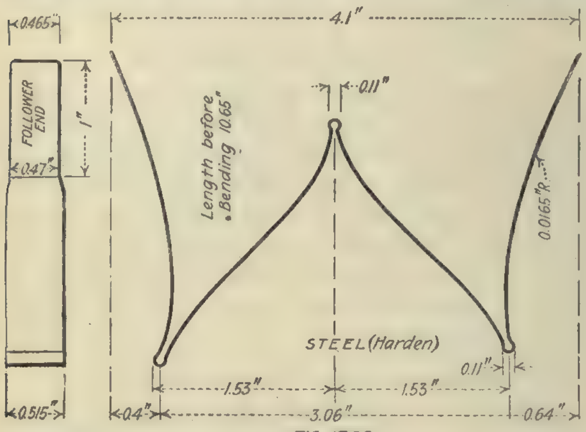


FIG. 1360

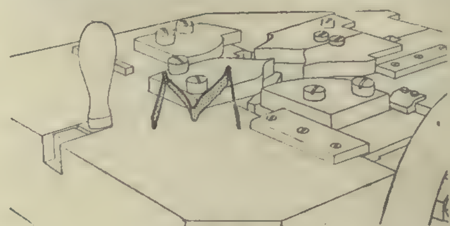


FIG. 1364

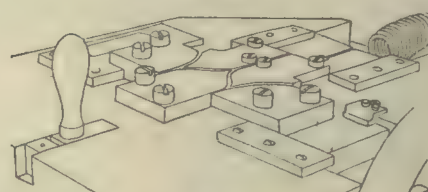


FIG. 1365


FIG. 1361

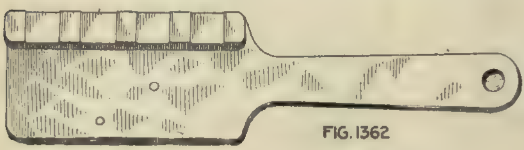


FIG. 1362

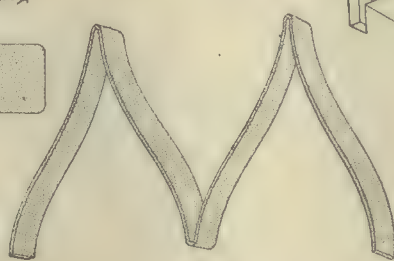


FIG. 1363

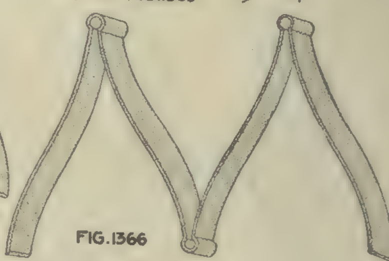


FIG. 1366

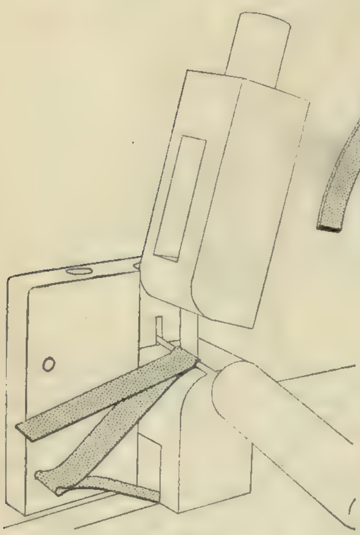


FIG. 1367

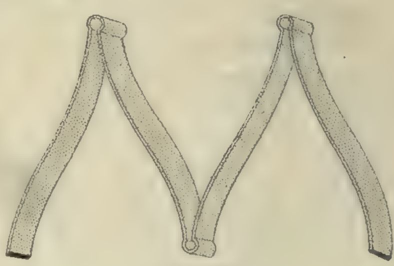


FIG. 1368

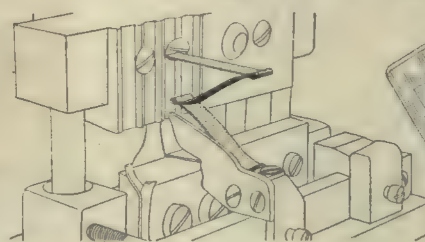


FIG. 1369

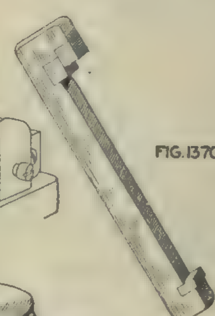


FIG. 1370

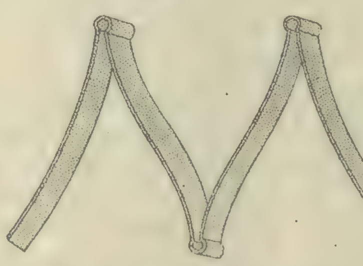


FIG. 1371

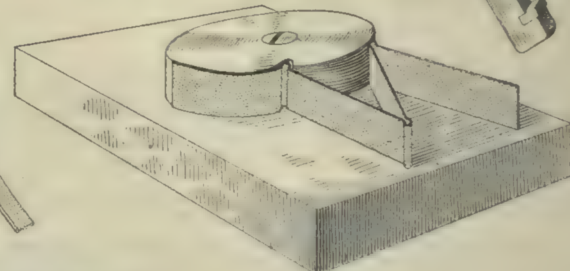


FIG. 1372

FIG. 1361, 1362, OP. A; FIG. 1363, 1364, 1365 OP. B; FIG. 1366, 1367, OP. C
FIG. 1368, 1369, 1370, OP. D - FIG. 1371, 1372 OP. E

Holders—Held in shoe by taper key. Stripping Mechanism—Steel stripper, screwed to face of die. Average Life of Punches—15,000 pieces. Lubricant—Stock coated with cutting oil. Gages—Width at different points, Fig. 1362. Production—500 pieces per hr.

OPERATION I. BURRING OPERATION A

Number of Operators—One. Description of Operation—Removing burrs from operation A. Apparatus and Equipment Used—Abrasive wheel. Production—350 pieces per hr.

OPERATION B. FIRST BENDING

Transformation—Fig. 1363. Number of Operators—One. Description of Operation—Bending spring to shape; strip is laid between dies; foot treadle closes the formers, making the center bend; a handwheel closes the side forms, thus completing the first bend (see Figs. 1364 and 1365). Apparatus and Equipment Used—Bending fixture. Fig. 1364, dies open; Fig. 1365, dies closed. Production—325 per hr.

of press. Stripping Mechanism—None. Gages—Length of ends, Fig. 1370. Production—600 pieces per hr. Note—Three holes for cutting end; when one hole is dull, holder is moved along to next hole.

OPERATION E. THIRD BENDING TO FINISH SHAPE

Transformation—Fig. 1371. Number of Operators—One. Description of Operation—Curving the ends of spring on hand fixture, Fig. 1372; spring is placed with eye in notch and the end bent over the roll, as shown; this is done for each end. Apparatus and Equipment Used—Curved block screwed to bench, Fig. 1372. Production—325 pieces per hr.

OPERATION F. HARDENING

Number of Operators—One. Description of Operation—The spring is heated in an open oil fire to 1,450 deg. F., it is then quenched in oil and is ready for tempering. Apparatus and Equipment Used—Rockwell oil furnace and oil bath.

OPERATION G. TEMPERING

Number of Operators—One. Description of Operation—Heated in bath of niter (saltpeter) to 800 deg. F.; quenched in water. Apparatus and Equipment Used—Equipment is regular bluing equipment, same as for other parts.

OPERATION H. CORRECTING SHAPE

Number of Operators—One. Description of Operation—The spring is apt to get out of shape in hardening and tempering, and as the different portions of the spring must be in line when compressed, they often require straightening; the straightness is tested by laying the spring on a flat plate, and if it must be straightened the operator takes a pair of pliers in each hand, holds the spring over an open flame, to heat sufficiently to avoid breaking, and bends the spring into its correct shape. Apparatus and Equipment Used—Bench plate and two pairs of pliers.

Cutoff

The cutoff that determines whether the rifle shall be used as a single shot or as a magazine is illustrated in Fig. 1373. It consists of a thumb-piece, the body, the magazine fire groove, the dismounting groove, the cutoff-spindle hole, the cutoff-plunger hole, the cutoff-screw hole and the serration on the thumb-piece. The opposite side of the thumb-piece carries the words "On" and "Off" to show whether or not the magazine is in position to be used. When the cutoff thumb-piece is turned down and the word "Off" shows, the rear end of the slotted locking lug of the bolt strikes against the projecting front end of the cutoff body. This prevents the cartridge from coming up from the magazine, and the arm is in position to be used as a single-shot rifle. The other position of the thumb-piece allows the cartridge to feed up from the magazine.

OPERATIONS ON THE CUTOFF

Operation
- A Forging from bar
- B Annealing
- B-1 Pickling
- C Trimming
- 1 Drilling, reaming, facing and hollow-milling
- 2 Milling rear end of thumb-piece (operations 2, 6 and 11 combined)
- 3 Milling right side
- 4 Milling left side
- AA Removing burrs from spindle hole and burrs left from operations 3 and 4
- 6 Counterboring rear end of body (operation 6 combined with operations 2 and 11)
- 7 Stamping sides of thumb-piece ("On" and "Off")
- 8 Drilling for spring, drilling and counterboring for spindle screw and reaming spindle hole
- BB Removing burrs from spindle hole (operations 2, 6, 11, AA and BB grouped)
- 11 Profiling under side of thumb-piece (combined with operation 2)
- 9 Profiling bolt stop
- 10 Milling bolt clearance
- 13 Hand-milling groove, end of thumb-piece
- EE Removing burrs left by operation 10
- FF Removing burrs from spring spindle and screw holes and those left by operation 13
- 14 Tapping spindle screw hole
- CC Removing burrs from spindle hole
- 12 Hand-milling corners, front and rear
- DD Removing burrs left by operation 12
- 15 Reaming and countersinking spindle hole
- 16 Polishing outer surface
- 17 Filing, general cornering
- 18 Casehardening
- 19 Polishing "On" side of thumb-piece
- 20 Assembling with screw, spring plunger and spindle

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1374. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots, packed with powdered charcoal, heated to 850 deg. C. (1,562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner, powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then put in the pickling solution, which consists of 1 part sulphuric acid to 9 parts water, and left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, pickling tanks, hand hoist.

OPERATION C. TRIMMING

Machine Used—Bliss back-geared press, 2-in. stroke. Number of Operators per Machine—One. Production—700 per hr.

OPERATION 1. DRILLING, REAMING, FACING AND HOLLOW-MILLING

Transformation—Fig. 1375. Machine Used—Pratt & Whitney No. 2½ hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Held in two-jaw chuck, Fig. 1376. Tool-Holding Devices—In turret. Cutting Tools—Turret tools; reamer; box-turning tool; facing mill; stem and collet for hollow and facing mills, and hollow mill. Number of Cuts—Six. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—For diameter of hole and depth of counterbore. Production—25 pieces per hr.

OPERATIONS 2, 6, 11. MILLING REAR END OF THUMB-PIECE; COUNTERBORING REAR END OF BODY; PROFILING UNDER SIDE OF THUMB-PIECE

Transformation—Fig. 1377. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held by formed jaws. Tool-Holding Devices—Taper shank. Cutting Tools—Double milling cutter, large cutter screwed on shank behind front cutter. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—For relation of wing to body; length; diameter; and diameter of counterbore. Production—800 pieces per hr.

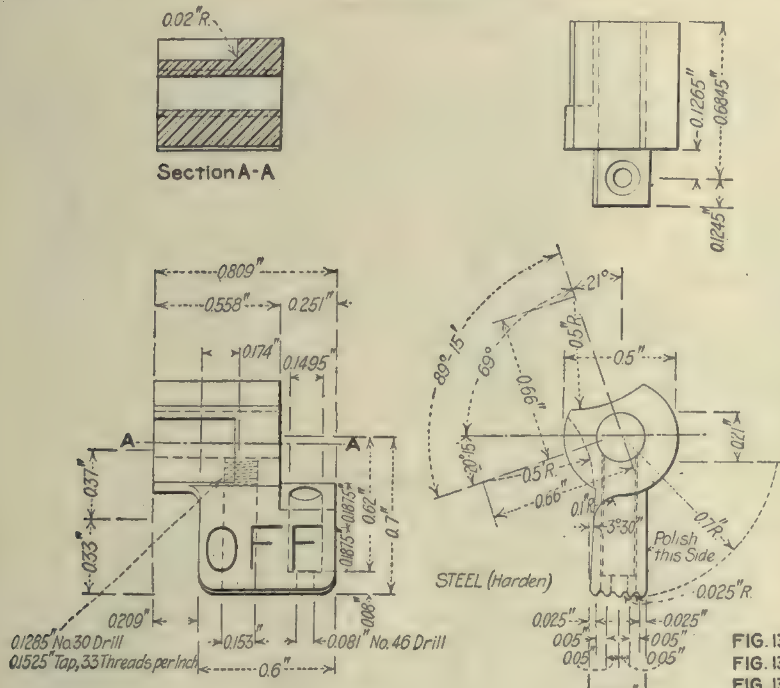


FIG. 1373

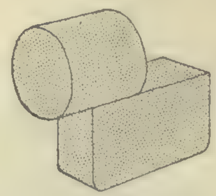


FIG. 1374

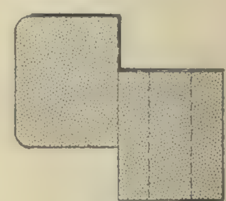


FIG. 1377

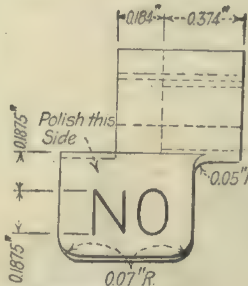



FIG. 1378

FIG. 1374 OPERATION A
FIG. 1375 & 1376 OPERATION 1
FIG. 1377 OPERATION 2
FIG. 1378, 1379, 1380 & 1381 OPERATION 3 & 4

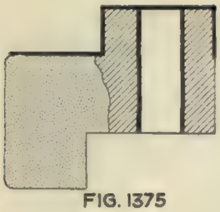


FIG. 1375

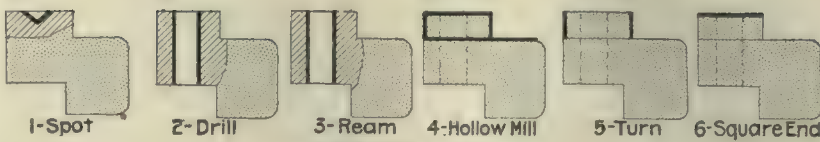


FIG. 1376

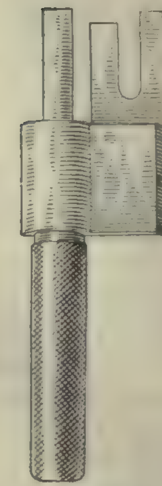


FIG. 1381

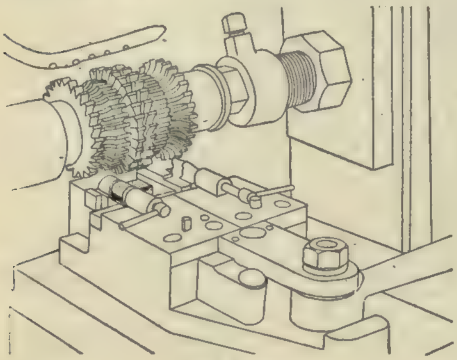
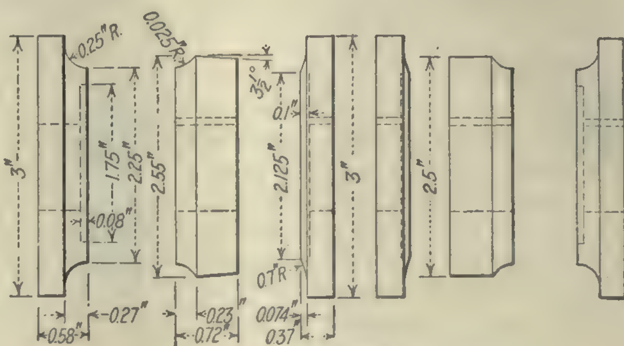


FIG. 1379



Fit to Model.
28 Teeth, Straight, Left Hand
FIG. 1380

OPERATIONS 3 AND 4. MILLING RIGHT AND LEFT SIDES

Transformation—Fig. 1378. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held by double vise jaws, Fig. 1379. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1380. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1381; radius of barrel and relation of wing to hole. Production—75 pieces per hr.

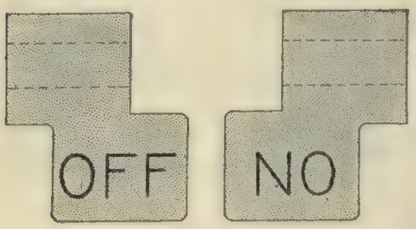
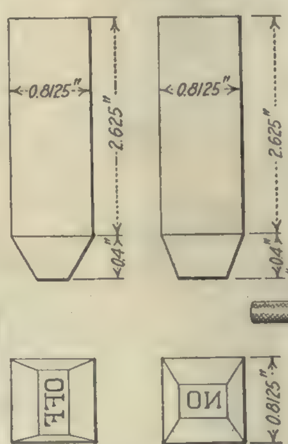


FIG. 1382



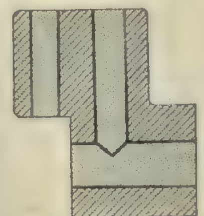


FIG. 1385

FIG. 1386

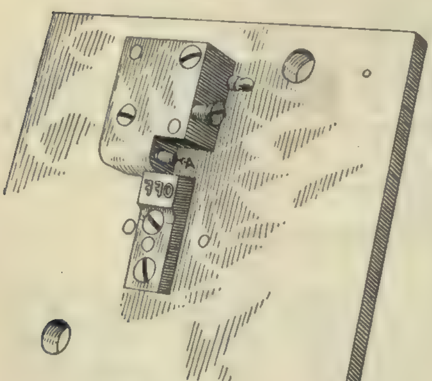


FIG. 1383

FIG. 1384

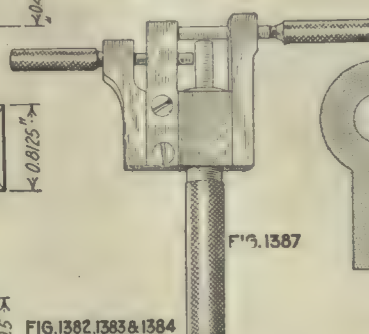
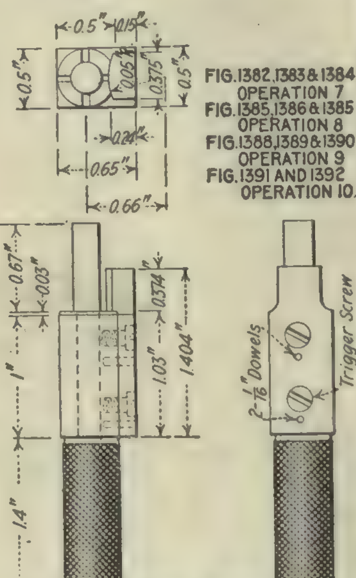


FIG. 1387


FIG. 1388

FIG. 1382, 1383 & 1384 OPERATION 7
FIG. 1385, 1386 & 1385 OPERATION 8
FIG. 1388, 1389 & 1390 OPERATION 9
FIG. 1391 AND 1392 OPERATION 10.



STEEL (Harden)
FIG. 1390

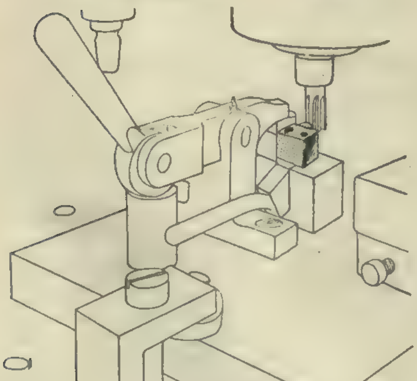


FIG. 1389


FIG. 1391

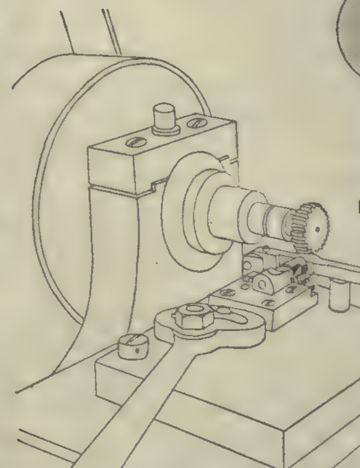


FIG. 1392

OPERATION AA. REMOVING BURRS FROM SPINDLE HOLE AND BURRS LEFT FROM OPERATIONS 3 AND 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 3 and 4. Apparatus and Equipment Used—File. Production—Grouped with operations 3 and 4.

OPERATION 7. STAMPING SIDES OF THUMB-PIECE

Transformation—Fig. 1382. Machine Used—Old Brooks press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Die and fixture screwed to bed of press, Fig. 1383; the punch is illustrated in Fig. 1384. Stripping Mechanism—None. Gages—None. Production—450 pieces per hr. Note—Work held on pin A; stamps "Off" on the under side and "On" on the top side.

OPERATION 9. PROFILING BOLT STOP

Transformation—Fig. 1388. Machine Used—Wood-Light Co. profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on pin; clamped by finger clamp A. Fig. 1389. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter 0.45 in. diameter, 7 teeth, right hand, 0.75 in. long. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 1390; radius of cut and radius of barrel. Production—60 pieces per hr.

OPERATION 10. MILLING BOLT CLEARANCE

Transformation—Fig. 1391. Machine Used—Pratt & Whitney No. 0 hand miller. Number of Machines per Operator—Two. Work-Holding Devices—Held on pin; clamped by jaws, Fig. 1392. Tool-Holding Devices—Taper shank. Cutting Tools—Formed milling cutter 1.45 in. diameter, 0.50 in. wide. Outside convex to 0.50 radius. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—85 pieces per hr.

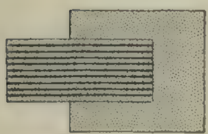


FIG. 1393

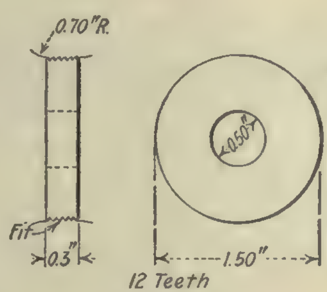


FIG. 1395

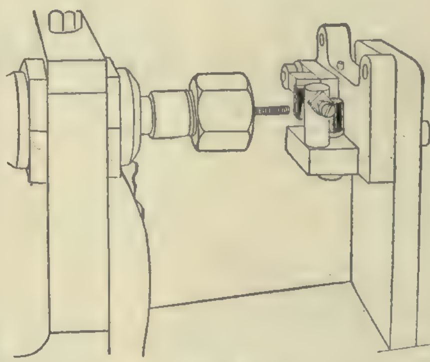


FIG. 1397

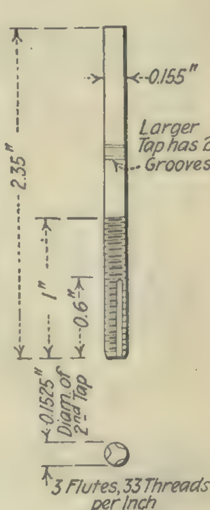


FIG. 1398

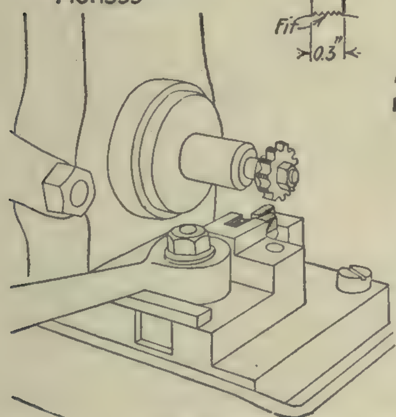


FIG. 1394

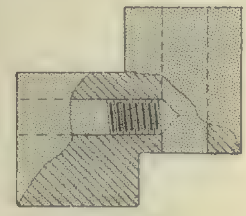


FIG. 1396

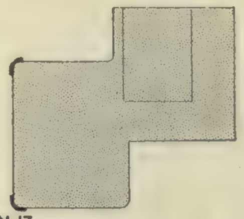
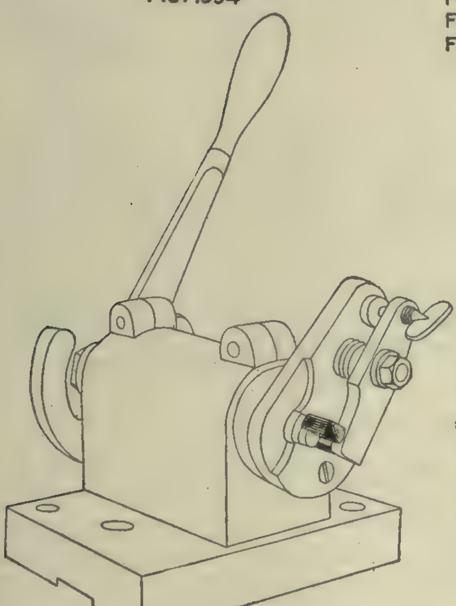


FIG. 1399

FIG. 1393, 1394 & 1395 OPERATION 13
FIG. 1396, 1397 & 1398 OPERATION 14
FIG. 1399, 1400, 1401 & 1402 OPERATION 12



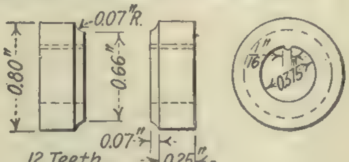
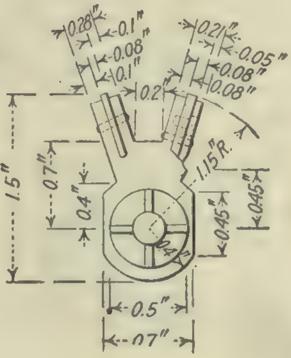


FIG. 1401



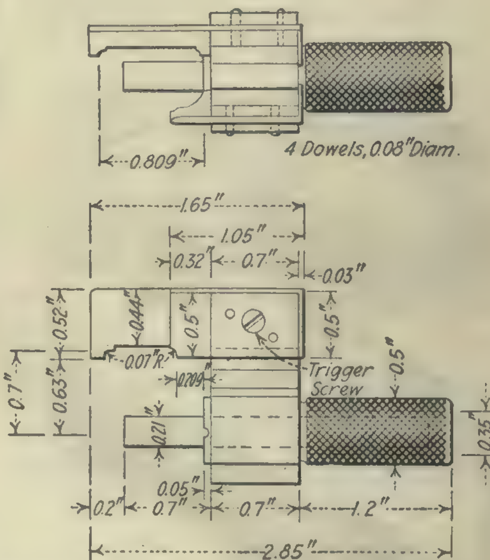


FIG. 1402

OPERATION 8. DRILLING FOR SPRING, DRILLING AND COUNTERBORING FOR SPINDLE SCREW AND REAMING SPINDLE HOLE

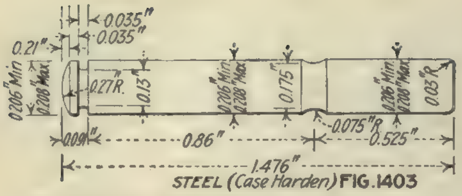
Transformation—Fig. 1385. Machine Used—Pratt & Whitney 16-in. four-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1386. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore. Number of Cuts—Four. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1387; diameter and depth and location from center hole. Production—38 pieces per hr.

OPERATION BB. REMOVING BURRS FROM SPINDLE HOLE

Number of Operators—One. Description of Operation—Removing burrs from spindle hole. Apparatus and Equipment Used—Reamer. Production—400 pieces per hr.

OPERATION 13. HAND-MILLING GROOVE, END OF THUMB-PIECE

Transformation—Fig. 1393. Machine Used—Pratt & Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, using thumb-piece as stop, Fig. 1394. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1395. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces Production—85 pieces per hr.



STEEL (Case Harden) FIG. 1403

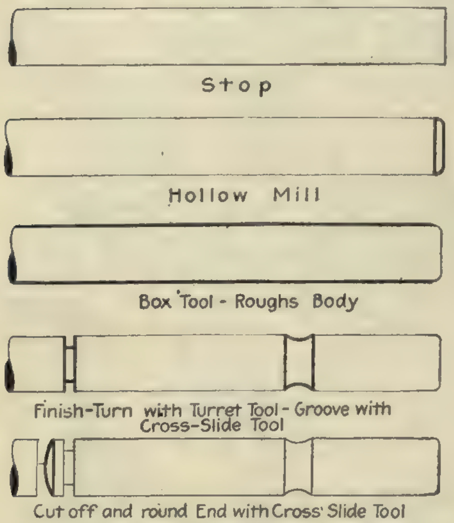
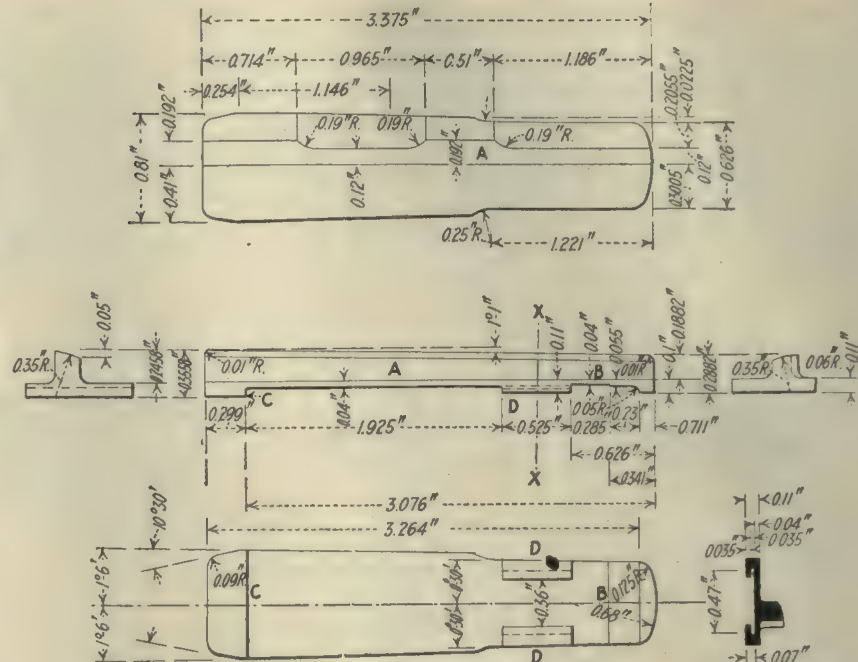


FIG. 1404



STEEL (Case Harden)

OPERATION 12 FIG. 1405

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 10

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 10. Apparatus and Equipment Used—File. Production—Grouped with operations 10 and 13.

OPERATION FF. REMOVING BURRS FROM SPRING SPINDLE AND SCREW HOLES

Number of Operators—One. Description of Operation—Removing burrs thrown up around spindle hole. Apparatus and Equipment Used—Speed lathe and reamer, 0.1495 in. diameter. Production—Grouped with operations 10 and B.

OPERATION 14. TAPPING SPINDLE SCREW HOLE

Transformation—Fig. 1396. Machine Used—Tapping machine built at the Hill shop. Number of Operators per Machine—One. Work-Holding Devices—Held on pin; clamped by screw; fixture held in special tapping machine. Fig. 1397. Tool-Holding Devices—Taper screw chuck. Cutting Tools—Three fluted taps, Fig. 1398. Number of Cuts—One. Cut Data—150 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Plug thread. Production—350 pieces per hr.

OPERATION CC. REMOVING BURRS FROM SPINDLE HOLE

Number of Operators—One. Description of Operation—Removing burrs thrown up around spindle hole. Apparatus and Equipment Used—Speed lathe and reamer. Production—800 pieces per hr.

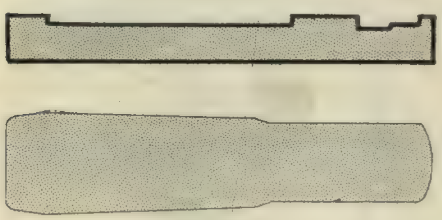


FIG. 1406
OPERATION A

FIG. 1407

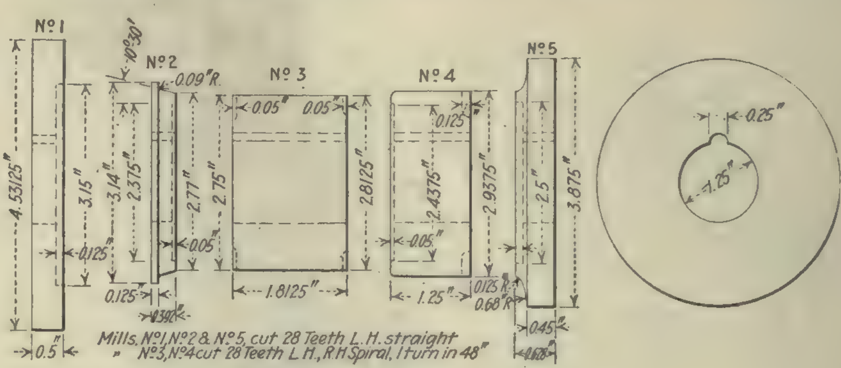


FIG. 1409

FIG. 1410

FIG. 1407, 1408 AND 1409 OPERATION 1 AND 3
FIG. 1410 AND 1411 OPERATION 2

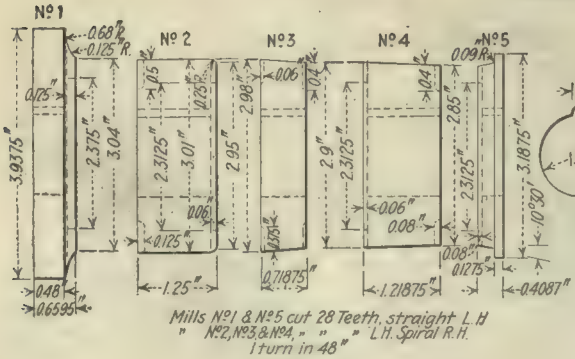


FIG. 1408

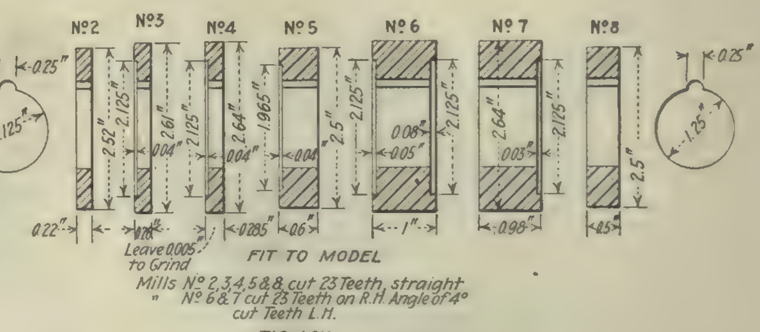


FIG. 1411

OPERATION 12. HAND-MILLING CORNERS, FRONT AND REAR END

Transformation—Fig. 1399. Machine Used—Garvin No. 2 hand miller. Number of Operators per Machine—One. Work-Holding Devices—On pin in rotating fixture, Fig. 1400. Tool-Holding Devices—Taper shank. Cutting Tools—Pair of milling cutters, Fig. 1401. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1402, corners gaged from center hole. Production—350 pieces per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 12

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 12. Apparatus and Equipment Used—File. Production—500 pieces per hr.

OPERATION 15. REAMING AND COUNTERSINKING SPINDLE HOLE

Number of Operators—One. Description of Operation—Reaming and countersinking hole. Apparatus and Equipment Used—Speed lathe, reamer and countersink. Production—500 pieces per hr.

OPERATION 16. POLISHING OUTER SURFACES

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Wheel and polishing jack. Production—50 pieces per hr.

OPERATION 17. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing and general cornering. Apparatus and Equipment Used—File. Production—90 pieces per hr.

OPERATION 18. CASEHARDENING

Number of Operators—One. Description of Operation—Packed in ¾ bone and ¼ leather; heated to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quenched in water. Apparatus and Equipment Used—Same equipment as previously described.

OPERATION 19. POLISHING "ON" SIDE OF THUMB-PIECE

Number of Operators—One. Description of Operation—Polishing side of thumb-piece stamped "On." Apparatus and Equipment Used—Polishing jack and wheel. Production—350 pieces per hr.

OPERATION 20. ASSEMBLING WITH SCREW, SPRING PLUNGER AND SPINDLE

Number of Operators—One. Description of Operation—Assembling plunger and spring. Apparatus and Equipment Used—Pinchers and hands. Production—150 pieces per hr.

OPERATIONS ON CUTOFF SPINDLE

Operation	
1	Automatic
2	Polishing

OPERATION 1. AUTOMATIC

Transformation—See Fig. 1404. Machine Used—Acme automatic No. 515; tool layout, Fig. 1404. Number of Machines per Operator—Four. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—In turret. Cutting Tools—Tools for automatic, Fig. 1404; forming and cutting-off tools; also, shaving or turning tool. Number of Cuts—Four. Cut Data—1,200 r.p.m.; $\frac{1}{16}$-in. feed. Coolant—Cutting oil, ⅜-in. stream. Average Life of Tool Between Grindings—1,200 pieces. Gages—For diameter; length; groove at one end, and groove at other end. Production—140 pieces per hr.

OPERATION 2. POLISHING

Number of Operators—One. Description of Operation—Polishing rear end. Apparatus and Equipment Used—Polishing jack and wheel. Production—1,430 pieces per hr. Note—Polish round end.

The Follower

The follower, shown in detail in Fig. 1405, has a rib A that serves to locate the cartridge in the magazine and guides the last cartridge into the chamber above. The front stop B is for the magazine spring, as is the rear stop C. The lugs D are the undercuts that hold the small end of the magazine spring.

OPERATIONS ON FOLLOWER

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
D	Cold dropping
1 and 3	Milling right and left edges and rear end
2	Milling bottom and front end
AA	Removing burrs left by operation 2
4	Milling top lengthwise (straddle rib)
CC	Removing burrs left by operation 4
5	Profiling for spring, rough (operations 5 and 6 grouped)
6	Profiling for spring, finish
7	Profiling clearance left by rib
DD	Removing burrs left by operation 7
9	Milling top of rib
10	Polishing top, rib, edges and end
11	Filing, general cornering
12	Casehardening

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1406. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—120 per hr.

OPERATION B. ANNEALING

Transformation—See Fig. 1406. Number of Operators—One. Description of Operation—Placed in iron pots, packed with powdered charcoal, heated to 850 deg. C. (1,562 deg. F.), left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace; oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then put into the pickling solution, which consists of 1 part sulphuric acid to 9 parts water; left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

OPERATION C. TRIMMING

Machine Used—Bliss back-geared press, 2-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held by set-screw on shoe. Average Life of Punches—15,000 pieces. Dies—15,000 pieces. Production—500 per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 per hr.

OPERATIONS 1 AND 3. MILLING RIGHT AND LEFT EDGES AND REAR END

Transformation—Fig. 1407. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Six. Work-Holding Devices—Clamped by vise jaws; the same vise holds follower for operations 1, 2 and 3. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Figs. 1408 and 1409; one for left, one for right side. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Form. Production—35 pieces per hr.

OPERATION 2. MILLING BOTTOM AND FRONT END

Transformation—Fig. 1410. Machine Used—Pratt & Whitney Lincoln miller No. 2. Number of Machines per Operator—Five. Work-Holding Devices—Vise jaws, same as before. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1411. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Profile. Production—35 pieces per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 2

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 2. Apparatus and Equipment Used—File. Production—Grouped with operation 2.

OPERATION 4. MILLING TOP LENGTHWISE

Transformation—Fig. 1412. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Clamped by vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Straddle milling cutters, 3 in. diameter; one 0.375 in. wide, other 0.50 in. wide. Inside corners rounded with 0.06 radius. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1413; thickness of sides and thickness of rib. Production—35 pieces per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 7.

OPERATIONS 5 AND 6. PROFILING FOR SPRING (ROUGH AND FINISH)

Transformation—Figs. 1414 and 1415, rough and finish. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held by vise jaws; pushed to a stop, Fig. 1416; this also shows profiling form. Tool-Holding Devices—Cutter, taper shank. Cutting Tools—Milling Cutters, Fig. 1417; roughing and undercutting for spring. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1418; width of slot and depth of spring undercut. Production—175 pieces per hr. Note—Operation 6 undercuts the lugs for holding the magazine spring.

OPERATION 7. PROFILING CLEARANCE LEFT BY RIB

Transformation—Fig. 1419. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—On form, held by finger clamp, Fig. 1420; a movable finger is operated by a cam. Tool-Holding Devices—Taper shank. Cutting Tools—Milling, Fig. 1421. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Profile. Production—80 pieces per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs left by operation 7. Apparatus and Equipment Used—File. Production—600 pieces per hr.

OPERATION 9. MILLING TOP OF RIB

Transformation—Fig. 1422. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Clamped by vise jaws, Fig. 1423. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1424. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, ½-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1425; for height of rib. Production—35 pieces per hr., two at a time. Note—Same style of fixture as in operation 4.

OPERATION 10. POLISHING TOP, RIB, EDGES AND END

Number of Operators—One. Description of Operation—Polishing top, edges and ends. Apparatus and Equipment Used—Polishing jack and wheel. Production—35 pieces per hr.

OPERATION 11. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Finishing and cornering. Apparatus and Equipment Used—File. Production—40 pieces per hr.

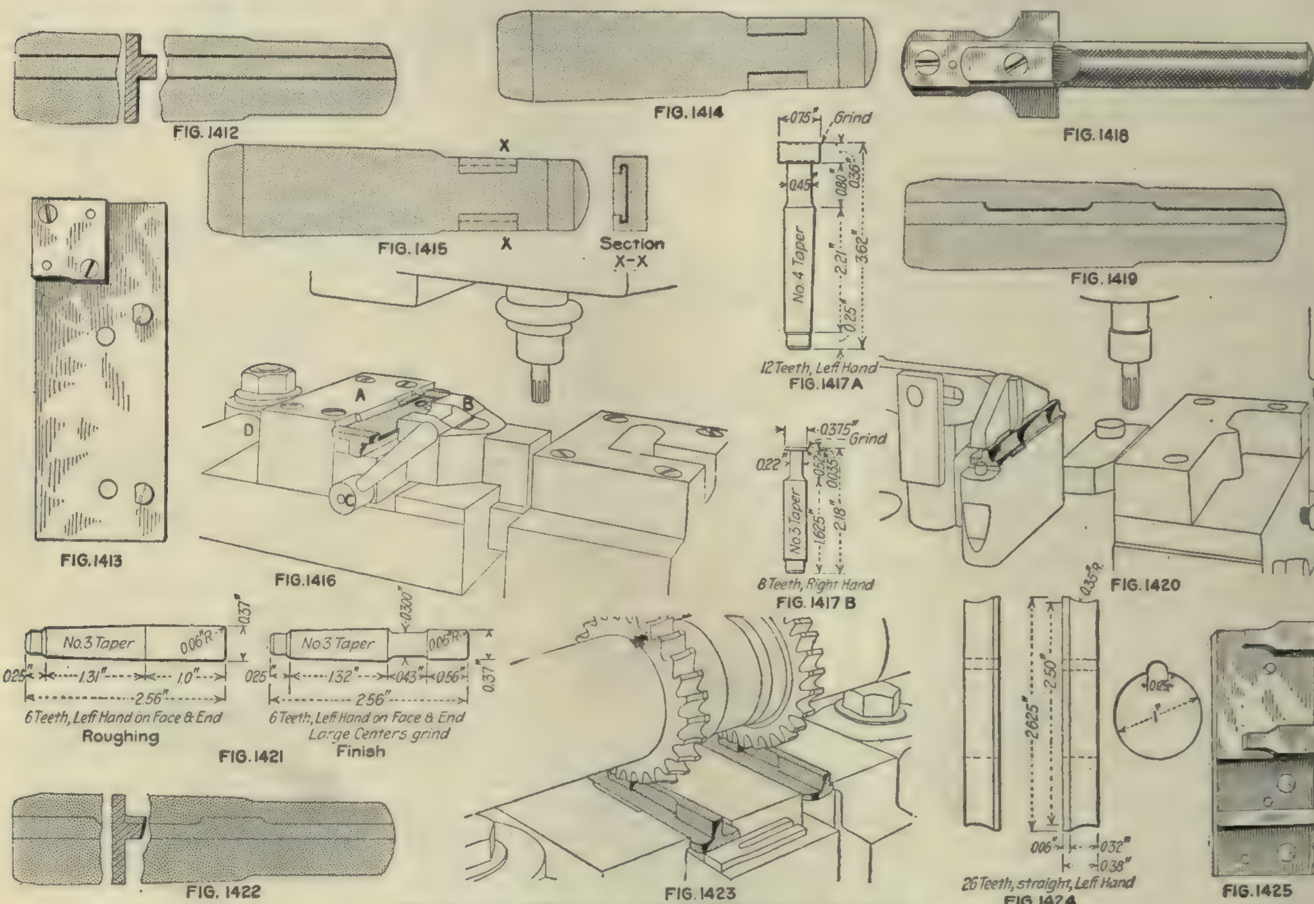


FIG. 1412 & 1413 OPERATION 4, FIG. 1414 OPERATION 5, FIG. 1415, 1416, 1417 & 1418 OPERATION 6, FIG. 1419, 1420 & 1421 OPERATION 7, FIG. 1422, 1423, 1424 & 1425 OPERATION 9

OPERATION 12. CASEHARDENING

Number of Operators—One. Description of Operation—Packed in whole, new bone; heated to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quenched in oil. Apparatus and Equipment Used—Same as other casehardening equipment.

Casting Valve Heads on Steel Stems

By H. F. McCray

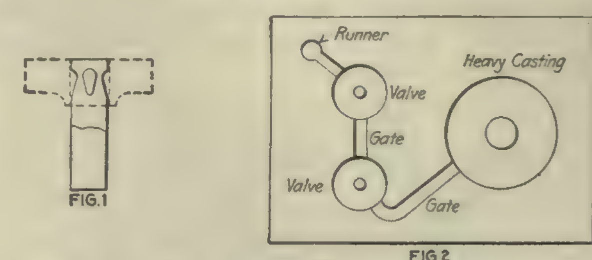
A considerable number of attempts have been made, with more or less success, to cast the heads of gas-engine poppet valves on the steel stems. A plan that gives good results is as follows:

The stems are cut to length from $\frac{1}{16}$-in. oversize stock and have four notches ground in the head end, about as shown in Fig. 1. There is nothing particular about the form or size; the only precaution to be observed is not to weaken the stem more than necessary.

The next operation is to tin the head end of the stem. This was found to be desirable, although venetian red, mixed in gasoline, gives good results. The tinning does not rub off, however, and for that reason is more convenient to handle. The shape of the head pattern is shown in Fig. 1. It is considerably heavier than the finished head, to give the metal a better chance to "burn in" and insure sound iron.

The method of gating is shown in Fig. 2. The stems are inserted in the pattern and rammed up in the drag. The pattern for any heavier casting, say 15 lb. or over, is rammed up in the same mold and gated as shown. It is evident that, by the time the large mold is filled, the valve stems are well heated; so when the metal sets around them, there is no tendency whatever to "blow" and separate.

It is necessary to take some care to insure clean metal in the first valve mold; for if gated plain, it will act as a skim, catching all the slag and dirt. By using a skim pocket ahead of the runner and gating from the runner to the first mold in the cope, the metal will be clean.



FIGS. 1 AND 2. METHOD OF CASTING VALVES

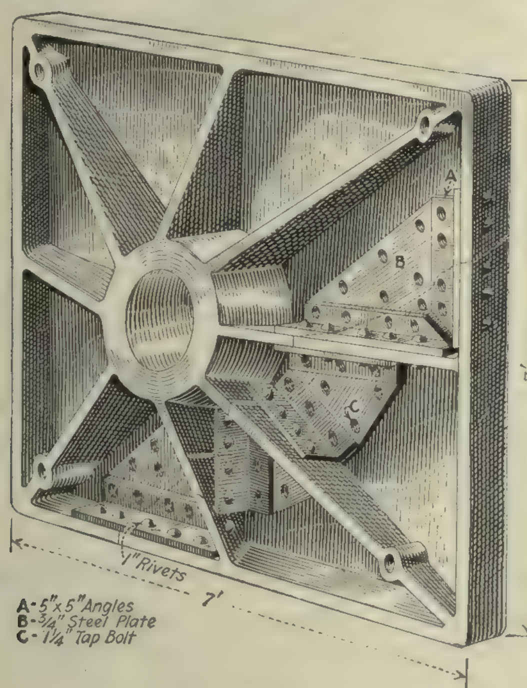
They may be tested for tightness by holding the stem end and tapping. A loose head will have a flat ring.

Letters from Practical Men

Repairing a Broken Accumulator Base

The illustration shows how we made a satisfactory repair to a broken accumulator base without dismantling it or unloading the tank.

After the plates and angles were fastened securely in place, the entire casting was filled in with concrete. I



REPAIRED ACCUMULATOR BASE

think the illustration is self-explanatory, but I may mention that the cause of breakage was faulty grouting.

Haddonfield, N. J. J. R. S.

Making a Lynch Pin

A lynch pin like the one shown in Fig. 1 was needed for a plow wheel. The head was to project over one side only and had to be beveled off, as shown.

The first set of tools made is shown in Fig. 2. They were for use in an Acme header. A heated bar was entered into the open dies up to the stop, and the machine was tripped; as the dies closed, the shear *M* cut the piece off the bar. The ram *O* then came up and entered the dies, forming the head entirely within the dies. The tools failed because the ram *O* could not be made to stand up; also, a fin developed between *O* and the dies.

The dies were then planed off back to the line *AB*, Fig. 2, and a new ram was made that was much larger and contained the whole head. These dies would make pins, but lots of them had a bad flash around the head; the job would have been all right if the pins had not been designed lopsided. The metal just simply refused to flow to one side and not to the other. The little job was having pretty much its own way when the chief implement designer gave me a sketch of a set of punch-press tools, as shown in Fig. 3.

The hot stock was pushed under a hook *G* into a half-round impression in the lower die *L* and against the stop *S*, which was bolted to the lower die. The upper die *N* came down and by a combined shearing and bending action cut off the first piece and made a head on the next one, as shown by the dotted lines. In practice, the bar was heated for a couple of feet and fed in continuously, the press running all the time. H. W. Johnson.

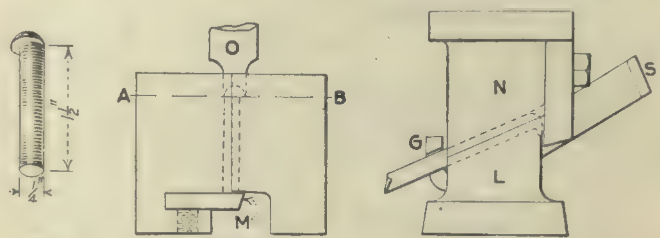


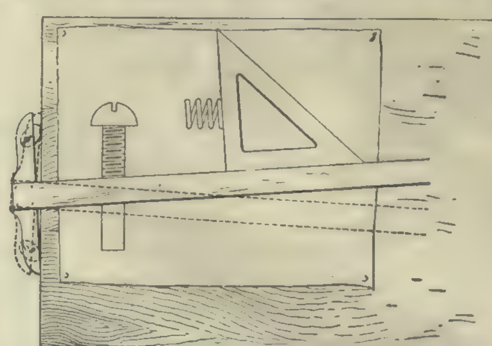
Fig. 1 Fig. 2 Fig. 3

FIGS. 1 TO 3. THE WORK AND HOW IT WAS MADE

Poughkeepsie, N. Y.

Attachment for Drawing Angular Lines

On shop drawings requiring series of parallel lines at angles, as for threads, springs and section lining, I have found the device shown in the accompanying illustration of advantage. It consists of an eccentric made of sheet brass and is attached to the T-square head by means of a small thumb-screw. The eccentric may be turned to give a variety of angles, and with the aid of the triangle, vertical angles may be obtained. A hole is made at both ends of the T-square head, and the eccentric is transferable to either end, as desired. H. Chait.



ATTACHMENT FOR T-SQUARE

Bronx, N. Y.

Guaranteed Output

In the establishment in which I am breaking in a planning department there are three electrically driven automatic machines, the output of each of which was "guaranteed" by the maker to be 4000 units an hour.

As a matter of fact, one got to doing only 2700, a second only 2300, and the third was "witching" and delivering nothing.

On request the adjuster, or "doctor," came around, tickled things with a screwdriver and pointed out (what I knew before, as I had been judge of awards in that line at the international exposition at which the machine made its début) that the speed could be regulated by moving a certain friction roll in toward or out from the center of a friction disk. But what I wanted was his statement as to the speed at which the machine should run to be most efficient—that is, to give a good output without chattering, or knocking itself to pieces. And I wanted that speed given either in turns per minute of some rotating member or lineal speed of a certain endless apron. That he could not tell me, although he was the professional, duly ordained adjuster—"trouble man"—of the concern.

So next day I sent for the head salesman and diplomat. When he came, he told me how young I was looking, offered me a piece of peppermint chewing gum and started telling a funny story. But when I insisted on "returning to my muttons," he informed me—what I also knew—that there were three causes for loss of speed: Lack of current, wear of commutator brushes and slackness of the driving belt. But as to naming a standard rotation speed of one part or a standard lineal speed of another—that was impossible. What I could do was at the end of the day see how many units each machine had delivered, speed up the next day by adjusting the friction drive, and so on until I had reached the 4000.

The next day, as two machines were "witching" and the third on strike, I sent for a "doctor." I thought myself justified, under the circumstances, in "letting George do it." This time it was another and very superior article of adjuster, with a larger screwdriver; and in the course of his hunting for the machine's *appendix vermiformis* he informed me, in reply to my innocent query as to why the wigglers did not wiggle, that there was absolutely no reason why the machine should not run one day just as fast as another.

So there I am. What I want to know is: (1) What does "guaranteed performance" mean? (2) How can anyone guarantee performance when he does not know what the normal conditions are, to produce the "guaranteed" result? ROBERT GRIMSHAW.

New York City.

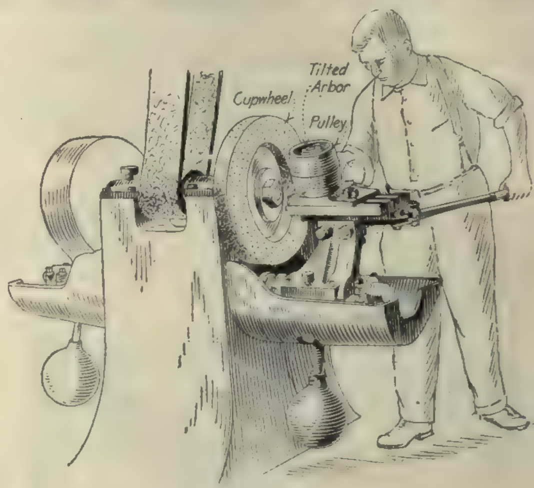
Finishing Pulleys on the Disk Grinder

The use of the disk grinder has resulted in some remarkable reduction in operation times, the pulley-grinding job herein described being an excellent example.

The necessary fixture is very simple. A shouldered stub arbor is mounted on a subplate at an angle equivalent to the desired crown, and the plate is bolted to the disk-grinder table. The shoulder on the arbor should be of such height as to allow the edge of the pulley to clear the fixture on either side. The frictional resistance of the hub to rotation is negligible, while if the edge is allowed to bear, the pulley must be raised too far above the center in order to induce rotation.

An ordinary abrasive disk will answer the purpose; the heavier built-up variety is somewhat better. The wear on disks is considerable, as the rapidly revolving pulley acts as an excellent dresser. The most satisfactory abrasive is a fairly coarse cup wheel, about 26-K Norton, which stands up well and leaves a good finish.

In operating, the upper half of the pulley is forced against the wheel and, being somewhat above center, im-



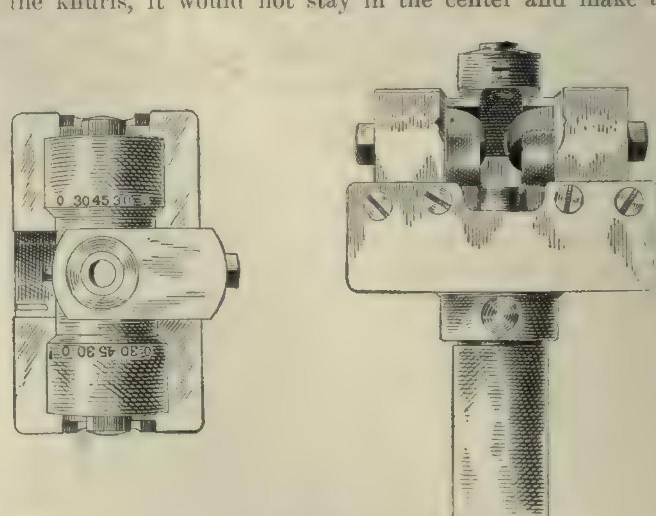
HOW THE PULLEYS ARE GROUND

mediately starts to rotate. If the casting is not extremely eccentric or shifted on the parting line, three or four passes across the face of the wheel put it in excellent condition. Reversing the pulley on the arbor, the operation is repeated for the other half. With fairly true castings, from 600 to 1000 pulleys can be finished in 10 hr.

Waterloo, Iowa. H. E. M.

Guide Bushing for Knurling Tool

In using a Brown & Sharpe knurling-tool holder with two knurls I experienced the following trouble: When the stock, which was $\frac{3}{16}$-in. round brass, was fed between the knurls, it would not stay in the center and make a



THE TOOL WITH GUIDE BUSHING

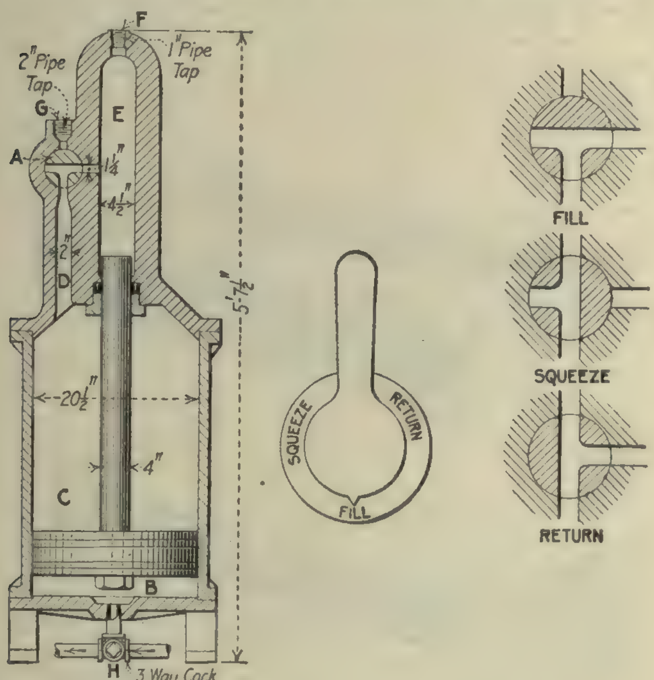
perfect knurl, but would move either above or below center and mar the stock. So I put on the knurl holder an attachment with a hole and a bushing in the front of the knurls the size of the stock to be knurled. This acted as a guide and kept the stock in the center, after which I got a perfect knurl. H. NORDEN.

Blue Island, Ill.

A Simple Hydraulic Intensifier for Use on a Band Press

The illustrations show a hydraulic intensifier, which while designed for use with a copper band press for high explosive shells is equally applicable in any other work requiring high pressure. The interesting feature of this intensifier is the provision for a rapid filling of the press under relatively low pressure, and a final squeeze at high pressure. Aside from this it has the desirable property of not depending on any unloading or relief valve, as the pressure cannot rise higher than the predetermined amount, though it can be held at that amount for any period of time desired.

Proportioned as here shown, the intensifier will give about 2500 lb. pressure per square inch if steam or air at



THE INTENSIFIER AND CONTROLLING VALVE

100 lb. is applied to the underside of the large piston as shown in the illustration.

The operation is as follows: If, with the piston down and the three-way valve *A* set as shown, steam is admitted to the space *B*, the oil in the cylinder *C* flows through the passage *D* and valve *A* into *E* and out at *F* to the cylinders of the press. The pressure exerted is somewhat less than the steam pressure. This brings the rams quickly up to the work. This part of the cycle is called the filling, and during the time it takes up the valve is set so that the index of the handle points to the word "Fill" on the valve dial.

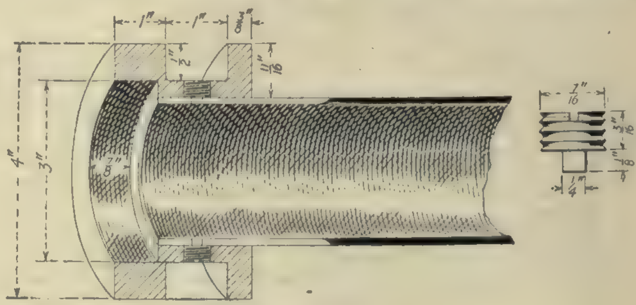
By moving the handle to index with the word "Squeeze" on the dial, the chamber *C* is cut off from *E* and the oil passes through *G* to a reserve tank. The pressure in *E* now rises in proportion to the plunger areas and completes the pressing. When this is done, the three-way steam cock at the bottom is set to exhaust and the piston begins to return. By setting valve *A* to "Return," chambers *C* and *E* are both connected to the reserve tank and the various parts assume their original normal position. G. M. Strombeck.

Moline, Ill.

Feed Repair on Gridley Single-Spindle Automatic

In the Gridley single-spindle turret lathe more or less trouble is often experienced with the pins that hold the brass spool to the end of the stock-pusher tube. These pins shear under certain pressure; but after the machine gets older the hole in the brass spool becomes enlarged so that the pin works loose, and this becomes a nuisance. We overcame it in a simple and efficient manner.

We drilled larger holes in the spool and threaded them with a $\frac{7}{16}$-in. tap. Screws with teats ⅛ in. long and ¼ in. in diameter were made to fit. The tops of the screws,



FEED-TUBE REPAIR

after being placed, came flush with the surface of the groove in the spool, the bottom of the threaded part resting on the tube proper with the teat projecting through the tube, holding the brass spool to the tube and acting as a shearing pin in case of excessive stress. The illustration shows the idea clearly. Let me say that we have had no trouble with the tubes since.

I should like to know what problems others have had with their machines and what they have done to overcome their difficulties. Problems in drafting are lacking in the *American Machinist*, and they would be interesting to the readers. Clinton J. Converse.

Bridgeport, Conn.

An Elastic Pattern

As might be incorrectly implied from the heading, this is not intended as an introduction of india rubber as a material for patterns. It is only a description of an interesting and highly useful pattern that resulted through the combined efforts of designer, pattern maker and foundryman. If it should succeed in convincing anyone that by such coöperation all concerned are benefited, the object of this article will be realized twofold.

The roller shown in Fig. 1 had to be cast, in composition and aluminum, in various lengths ranging from 8 to 36 in., with three sizes in between. It was of course desirable to make one pattern do for the whole job, which was done—hence the title of this narrative. It will be clear on inspection that this was a job for a good molder, but inasmuch as he was called in before this five-in-one pattern was made, there was no kick from that direction. Various ways were suggested for making a pattern to fill the essential requirements, but all were discarded with the exception of that illustrated, and it gave good service in use.

The pattern, shown in Fig. 2, was made in two parts *A* and *B* and molded, as shown in the figure, for the longest casting. When the smallest casting was desired, part *A* was

only rammed up as far as necessary; part B was set in as shown at B_1, and the mold was finished. Similarly, all intermediate sizes were molded.

The core box is illustrated in Fig. 3. The manipulation will be evident. Notches were provided at proper distances, and to make any length of core the movable print

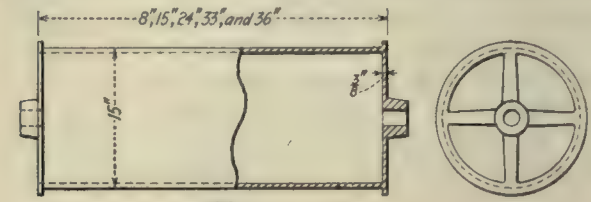


FIG. 1

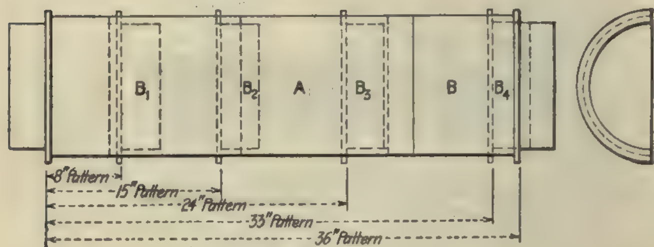


FIG. 2

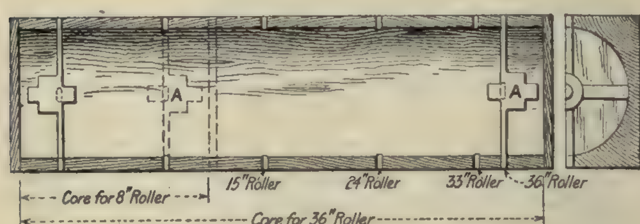


FIG. 3

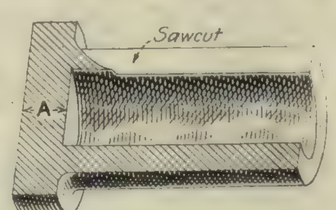
FIGS. 1 TO 3. CASTING, PATTERN AND CORE BOX

A had only to be put in the corresponding notch. The casting, naturally, was poured on end. Although a little trouble was at first experienced with the aluminum, the castings were clean and straight. The bronze castings gave no trouble at all. J. W. WUNSCH.

Brooklyn, N. Y.

Simple Foot for Use with Inside Micrometers

The ordinary type of inside micrometer is handy for measuring between concave surfaces, as in gaging holes, and to a less degree in measuring between parallel flat surfaces. But when one wishes to measure the distance between two convex surfaces, as for instance two buttons or two parallel shafts, the rounded points of the micrometer tend to run off the rounded surface of the work and make accurate measuring almost impossible. To obviate this, buttons, or false feet, can be made as shown in the illustration, of a certain definite thickness at A. The shank is split to form a good grip on the micrometer rod. These feet are also of advantage when using the micrometer as a height or depth gage.



FOOT FOR INSIDE MICROMETER

Elkhart, Ind. S. M. RANSOME.

Casting Annealing Pots with a Minimum Amount of Labor

The accompanying illustrations show an annealing pot for which we had a large order. The pattern was made box shape, 30 in. long, 10 in. deep and ½ in. thick, with two flanges on each side 2½ in. wide and ½ in. thick. For some time we were able to make only five of these pots each day. After slightly changing the pattern, we now produce 40 each day with the same labor and considerably less trouble.

At first we made the castings in the regular way, as in Fig. 1. Now we have removed the bottom of the pattern and placed two long cores with a recess 2½x½x30 in. along each side, to form the flanges.

The pattern is put on the ground with the two cores on each side, as shown in Fig. 2. Both the inside and the outside are rammed up at the same time, then slicked off even with the pattern and the top of the flask, and the

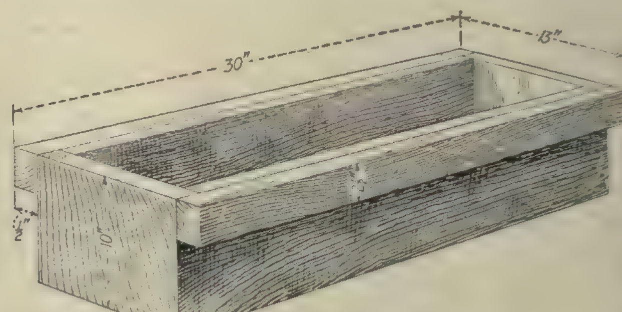


FIG. 1

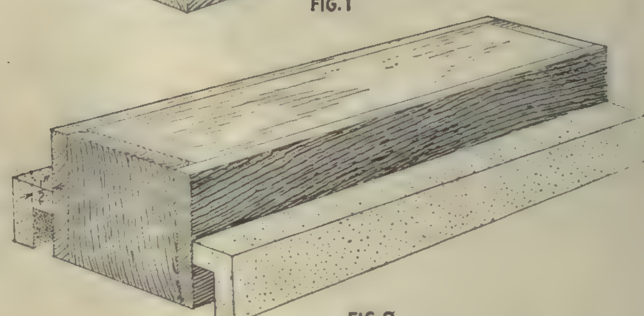


FIG. 2

FIGS. 1 AND 2. OLD AND NEW METHODS OF MOLDING

cope rammed up. Next, the cope is removed, and the required amount of sand is taken from inside the pattern to form the thickness of the bottom of the casting. The pattern is then removed and the mold closed ready to pour. One man is able to do all the work, as there is only the cope, which is very light and does not require two men for lifting. A. E. HOLADAY.

Naugatuck, Conn.

Keeping Track of Cutters

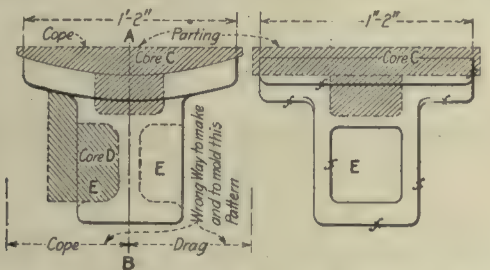
To make easy the work of returning cutters from the tool grinder to the department from which they come, a number of V-shaped cards with the department letter printed on them are kept on hand by the tool grinder. As soon as a cutter is sharpened, a card is inserted in the hole of the cutter. When the errand boys come around, a glance only is necessary to determine to which department the cutters belong. D. E. MAPES.

Milwaukee, Wis.

Discussion of Previous Question

Efficiency in the Pattern Shop

On page 956, Vol. 44, John J. Eyre writes: "When the work (pattern) is received at the foundry, the foundry foreman refuses to accept it until it has been changed to suit him, and these alterations entail extra cost and delay." The pattern here shown is for a tank saddle cast in steel, and 75 castings were wanted. It is a very good example of the kind of patterns referred to in Mr. Eyre's article. When a large number of castings are to be made from a pattern, either simple or complicated, I take the matter up with the foreman of the foundry. Very often, as it was in this case, the foundry in which the castings are to be made is located in another town some distance



RIGHT WAY AND WRONG WAY TO MAKE THE PATTERN

away. It is then that the patternmaker's knowledge of the molding game is called into action. Guesswork on a 75-casting job is poor policy. The pattern, if it is made wrong, will be returned, or the necessary changes will be made in the local jobbing pattern shop and the bill rendered.

This pattern was made in halves, split at the line *AB*, to be molded one-half in the drag and one-half in the cope. This construction is quite contrary to practical patternmaking and practical molding. This is especially true of patterns from which steel castings are to be made.

The molding of one-half of this pattern in the cope makes necessary the following: For every mold or flask put up by the molder in his day's work, a special cope flask must be rigged up with sand bars to aid in securing and supporting the heavy and irregular body of sand in the cope. To aid further in securing this sand, gaggers are also used. The slab core *C* must be firmly secured in its place so as to prevent it from shifting or falling back into the mold, all of which means extra cost and delay that can be avoided with practically constructed patterns.

The pattern was changed by the foundry foreman and molded as follows: The two halves of the pattern were fastened together. The pockets *E* were changed to mold in the core, as at *D*. The whole pattern was molded in the drag. No cope was used, the core *C* answering the same purpose. Any old box that looked like a flask was used for the drag. With the split pattern about five castings would be a day's work for the molder, while 12 to 15 castings could be made the first day from the practically made pattern. M. E. DUGGAN.

Kenosha, Wis.

Drafting Room Versus Shop

The article by Charles M. Horton, on page 147, on the eternal strife between the drafting room and the shop, from the draftsman's point of view, shows a disposition on his part which, if it were more generally true of most draftsmen and designers, would tend to lessen the friction between the man at the board and the man at the machine.

In its final analysis the article is simply an excuse for the mistakes made by the draftsman and his reasons for making them. Mistakes, not of design (for the average man in overalls and jumpers is hardly competent to pass judgment on that), but of execution in the drawing. Believe me, if the mechanics made as many "buhls," as his Russian friend calls them, there would be a wholesale "fire-fest" in the machine shop.

But the best of us will make mistakes, and as each is dependent on the other for the success of the final product a spirit of "get together" on the part of each would help to eliminate, partially at least, the strife between the two.

"But it certainly does start the blood boiling in a draftsman when a grinning machinist points out an error in a drawing." It also starts the blood boiling in a machinist who is sure of his ground and whose ability has been proved, when some draftsman (not all, I am glad to say) with supercilious assurance strives to impress upon him his superior knowledge of the machinist trade; not his only, but the molder's and the patternmaker's also.

As long as these two—the supercilious draftsman and the contemptuous machinist—come together there will be trouble. But I speak to the fair-minded men in both lines, asking them to concede each other's knowledge and ability, to give and take, learn from each other and take and give criticism in a fair, open spirit. Then both will have a common ground for understanding and mutual help. J. C. MACKY.

Woodhaven, L. I.

I wish to express my thanks and those of my fellow draftsmen to Charles M. Horton for his excellent article on page 147 entitled "Drafting Room Versus Shop," in which he artistically sets forth with accuracy, comprehension and understanding the psychology and the trials of draftsmen. Our language is one mostly of lines—mechanical lines—words we use only incidentally. Consequently we suffer somewhat in interpreting ourselves to men whose language is chiefly one of words. That deficiency Mr. Horton has supplied most excellently.

As the subject is now in our minds, may I add a few more of the draftsman's troubles and limitations with which the shopman may not be familiar?

One arises from the fact that in many places the draftsman is disregarded and neglected, because he is designated a nonproducer; and so any old equipment and atmosphere are good enough for him. Now there are drawing boards on which a man can work without being pivoted on his

pneumogastric nerve, without pushing his breastbone into his stomach, without deviating from that upright attitude that is one of his distinctions from the beast. And there are drawing boards on which he has to do all the aforementioned things in order to work. They abound in plants that would not dream of using a machine correspondingly inefficient. I foresee a time when these poor drawing boards will be kept in museums as examples of the unintelligent sacrifice of the health and productivity of draftsmen in that barbaric period—the beginning of the twentieth century.

The atmosphere in some drafting rooms makes one marvel at the endurance of the human. One little box of a room in which it was my misfortune to be confined for some time was situated around the main steam riser, which carried the steam for three or four entire floors. We never had the steam turned on; this main riser was more than enough, the temperature soaring to the vicinity of 90 deg. F. And the air was foul and dead.

We observed that our best ideas came to us in the washroom. Now there was nothing inspiring about that place. It was not up to the usual standard, and I long ago came to the conclusion that it was just the comparative coolness and freshness of the air that accounted for our inspirations there. In the drafting room it was an effort to keep awake, and it was a much more strenuous effort to design.

"Why didn't you open a window?" queries some brother. Well, we did; and there was almost a riot. Some one in the throes of a cold or recovering from one would raise his voice in protest. "His head was hot and his feet were cold"—literally. "He was being cut in two by the draft."

In another drafting room, located in a modern plant, the air would get so bad that the boss would throw open every window to its maximum in below-zero weather to air it. And this plant had a heating and ventilating system. But the engineer kept for himself all he could save on the coal bill, and I have often wondered whether in his zeal to save he pumped the same old air into the room over and over again, instead of taking fresh air from the outside, which would necessitate burning more coal to heat it.

Another limitation is the boss and the hierarchy of bosses that extends above him. Now the boss generally has different standards from the shop. He has to get the drawings out cheaply and frequently within a certain time. His chief consideration is not for the shopman, but for those above him who often are distinguished more by executive ability than by any knowledge of shop requirements. To his instructions the draftsman must work—or get out—whether they be good or bad. Often we draftsmen have to do things we know are not right from the standpoint of the shop just because we are instructed to do them. To argue against them is sometimes to provoke anger and antagonism. So we don't argue but simply do as we are told.

Of course, all bosses are not like this. Some—all honor to them—will listen to the draftsman's case and give his way the preference if he can prove its superiority. Some, indeed, will give him credit for it.

There are some draftsmen who do not know how to consider the shop end, having had no experience in it; but many of us who do know how are not allowed to give effect to our knowledge. J. J. Woffington.

Springfield, Mass.

Making Drawings for the Pattern Shop

The article on page 138, relative to "Making Drawings for the Pattern Shop," brings to mind a similar method used by several factories with which I have been affiliated, which I think will be of interest.

The draftsmen, in detailing parts that call for castings, first make an accurate line drawing showing the plan, elevation and side views. The plan and side views are then cross-sectioned and necessary dimensions placed on the three views to permit making the pattern. Tracing cloth is placed over the drawing and a pencil tracing made of the three views, enabling the draftsman to finish the drawing for the machine shop, adding the necessary dimensions and notes. The line drawing is shellacked and delivered to the pattern shop, as a pattern drawing of record in place of a blueprint.

This method eliminates the necessity of a layout, as the drawing primarily is a layout and is made for that purpose, with no more than the necessary pattern dimensions. The system has proved inexpensive, and it eliminates a lot of useless additional work on the part of the pattern foreman. F. H. Korff.

Chicago, Ill.

Employment Bureaus for Classifying Workmen

The article by E. W. Johnson, on page 64, brings out a point that is of vital interest to the manufacturer of the present day. That it costs the average manufacturer a substantial sum of money annually to break in new men is a fact that no one will deny; and if someone could originate a simple method of classifying workmen, a system that would prove just to both employer and employee, he would without doubt supply a long-felt want.

Even good workmen will persist in drifting from shop to shop, but Mr. Johnson's statement that their object is to find a "soft" job does not hold true in all cases. Workmen of all trades aim to find employment where conditions are good and their surroundings cheerful; and when a job does not suit them, they look for another. Men often have queer reasons for quitting. I recall one good tool maker who left a good place because smoking in the shop during the noon hour was prohibited. In another shop a good workman quit because the time clock was nearly a fifth of a mile away from his work and the management would not allow the men to ring in and out at the same time during the noon hour. A draftsman whom I know left a good-paying position because the management requested him to refrain from chewing tobacco.

From this I do not mean to infer that the management of any shop should cater to every passing whim of the workman, but nevertheless the fact remains that workmen eventually settle where the surroundings are congenial.

It is a fact that workmen often overrate their ability when seeking a situation, but are we not all inclined to do this? Is it not the tendency of human nature? In looking for employment we all wish to create a good impression, and we realize that we must convince the management that our services will prove of value in order to be placed on the payroll. This fact often leads the worker

to over-estimate his ability, hoping that he will make good, even against heavy odds. This trait of human nature denotes ambition if nothing more, and shows that the worker wants to succeed in his chosen calling.

It is no small task to state accurately a workman's ability, owing to the fact that a man may make good in one place and fail utterly in another. I recall an incident that happened to me some years ago. I had secured a job as die maker at good wages, the foreman hiring me at my figure. In boring out a die on a lathe, the die slipped from its setting slightly and was spoiled, the result being that I was discharged. Now that man could not recommend me as a good workman, owing to the fact that I spoiled a valuable piece of work through misfortune, or as he would say carelessness.

Unfortunate accidents of this nature often give a workman a black eye, so to speak, but it is not just to condemn a man eternally because of them. For example, consider the following case: A young tool maker was boring a jig on a universal miller, and in some unknown manner his hammer fell on the miller knee between the saddle and the upright. The knee, of course, had to stop when it reached the hammer, and an examination of the crossfeed screw showed that it was badly out of shape, and that a new one was necessary. The man in question was not discharged; but the management thereafter refused to raise his pay, notwithstanding that he was an excellent workman of a willing disposition. He quit a year or so afterward, and the last time I met him he was receiving high wages in a place he had occupied for over three years. His present employer, no doubt, would be willing to recommend him highly, while his former foreman would shake his head doubtfully, stating that the man was too careless to trust with high-grade tools.

It is a very good plan for a workman to have two or three letters of recommendation, written on regulation letterhead paper and signed by the superintendent or some other person in authority. As no firm that has a reputation to protect will recommend a man who is not up to standard in his particular line, these letters can be taken at their face value. I will admit that Mr. Johnson's Classes A, B, C, D and E are theoretically correct and would work out in practice if a workman invariably made good on every job he undertook; but good workmen sometimes make unfortunate blunders, which should not be allowed to underrate their ability as a whole.

A state labor bureau might prove of value, provided it was run on an impartial basis for the benefit of the worker as well as the manufacturer and kept wholly free from political influence. As the matter stands today, however, the manufacturer will have to do as he has done in the past—that is, take a chance in hiring men and retain those who come up to his standards, ever bearing in mind the fact that workmen stick where their surroundings are pleasant. F. B. Jacobs.

Indianapolis, Ind.

Discarding Micrometers

As so interestingly told by W. D. Forbes on page 1132, Vol. 45, micrometers, in common with wire gages and similar devices, are never thrown away.

This reminds me of a micrometer that came in contact with a milling cutter about 20 years ago. It was so badly damaged that the makers declined attempting to repair it. This placed it so near the discard that I came to be the owner at no cash outlay. I cleaned it up and etched the name of a very small boy on it. It served him as a plaything, hammer, etc.

Imagine my surprise on meeting this same small boy, now grown to man's estate, to be told that this same micrometer has recently served for some time as the only micrometer in a manufacturing establishment that, from the number of men employed and the character of the output, should keep several first-class micrometers fairly busy. William S. Rowell.

Wilkinsburg, Penn.

Dashpots for Starting Rheostats

On page 121, Mr. Bennett states that little attention has been given to starting apparatus for electric motors. This assertion, I know, is not in keeping with facts. Still, there are no highly satisfactory low-priced motor starters on the market. The motor starter has a great deal of attention from the viewpoints of the user, the manufacturer and inventor. I have designed at least a dozen motor starters and experimented with several types of dashpots; and in spite of the fact that there is one starter built according to these designs and now on the market, I do not regard the problem as solved. A low-priced motor starter, doing its duties independently of the operator, still offers a virgin field for inventors.

The dashpot shown by Mr. Bennett does actually retard the moving of the starting lever, but it will also retard the lever when moving back. This will in many cases lead to serious complications, as it is often necessary to stop the motor suddenly when just speeding up. This is a serious objection. Practically every starting box is provided with a magnet for holding the lever in position, and releasing it automatically when the voltage across the line drops below a fixed minimum. The dashpot as shown will hold the lever in the running position, even after the voltage has been taken off the line accidentally or by opening a main switch.

When the circuit is closed again, the resting motor not opposing the inrush of current, its resistance while at rest being negligible, there is practically a dead short. The fuses will blow, or in case of an unprotected motor the machine itself will burn out. A small ball valve in the bottom of the cylinder or in the piston will eliminate a part of the retardation, but still it will be found to be impracticable to produce a cheap dashpot that will stand long service and always let go the lever in time. Even without this extra incumbrance, starting levers often stick, when the contact knobs are slightly burned.

A very interesting problem heretofore not satisfactorily solved is a motor starter for small capacities, say up to 8 hp. Such small motors do not need a resistance box; only the fuses have to be protected while starting. The great flux of current then will blow them, and therefore by connecting the fuse blocks simultaneously while putting the switch in and then removing this current-carrying connecting piece, after the motor has gained speed, the fuse itself will take the running load. Taking the connecting piece out of the circuit can be done by a magnet, a spring, a dashpot or even a pendulum timing device. To do it commercially is a problem worthy of the attention of the cleverest. Jan Spaander.

Brooklyn, N. Y.

The Coincider

On page 88 Mr. Brophy refers to the man who always agrees with everything the boss may say to him. What about the boss who is not satisfied with any other kind of man? There are plenty such bosses, and they are in the manager's chair as well as in the gang boss' overalls. They ask advice of their lieutenants in the spirit of seeking self-assurance rather than criticism. They resent a man's showing the courage of his own convictions, and the only way to get along with them is never to let them think you have views that differ from theirs.

There is probably no place in the shop where an executive of this sort can make such a nuisance of himself as in the designing room; he forces his ideas, good or bad, into every new machine built. When he is an engineer and really knows, it is not so bad; but that is seldom the case.

A designer may perhaps spend weeks upon a machine, laying out, discarding and relaying out, giving every detail the benefit of careful thought and judgment. Yet an executive of the type I have referred to is able to look over his shoulder and in three minutes relegate the entire thing to a scrap heap. In eighteen seconds more he has shown an immensely better plan. No arguments can dampen his enthusiasm any more than that of a perpetual-motion inventor. In his eyes the best proof of a good designer is the agility with which that individual recognizes the merits of his schemes. The only thing to do is to agree with him.

It is deplorably true that such men can always find underlings who will play the rôle required, and by their apparent agreement furnish the boss with the necessary supply of self-confidence. C. E. SERVICE.

Rochester, N. Y.

The Five Metric Myths

My attention has been called to the article on page 93 by Mr. Halsey with the title "The Five Metric Myths," presented specially as an answer to an article of mine in the December, 1915, number of the *Scientific Monthly*. Those readers who saw Mr. Halsey's forceful presentation will doubtless wonder what sort of a rejoinder could be made to it. I will try to give a fair and brief one.

First of all, as far as my knowledge goes, Mr. Halsey's statements of facts, especially his specific statements, are correct. However, it does not follow from this concession that his conclusions are correct or that the reasoning from his statements is not fallacious. Only those who have put to the test both systems of units are competent to compare the merits of the two or competent to judge between them. College professors in this country have had this experience, and they are practically of one mind in refusing to accept Mr. Halsey's contested points. A young Swedish engineer of my acquaintance out of his double experience condemned our system utterly. Those nations now using the metric system show no purpose nor even tendency to go back to any old system. The adoption of the French system by the English after the war is now freely predicted, and if they do we alone will be outside the pale.

Does Mr. Halsey know that it took three or four centuries for the Arabic decimal notation to replace the Roman notation? The old system used pebbles or the like instead of figures, the Roman numerals being employed merely to record the answer. I am sure Mr. Halsey's adroitness would have enabled him four centuries ago to make out a good case against the Arabic numerals.

Leaving it to others to deal with the other myths, I will turn to that one in which I am specially interested—the educational metric myth. In the *Educational Review* for October, 1916, will be found an article by me that gives a tolerably full explanation of how two-thirds of a year of a child's educational life would be saved were the metric system in use in this country. It is based on German programs of studies and on the common understanding of the comparative knowledge of arithmetic for practical purposes of German and American children.

Mr. Halsey gave a *reductio ad absurdam* proof of the fallacious claim that two-thirds of a year is saved when he showed *that less than this time is used for the full elementary course in the New York City schools.* But there is one fact he overlooked. In the old days, when four years were given to arithmetic, the graduates of our schools could solve all the problems in the book. In these degenerate days, when the fads have crowded arithmetic out of the curriculum, leaving only seven months of time for it, the pupils do not know common fractions when they come out of our schools. I was told the other day by a teacher of sewing that the graduates of high schools have a serious time with such a problem as finding one-half of 25½ or 25¾ inches. Ye gods! would that have troubled any one of the pupils of the old régime? I know little about the arithmetical ability of the graduates of the Gotham schools, but have heard enough from the men of Chicago as to what they think of the present-day arithmetical instruction to make me skeptical.

The American people need but to know well that metric arithmetic is much easier to learn than our present arithmetic and textbooks would need to be scarcely more than half their present size. If that portion of the National Association of Manufacturers that is blindly holding onto the old units and the old arithmetic could but know how much easier the new arithmetic would be for their children in school, they would push expense aside and themselves force the adoption of the new. The total cost to make the changes needed in manufacturing has been set at $600,000,000. If the two-thirds of a year is a fair estimate, then the *annual* saving through education alone is over $200,000,000, since it means the cost of educating about 2,000,000 children for two-thirds of a year.

It is often curiously true that from a long list of apparently very convincing facts an entirely fallacious conclusion is derived, and that is the case in this instance.

In conclusion, perhaps one more illustration of the wonderful absurdities of the old system will be allowed. I asked a half-dozen druggists, part of them oldtimers and able men, and the others fresh from the schools, whether a pint of water at 60 deg. F. weighed a pound, making, of course, a fluid ounce of water weigh an avoirdupois ounce. Part of them said it did, exactly, and the others said they did not know. The chances are that 19 out of 20 druggists would give either one or the other of the foregoing answers, and they use this truth in dispensing medicine. Figure it out for yourself, reader, but know that nine out of ten school teachers in this country could not do it. In the metric system a liter of water weighs exactly a kilogram. JOSEPH V. COLLINS.

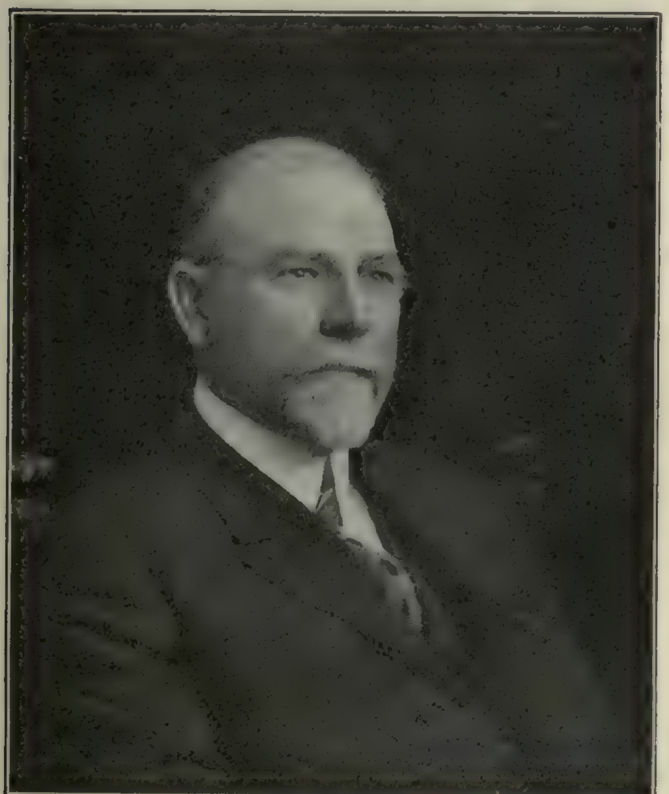
Stevens Point, Wis.

Editorials

Announcing a Step Toward Broader Service

Service is the businessman's abbreviation of the Golden Rule. The hope of Service sells machine-shop products—the realization of this hope repeats the order.

The *American Machinist* was founded on the rock of Service *to* machine-shop men. Its forty years of steady growth have demonstrated the appreciation of service *by* machine-shop men. And in the future, as in the past, the heart and soul of the *American Machinist* (for helpful publications do indeed have hearts and souls) will be devoted to the extension and the intensification of its particular service—the spread of technical information for machine shops.



JAMES H. McGRAW

A man is known by the company that he keeps—a magazine by the company that publishes it. The *American Machinist* is proud to have been a member of the Hill family of five that were reared in the religion of Service by John A. Hill. And we are equally proud to announce that hereafter the *American Machinist* will be a member of the McGraw-Hill family of ten.

The two publishing companies that have stood without equivocation for the development of a real Service in their respective technical fields—the McGraw Publishing Co. and the Hill Publishing Co.—have amalgamated so that their common aims may be more effectively carried out for the benefit of those whom they serve.

Readers of this journal are familiar with the history of the late John A. Hill, the record of whose progress from railroad fireman to head of the Hill Publishing Co., reads like a romance. James H. McGraw, the president of the new McGraw-Hill Publishing Co., equally exemplifies in his rise from teacher in a country school to head of the largest technical publishing company in the world, the fact that ability will force its way to the top. When the subscription representative of the *American Machinist* calls to see you next time, you can, with good precedent, regard him as perhaps the future head of some large corporation, for when Mr. McGraw came to New York to enter the publishing business, he became a subscription solicitor, and what is more, a subscription getter.

Getting small things leads to getting big things, and in 1888 at the age of 28, Mr. McGraw became the sole owner of the *Street Railway Journal*, which is now the *Electric Railway Journal*. This was the beginning of the extensive publishing business developed and controlled by him. His policy of service to readers caused this journal to keep pace with and even lead the enormous development in electric traction which has taken place since that time.

Eight years after this, he became owner of the *American Electrician*, a monthly periodical. Three years later, seeing an opportunity to extend the influence and service of his publication in this field, he acquired the two leading weekly electrical journals—the *Electrical World* and the *Electrical Engineer*. All of these were consolidated into one publication, the *Electrical World*, which stands today in the electrical field as does the *American Machinist* in the mechanical field. Shortly after this the McGraw Publishing Co. was formed to control the properties mentioned above.

The *Engineering Record* became a member of the McGraw family in 1902. This is the only publication in that family which covers a field also covered by a Hill publication.

The *Engineering News* and the *Engineering Record*, occupying practically similar fields for the last quarter-century, will be combined and known as the *Engineering News-Record*, the first issue of which will appear on Apr. 5. The remaining nine technical journals published by the new company, including the *American Machinist*, will each continue to serve its readers in its own distinct field, but with increased effectiveness.

During 1902, Mr. McGraw, with others, started in Philadelphia a publication known as *Electrochemical Industry*. This was the beginning of the McGraw semimonthly *Metallurgical and Chemical Engineering* of today.

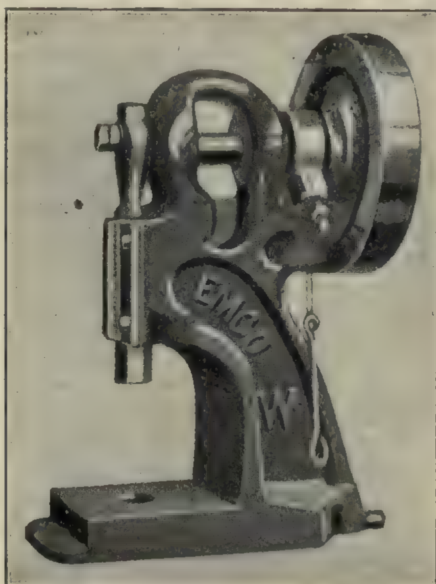
Electrical Merchandising was a comparative newcomer to the family already strong in numbers and strong in service, the first issue under the new name and manage-

(*Continued on page 440*)

Shop Equipment News

Small Power Punch Press

The illustration shows a small bench power punch press that has been brought out by the Enterprise Machinery Co., Chicago, Ill. The aim of the maker has been to manufacture a small power press for the use of small parts makers that could be marketed at the price of the ordinary foot-power press. It may be so arranged as to discharge by gravity and may be fitted with an automatic feed for high-speed production. The press is 20 in. high, weighs 110 lb., has an adjustable stroke up to ½ in., a 4-in. die space, two striking pins, a brake and a standard clutch.

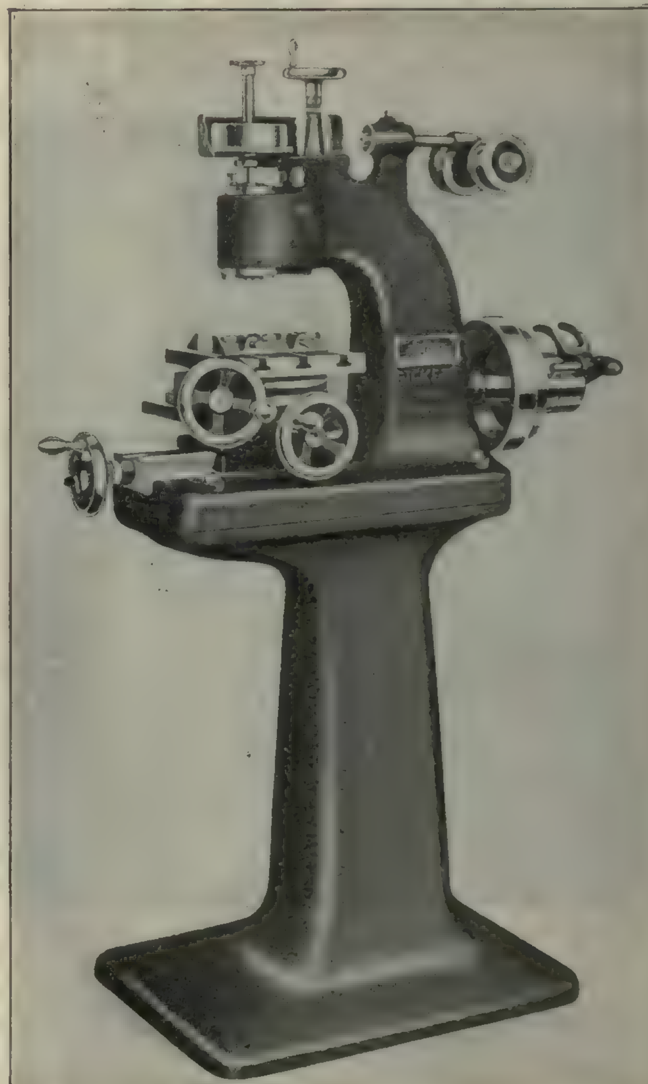


PUNCH PRESS

Vertical Miller with Adjustable Spindle Head

The machine here shown differs from the ordinary small vertical miller in that it has an adjustable spindle head and a stationary knee. This gives a very rigid table, reduces vibration and helps maintain true alignment at all times. The machine is especially designed for high-speed, accurate production. It will safely run at continuous high speed and is valuable for such work as die sinking, letter cutting, cam milling, splining, profiling and the varied work on sewing machines, typewriters, scientific instruments, firearms, etc. The machine is entirely self-contained and very convenient of operation. If desired, this machine can also be furnished with a lever feed attachment in place of the elevating screw. This attachment is handy for certain classes of work, such as profiling and the like.

The spindle is of crucible steel, accurately ground. It is mounted on high-grade radio-thrust bearings and is provided with means to adjust for wear. The nose is fitted with a No. 3 Hardinge draw-in collet operated from the top of the spindle. The spindle head is well gibbed to the column and is adjusted by means of an elevating screw fitted to a standard just back of the spindle. The various feeds are provided with adjustable graduated dials. All screws are Acme thread. The rotary table is operated by means of an Acme thread screw meshing with a large worm gear. This feed can be thrown in or out at will, and an efficient method of taking up wear is provided. This machine is made by the Bickett Machine and Manufacturing Co., Cincinnati, Ohio.

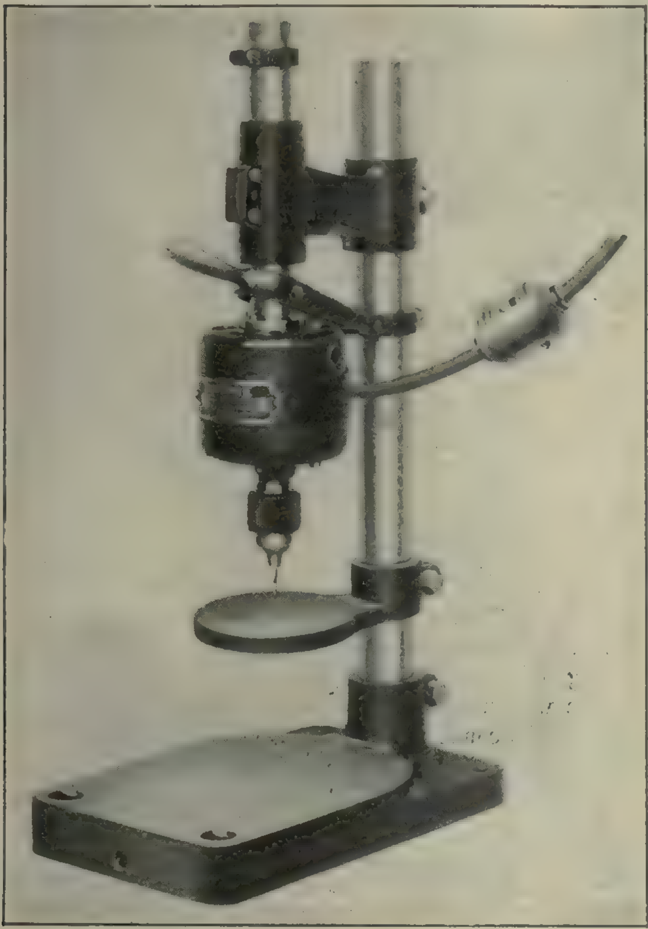


VERTICAL MILLER WITH ADJUSTABLE SPINDLE HEAD

Longitudinal feed, 6 in.; traverse feed, 5 in.; vertical feed, 2 in.; table is 7x10 in. and has three ½-in. T-slots; distance from spindle nose to top of table, 4¼ in.; total height of machine without pedestal, 26 in.; spindle will run up to 2500 r.p.m.; spindle pulley is 1¼x4 in. in diameter and has lower flange and belt guard; intermediate pulleys are 1¼x2½ in. in diameter flanged both sides; two-step cone pulley is 1¼ in. wide by 8 and 6 in. in diameter; loose and tight pulleys are 1¾ in. wide by 3½ in. in diameter; base is 11x20 in.; total weight, about 200 lb.; regular equipment, toolmakers' vise, 1 in. high by 6 in. wide, 6-in. opening; one No. 3 Hardinge collet; draw-in attachment; necessary wrenches. Special equipment: Pedestal 26½ in. high.

Electric Sensitive Drilling Machine

The Wisconsin Electric Co., Racine, Wis., has placed on the market a small electrically operated sensitive drilling machine, intended especially for the use of watch, jewelry or instrument makers. It consists essentially of a base supporting a cylindrical upright to which the work



SENSITIVE DRILLING MACHINE

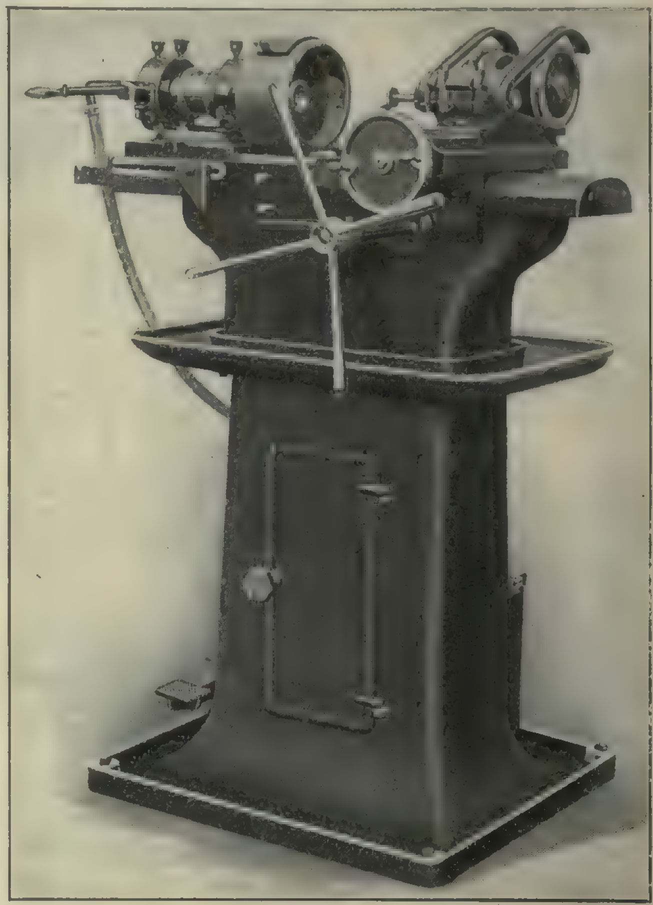
Height, 18 in.; weight, 15¾ lb.; drills to the center of work 6 in. in diameter; capacity, in steel up to $^{3}/_{32}$ in., in brass, aluminum or alloys, up to $^{13}/_{64}$ in.; speed, 6000 r.p.m.

table and the arm supporting the motor are attached. The feed is by means of a lever, a spring serving to keep the spindle in its upper position. The chuck, which has a capacity up to $^{13}/_{64}$ in., is mounted directly on the motor shaft, which runs on SKF ball bearings. The revolving parts are dynamically balanced to reduce vibration. The table is adjustable and may be swung entirely out of the way for the purpose of drilling work placed on the base. The motor is equipped with universal windings in order that it may be used with either direct or alternating current.

Internal Grinder

The grinder shown is one of the recent products of the Lansing Stamping and Tool Co., Lansing, Mich., and is known as the Capital internal grinder. The table is a single unit fitted to the ways on top of the base and is operated by a rack and pinion, passing beneath the cross-slide, which carries the wheel-spindle head. A roller and dog are used at the back of the table to operate a brake mechanism for stopping the work spindle for gaging purposes. The work-spindle head may be swiveled on the table to any angle up to 90 deg. The spindle runs in SKF ball bearings and is threaded on the nose to hold a standard chuck.

The grinding-wheel head is made in two sections carrying the wheel spindle and the driveshaft. The driveshaft head is so arranged that the center to center distance between the two shafts may be adjusted in order to



INTERNAL GRINDER

Capacity, ¼ to 2 x 2 in.; swing over table, 8 in.; work-spindle speeds, three, 50 to 200; table travel, 10 in.; table, 36 x 7 in.; length of work spindle, 10⅜ in.; length of cross-slide table, 15 in.; belt adjustment, 2 in.; grinding-spindle speeds, three, 15,000, 18,800 and 30,000 r.p.m.; diameter of thread on work-spindle nose, 2 in.; diameter of hole through work spindle, 1¼ in.; floor space, 30 x 50 in.; total weight of machine, stand and countershaft, 1300 lb.

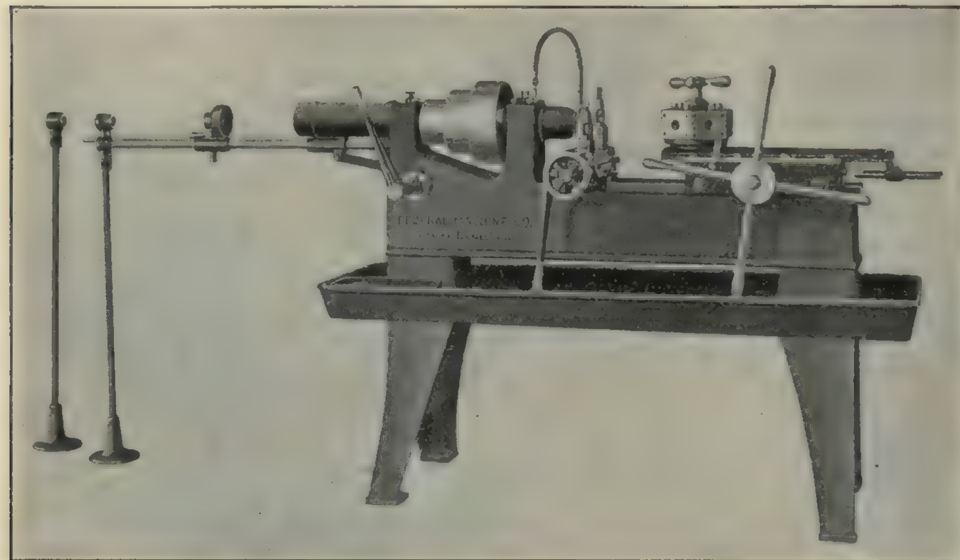
provide proper tension in the endless canvas belt. The wheel spindle runs in SKF ball bearings.

If desired, the machine can be furnished with water attachments consisting of a gear-driven pump, a water guard for the work spindle, water tank and proper piping.

Plain-Head Screw Machine

The Federal Machine Co., South Bend, Ind., has recently brought out what is known as its No. 3 plain-head screw machine. The head and bed are cast in one piece, and the spindle runs in phosphor-bronze bearings. The automatic chuck and bar feed are operated by a lever at the front of the head. The turret is made with six tool holes, each fitted with self-aligning and self-raising binder bushings, and bolt holes are provided for securing tools to the faces. The turret is revolved automatically by the reverse movement of the slide. The turret-locking

bolt locks at the extreme edge of the turret in taper bushings. Independent adjustable stops are provided for each position of the turret. The turret saddle has taper gibs for side adjustment. The cut-off has adjustable stops, graduated dial on the handwheel, and combination lever or screw feed. An adjustable wedge is provided for raising or lowering the tools. The cut-off saddle is bound to the bed by a single screw. A lubricant pump is provided and a tank is placed between the legs at one end.

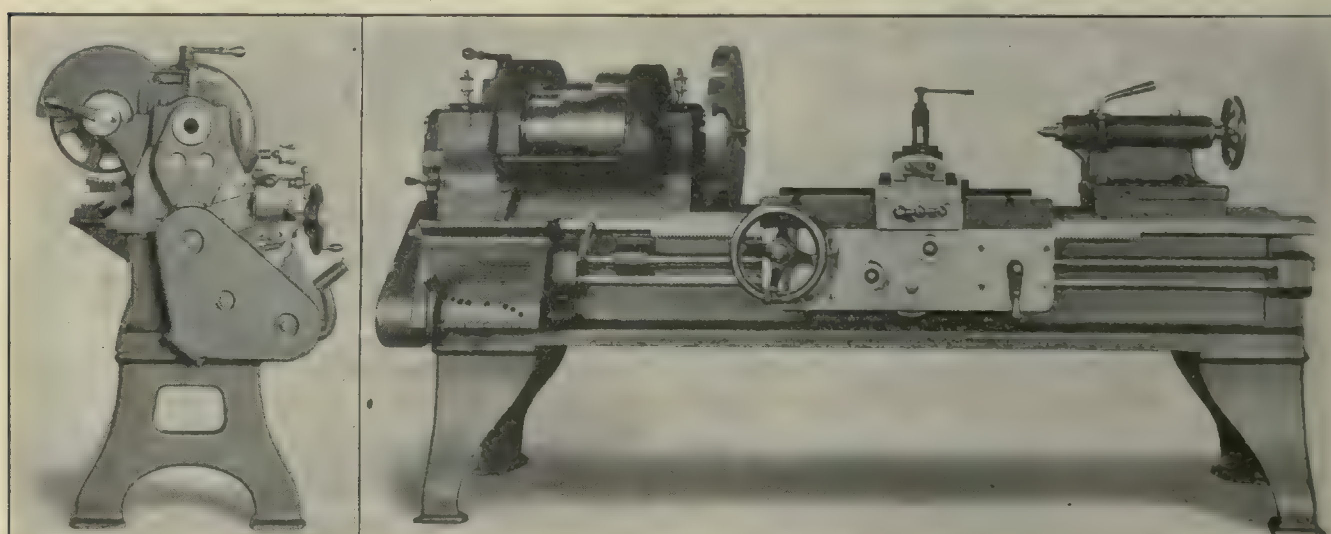


PLAIN-HEAD SCREW MACHINE

Chuck capacity, $1\frac{5}{16}$ in. round, $\frac{29}{32}$ in. square and $1\frac{1}{8}$ in. hexagon; hole in automatic chuck plunger, $1\frac{5}{16}$ in.; hole in spindle, $1\frac{9}{16}$ in.; length that can be turned, 8 in.; maximum distance, end of spindle to turret face, 19 in.; swing over bed, 14 in.; swing over cutoff slide, $6\frac{1}{2}$ in.; distance across turret faces, $8\frac{3}{4}$ in.; diameter of turret holes, $1\frac{3}{4}$ in.; size of tapped holes in turret faces, $\frac{7}{16}$ in.; size of tools in cutoff, $\frac{5}{8}$x$1\frac{1}{4}$ in.; floor space, 2 ft. 3 in. by 7 ft.; weight, 1670 lb.

Double-Back-Geared 18-In. Lathe

The illustration shows the latest design of 18-in. engine lathe manufactured by Flather & Co., Nashua, N. H. This lathe retains many of the well-known characteristics of the Flather product, while such new ideas as have proved satisfactory in practice have been added. The bed is very deep; the headstock is massive, with the sides brought up high enough to secure stiffness without interfering with convenience in handling the belt. The standard Flather babbitt bearing is used, with its 20-year guarantee, the bearings being $3\frac{1}{4}$x$5\frac{1}{4}$ in. in front and $2\frac{3}{4}$x$4\frac{1}{2}$ in. in the rear. The spindle will handle $1\frac{1}{2}$-in. stock. The cone is made for a $3\frac{3}{4}$-in. belt, the small step being $3\frac{3}{4}$ in. and the larger one 14 in. The lathe is double-back-geared in ratios of 1 to $3\frac{1}{2}$ and 1 to 11.04. The feeds are in geometrical ratio with an increment of 1.5. These begin at 15 and go to 371 per in.; a double gear shift gives two other feed ranges, so that threads of from 2 to 64 can be cut without changing gear. Gear ratios can be readily changed, however, by opening the gear box at the end of the lathe. The back gears are readily thrown in by a neatly designed gear shift which controls either back-gear ratio. The carriage is of the double-wall type and $35\frac{1}{4}$ in. long. The bridge is 9 in. wide and the compound rest very wide and rigid. The tail spindle is $2\frac{1}{4}$ in. in diameter. The shipping weight is about 4000 lb. The lathe is furnished with the well known Flather taper attachment when so desired. The countershaft has 14x4 in. pulleys and runs at 245 r.p.m.



DOUBLE-BACK-GEARED 18-IN. LATHE

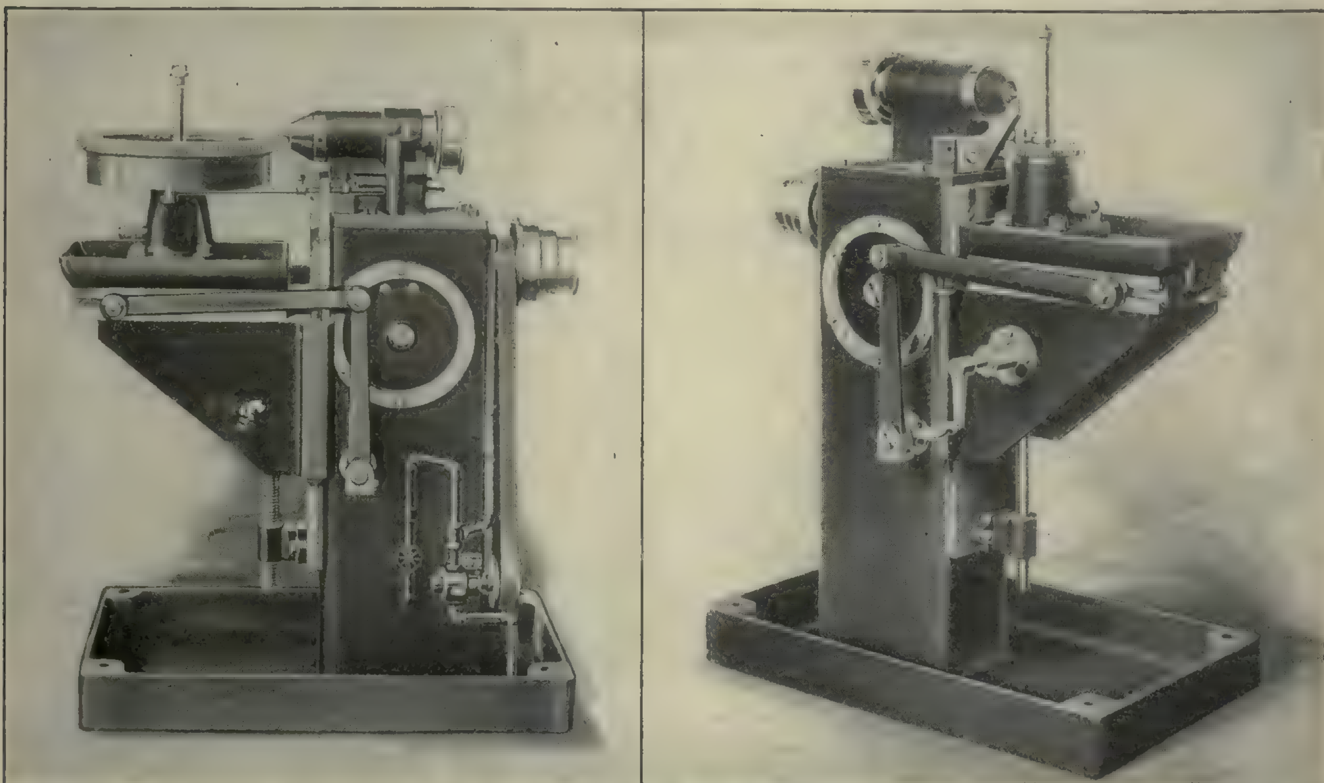
Gear-Tooth Rounding Machine

The machine shown in the accompanying illustrations was designed especially for rounding the ends of teeth on automobile transmission gears or any sliding meshing gears, such as those used in machine tools of various kinds, or other machinery.

It will cut any degree of roundness on the end of a tooth, from simply taking off the edges to a full half-

circle. It will handle gears solid on shafts as easily as those mounted on an arbor. It will remove burrs from spur gears or bevel pinions quicker and more neatly than by filing, and will remove sharp, angular corners and burrs left on spiral gears by a hob. A bevel can also be cut on one side of the tooth if desired.

The speed with which the machine works can be judged from the following: 19-tooth, 8-pitch, chrome-nickel gear, 75 sec.; 17-tooth, 5-pitch, chrome-nickel steel, 2 min.; 133-tooth, 7-pitch, cast-iron flywheel, 12 min. These



OPPOSITE VIEWS OF CROSS GEAR-TOOTH ROUNDING MACHINE

Capacity, spur gear, flywheel or flywheel ring, up to 30 in. in diameter, 12-in. face, any number of teeth from 8 to 250, including odd numbers; spindle is 3 in. in diameter by 9 in. long, driven by a 1½-in. belt, and runs 960 r.p.m.; main drive-shaft has three-step cone for 1½-in. belt; complete equipment includes countershaft, splash guards, one double-end high-speed cutter of any angle, three sectors of any pitch, oil pump, piping, tailstock for holding gears solid on shaft, one arbor of any size, set of wrenches; floor space occupied, 3x4 ft., weight, crated, 800 lb.

teeth were all rounded to a full half-circle and the time given is from floor to floor.

The action of the machine is extremely easy on the cutter, which will remain sharp for at least 20 working hours, and there is no loss from breakage.

The indexing mechanism is positive, and it is impossible for the work to get out of index and allow the cutter to cut a hole in the tooth. The teeth of the gear might not be centered correctly on the arbor, but regardless of this each tooth would be accurately rounded because each tooth is handled as a separate unit. Teeth out of size as much as $\frac{1}{16}$ in. will be rounded perfectly. There are no cams or gears used in the index mechanism, so there is no backlash or wearing parts to cause trouble.

The spindle surmounts the column and has a bearing its entire length. It can be offset any degree to conform to the pitch of the tooth and can also be adjusted lengthwise to conform to the depth of the tooth. The cutter is held in the spindle by a spring collet and when working oscillates in a 180-deg. arc.

The table can be adjusted according to the face of the gear and once set can be locked in place. It does not have to be changed while working on gears of the same face. The work arbor rests in a heavy support bolted to T-slots in the table and can be adjusted for different diameters of gears.

As the work on each tooth is completed, the table automatically moves out 1 in., and the indexing rod operates pawls which rotate the ratcheted revolving base of the arbor and approximately position the next tooth. As the table moves in toward the cutter, the tooth of the gear is brought in mesh with a locating sector placed just below the cutter. This sector has two hardened master teeth cut the same pitch as the gear. As the gear tooth meshes with this sector it is positively and accurately centered, and held as in a vise during the cutting operation.

The machine is equipped with a high-pressure pump which gives an ample supply of coolant to the tool and washes away the chips. The base of the machine acts as a reservoir for the coolant.

This machine is built by the Cross Gear and Engine Co., Detroit, Mich., and is handled by Charles H. Walker, 1565 West Grand Boulevard, Detroit.

To Prevent Scale from Brass Forgings

Fuse bodies and work of a similar nature which must be made of forged or compressed brass are liable to have a scale that is hard on the cutting edges of tools.

This condition can be prevented to a large extent by removing the scale of the casting before the plug is forged or pressed to shape. This is done by forcing the plug through a plain shaving die. A lubricant for this shaving operation is made up of: Water, 20 to 25 gal.; mineral lard oil, 5 gal.; soda ash, white, 2½ lb.

Announcing a Step Toward Broader Service

(*Continued from page 435*)

ment appearing last July. The most recent addition to the McGraw Publishing Co., however, was the *Contractor,* originally the *Contractor and Contractors Review* of Chicago, which first saw light under its new name in January, 1917.

Mr. McGraw should be no stranger to readers of the *American Machinist,* for he owned this paper a number of years ago. It is of interest to note that he has been at different times the owner of two other Hill publications also, namely *Power* and the *Engineering and Mining Journal.* The other two Hill papers are the *Engineering News,* and *Coal Age.*

Now we have mentioned all ten members of the McGraw-Hill family, but there are more, and the most important members—the readers and friends of each of these journals.

Real Service is a double-acting affair and works both ways. It would be impossible to publish a technical journal such as this, if it were not for the multitude of our machine-shop friends who, through our columns, share their knowledge with their brothers in the industry. The pages of this paper are democratic, and you will find associated there Captains of Industry side by side with the boys in blue who keep the shop wheels turning. These men—owners, executives, department heads, designers and mechanics—are actuated by the common desire to help make better machine shops and more and better machine-shop products.

New Publications

English and Engineering. Edited by Frank Aydelotte. Three hundred and ninety $4\frac{3}{4}$ x $7\frac{1}{4}$-in. pages; cloth bound. Published by McGraw-Hill Book Co., New York City. Price, $1.50.

Reviewed by Dexter S. Kimball*

This interesting volume is not a textbook, in a strict sense, though intended for the use of engineering students. It is a collection of selected essays, some by famous authors and some by others of lesser note. In general, these essays have to do with science, pure and applied, and with its bearing on our life and civilization. They are intended to be read in connection with constant discussion by a teacher and constant writing on the part of the student.

The most interesting part of the book, to the teacher at least, is the author's introduction, in which he outlines his object and his point of view. He says truthfully: "No student (nor any other person) ought to write unless he has something to say and a strong desire to say it." He could as truthfully have applied the same remark to speaking, as well. From this he reasons that the engineering student and his English teacher can deal most profitably with the ideas that are to be found in literature, in general, rather than in the technical writings with which the student is familiar. The book is designed consequently with the aim of training the student to write by training him first to think, and to stimulate his thought by directing his attention to problems of his own profession and of his own education and to the illumination of them which he can find in literature.

The book is divided into six sections: Writing and Thinking; The Engineering Profession; Aims of Engineering Education; Pure Science and Applied; Science and Literature; Literature and Life. Each section consists of a number of essays, of which there is a total of 27. The first section, which contains among others an essay called "Writing and Thinking," made up of extracts from Ruskin's lecture on "The Relation of Art to Morals" and an essay entitled "The Question of Style," by Arnold Bennett, is intended to assist the student to see the dependence of writing upon thinking and to impress upon him the fact that to write well he must have something to say.

The second and third sections are devoted to essays on engineering and engineering education and are intended to help the student to get a broader perspective of his future calling and of his educational needs for this calling. Sections five and six deal with the relations of pure science and applied science to literature, with a view of extending the student's interest in that direction and of broadening his appreciation of literature in general. The last section, Literature and Life, offers a few carefully selected essays illustrating literature as a comment on life, with the view of teaching the student how he may read thoughtfully and broadly and of serving also as an introduction to a more extended study of literature.

There can be little doubt as to the soundness of some of the author's argument. All educational experience has shown that the first and foremost requirement in all educational work is to arouse the interest of the student and that the most effective means of arousing his interest is to connect the subject to be studied with life itself. Latin as an abstract study is one of the most deadening, but as a commentary on the life of the Roman people it may be made most fascinating. Without question, therefore, greater success will attend the use of such material as is included in this volume, so far as broadening the view of engineering students is concerned, than could be obtained with essays and theme writing on abstract subjects assigned by the teacher or picked up at random by the pupil.

It is not so clear, however, that the material here presented can claim special merit for the purpose of teaching engineering students to think accurately and express themselves clearly as compared to literature that is more technical in character. If there is one thing that an engineering course should do, it is to teach the student to think clearly, accurately and comprehensively. And there is no form of written expression that demands clearness and accuracy so much as engineering literature, particularly such documents as specifications and contracts. If any man doubts this, let him try to describe accurately the constructive requirements of any household article that he may wish to have built. I have long believed that the written reports and problems required of engineering students embody wonderful possibilities for teaching English, so far as accurate writing and thinking are concerned. It must be conceded of course that this form of literature is not broadening, and in this respect Professor Aydelotte's argument is correct. On the other hand, technical literature is, for the most part, well written, and much of it is unexcelled for clearness and accuracy.

His arguments do apply fully, moreover, to the fields of secondary and primary education, where, after all, the great weakness of our written and spoken language exists. The greatest enemy of good English is the language of the home and of the street. If this influence is not combated by the school from the very start, there is little hope that any four or six hours of instruction in the university will offset these early influences. In these early stages of education the interest of the student is of prime importance, and there is no doubt that the teaching of English in these earlier stages could be much improved by the application of Professor Aydelotte's ideas. English is something more than semicolons and commas, though many students leave high school with that impression.

Aside from the educational features of the book it is a most interesting collection of good writings that any man will profit by reading, and it should find a welcome on the shelf of every technical man who aspires, as he should, to evaluate the place that his profession occupies in the affairs of the world.

*Professor of Machine Design and Industrial Engineering, Sibley College, Cornell University.

Business Item

The Titanium Alloy Manufacturing Co. has moved its New York office from 15 Wall St. to the City Investing Building, 165 Broadway.

Personals

R. S. Alter has been elected president of the Foreign Trade Association of the Cincinnati Chamber of Commerce.

William J. Kaup has become associated with the Ordnance Department of the Crucible Steel Co. of America, with the position of chief engineer.

Harry S. Hunter, Pittsburgh manager of the Chicago Pneumatic Tool Co., has resigned to become president of the Hunter Saw and Machine Co., Pittsburgh.

J. C. Jay, Jr., has become associated with the firm of Jamieson, Houston & Graham, consulting engineers, 40 Wall St., New York City. Mr. Jay was formerly chairman of the board of the Maxwell Motor Co. and vice-president of the Pennsylvania Steel Co.

Trade Catalogs

Bronze Alloys. Lumen Bearing Co., Buffalo, N. Y. Booklet; pp. 22; 4x8½ in.; illustrated.

Filing Machines. Holmes Manufacturing Co., Shelton, Conn. Catalog; pp. 10; 3½x6 in.; illustrated.

Cross Gear Tooth Rounding Machine. Charles H. Walker, 1565 West Grand Boulevard, Detroit, Mich. Circular; illustrated.

Electric Welding Machines. Winfield Electric Welding Machine Co., Warren, Ohio. Catalog; pp. 34; 7x10 in.; illustrated.

Vasco Special, Vasco Electric and Vasco Latrobe Carbon Tool Steels. Vanadium-Alloys Steel Co., Pittsburgh, Penn. Folder.

Electric Fans. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. Catalog 8-A. Pp. 28; 8½x11 in.; illustrated.

"Quality" Hack-Saw Blades and Frames, Hack-Saw Machines, etc. Napier Saw Works, Inc., Springfield, Mass. Catalog No. 3. Pp. 34; 5x8 in.; illustrated.

Catalogs Wanted

Stauble & Salvini, 76 Foro Bonaparte, Milan, Italy, dealers in electrical and industrial supplies, including motors, lamps, measuring instruments, telephone and traction material, would like to hear from American concerns that desire representation there and to receive catalogs, prices, etc.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

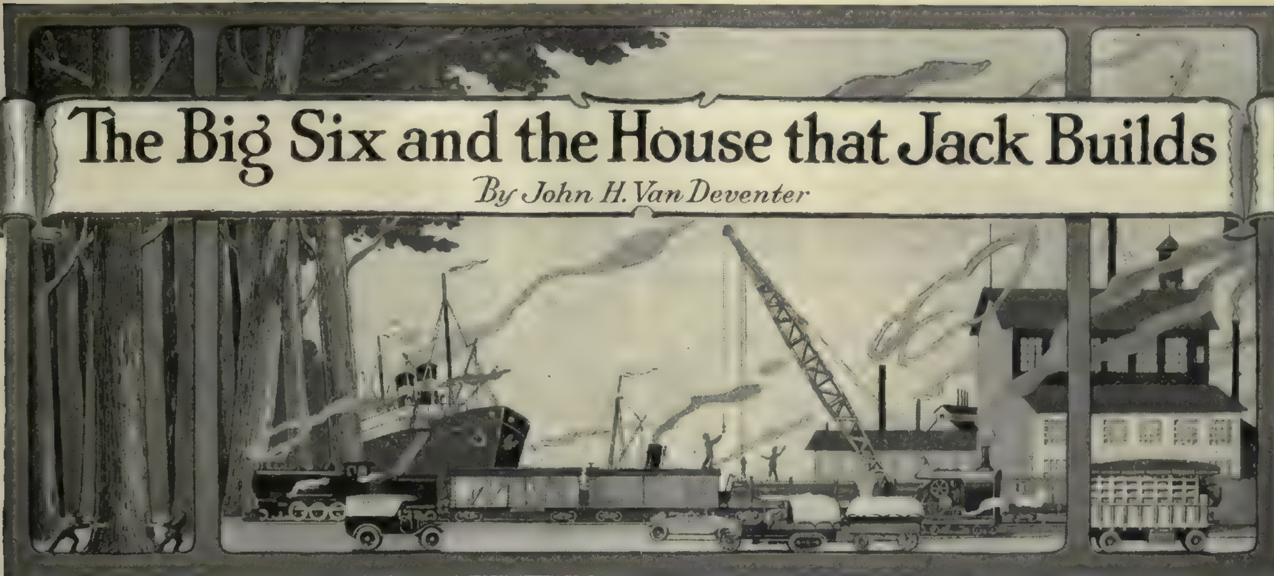
Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.



The Big Six and the House that Jack Builds

By John H. Van Deventer

SYNOPSIS—American manufacturers in related industries must obtain a clearer understanding of one another's problems if they are to meet successfully the coming world competition. Six manufacturing industries provide 90 per cent. of our machine shops with work. A knowledge of the economic truths underlying these six and of the common mechanical processes employed in them will be the first step for the American machine-shop executive to take toward industrial-competition preparedness. This article points out some of these features and calls attention to the economic facts underlying the lumber industry—one of the "Big Six" and a large user of machine-shop products.

Some weeks ago I stood beside a large veneer lathe watching it peel cottonwood logs into thin sheets used in the manufacture of packing boxes and crates. Here was a machine-shop product employed in the woodworking industry to make boxes for bakery products and to make crates for the meat-packing trade, both of which industries are themselves large users of machinery. In the materials entering into the construction of the veneer lathe two more machinery-using industries of enormous size were represented, so that in that space of a few hundred square feet were gathered representatives from all the "Big Six"—the only billion-dollar manufacturing industries of America[1], measured by value of annual output.

How You Connect with the Big Six

Out of every dollar that you receive, Mr. Machine Shop Owner, it is probable that 90c. comes from one or more of the Big Six. They are good people to cultivate for customers, for at least one of them is mixed up in every deal that involves a machine shop or its products. Their credit is as the credit of billionaires should be, and they are far from niggardly in their business transactions, rewarding real service handsomely.

This inter-relation of industries is a vitally important thing for the machine-shop man to study, for machinery building and machine-shop products make possible the existence of manufacturing, just as manufacturing makes possible the building of machinery products. It is a particularly vital study now, for the understanding of these problems will determine the survival or eclipse of American manufactures in the face of the competition that is undoubtedly coming.

The actual origin of machinery sales is none too clear in the minds of a majority of those building machines and selling machined products. This origin goes farther back than the salesman, farther back than the contract, even farther back than the buyer. It goes way back to the economic need for this particular product in that particular shop—something that may not be and in most cases is not thoroughly understood even by the purchaser of the machine. In fact, one of the necessary requirements of the master builder and seller of machinery in the future will be a comprehension of these problems as applied to his particular machine, with the resulting ability to make clear this economic need to those in contributing industries.

Jones of the Old School

Jones, for example, is an old-school builder of an admirable machine. He would laugh at the suggestion that he does not understand his own product thoroughly; in fact, he does, but his lack of understanding is in connection with the other fellow's business. He knows his product from one point of view, which is not enough by several dozen.

Smith, in this same example, is an operator of machinery, also of the old school, whose product goes into a third industry, the needs and requirements of which, aside from the immediate demand for his goods, he troubles very little about. In common with a great number of operators of machinery he expects his customers to work out the salvation of their own product. Smith, being in need of a machine to replace an old one, gets in touch with Jones.

The Angel of Unlimited Possibilities is always present when the installation of new machinery is being discussed, although it must be admitted that she holds herself invisible to men of the Smith and Jones type. Having unlimited vision, it grieves the A. U. P. to observe Smith and Jones spend the better part of the day in violent discussion of price (being some $10 apart in the matter), for she knows that a slight change in Jones'

[1]According to 1914 census statistics.

machine would produce a material alteration in Smith's product, which would effect a revolution in the third industry. She knows that this industrial revolution and the eventual rewards for inspiring it will await the meeting of a machinery builder and a machinery user of the new school, who have studied the third party's problems.

The Big Six produce among them each year one-half as much, measured in dollars and cents, as all the manufacturing industries in this country combined. No wonder that their trade is worth cultivating, for buying power goes with producing ability.

Those three of the Big Six with which the reader is probably least familiar lay claim to a million out of every five million dollars' worth of manufactured products. Over 100,000 manufacturing establishments are incidental to the squeal of the pig, the buzz of the saw and the odor of baking bread.

The slaughtering and meat-packing industry, the lumber and wood-products industry, the grain-milling and bakery industry—these three turn out among them 20 per cent. of all the products manufactured by all the industries in this country.

Three Essentially Machinery-Using Industries

And these three are essentially machinery-using industries. A pig becomes sausage, a tree turns into a library table, and a handful of wheat changes into biscuit to the accompaniment of the hum and clatter of many and diverse machines. These three industries form a large part of the machinery market that starts with the machine-tool builder, who makes machines for making machinery for making something else.

A knowledge of the industrial economics and common mechanical processes of the Big Six is highly desirable. One undertaking to select a new product to build in his shop can measure the broadness of its application in no better way than by asking himself how many of these leading industries it will serve; and one who wishes to extend the field of his present product must have at least enough acquaintance with the methods of these industries to be able to think intelligently about them. Spending time in studying these six is planting seed in fertile soil, for they represent at least three-quarters of the total machinery-buying power.

The machinery-building industry is the father of all the others, although strangely enough its biggest son is older than his parent. Woodworking came before metalworking, but the latter made the former one of the Big Six. Now, in return, the son helps to keep the parent in the billion-dollar class—an illustration of reciprocity.

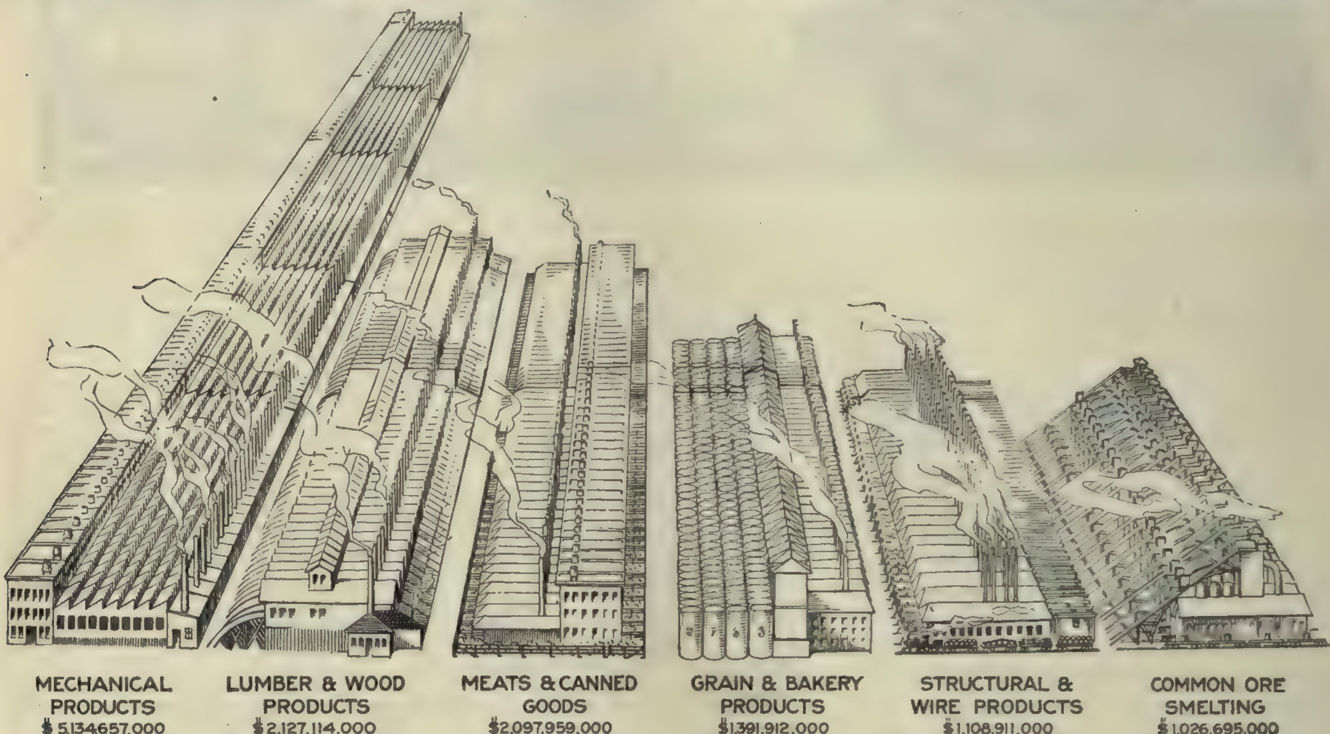


FIG. 1. A COMPARISON OF THE "BIG SIX" BASED ON THE TOTAL VALUE OF PRODUCTS OF EACH, FROM 1914 UNITED STATES CENSUS FIGURES

Mechanical products go into the lumber and woodworking industry and into all others in two ways—directly and indirectly. Sometimes the same product gets in through both doors. The lumber-jack swinging an ax in the forest is a primitive figure and his ax a simple tool, but the house that Jack builds is a wonderful industrial edifice. The ax that Jack swings is a simple tool, but back of it are the mining machines that dig their way into the earth in search of ore—steamships and railroads that carry this burden to the mills—furnaces and rolls that fabricate the steel—forging hammers and dies that shape it—grinding and polishing wheels that add the finishing touches. The ax typifies all the direct products that you mechanical members of the Big Six sell to your brother in the lumber industry. And with that ax, although the sale is unseen, you also sell him mining machines, steamships, locomotives, furnaces, forging hammers and everything else that goes with the manufacture of the ax.

What Is in Front of the Tree

The tree that Jack fells is a simple tree, but in front of it, waiting to perform its work, is an array of machines and mechanical equipment stretching farther than the eye can reach. There are as many, if not more, varieties,

styles, types and sizes of machines for fashioning wood as there are for fashioning metal. Add to these the mechanical equivalent of the 5,000,000 horsepower that is needed to keep this machinery in motion; the transmission apparatus required to put this power into effect; the vast system of transportation, indoors and out, necessary to keep the product moving—and with such a picture you may begin to have a faint conception of the magnitude with which machine-shop products enter this industry.

If you are a builder of metal-cutting lathes, your product enters both doors. It goes directly into the machine shops that are operated in connection with sawmills or large woodworking establishments, and it enters indirectly through the builder of woodworking machinery and engines and other direct equipment. If you measure your trade with the lumber industry merely by the direct products that you sell to it, you are overlooking by far the biggest part of the business that it gives you.

TABLE 1. STATISTICS OF THE WOOD-PRODUCTS INDUSTRIES, FROM THE 1914 CENSUS

Division	Number of Plants	Value of Products
Boxes, cigar	238	$8,337,000
Boxes, wooden packing	1,174	86,567,000
Carriage and wagon manufacturing	4,601	106,697,000
Carriages and wagons, materials	456	24,850,000
Children's carriages and sleds	92	11,752,000
Coffins, etc	287	26,325,000
Cooperage	1,259	50,017,000
Furniture	3,192	265,706,000
Lumber and timber products	27,249	715,942,000
Musical instruments, organs	85	6,297,000
Musical instruments, pianos	255	62,775,000
Paper and pulp wood	718	332,147,000
Pipes, tobacco	47	4,220,000
Planing-mill products	6,061	316,840,000
Pulp goods	24	4,483,000
Shipbuilding, wooden	1,068	22,465,000
Turpentine and rosin	1,394	20,990,000
Wood carpet	6	557,000
Wood distillation	95	9,883,000
Wood preserving	68	21,055,000
Wood, turned and carved	828	19,047,000
Woodenware, not otherwise specified	274	10,162,000
	49,471	$2,127,114,000

Primary horsepower developed at the above plants	4,979,884
Number of wage earners in the above plants	1,025,780

TABLE 2. IMPORTANCE OF DIVISIONS OF THE WOODWORKING INDUSTRY, MEASURED BY RELATIVE ANNUAL CONSUMPTION OF LUMBER*

	Million Bd.Ft
General construction and building	19,836.00
Planing-mill products, sash, doors, blinds and millwork	13,428.00
Boxes and crates	4,548.00
Car construction	1,262.00
Furniture	945.00
Vehicles and parts	739.00
Woodenware and novelties	405.00
Agricultural implements	321.00
Chairs and chair stock	290.00
Handles	280.00
Musical instruments	260.00
Tanks and silos	226.00
Ship and boat building	200.00
Fixtures	187.00
Caskets and coffins	153.00
Refrigerators and kitchen cabinets	137.00
Excelsior	100.00
Matches and toothpicks	85.00
Laundry appliances	80.00
Shade and map rollers	79.00
Paving materials and conduits	76.00
Trunks and valises	75.00
Machine construction	69.00
Boot and shoe findings	66.00
Picture frames and moldings	65.00
Shuttles, spools and bobbins	65.00
Tobacco boxes	63.00
Sewing machines	60.00
Pumps and wood pipe	56.00
Pulleys and conveyors	36.00
Professional and scientific instruments	35.00
Toys	29.00
Gates and fencing	27.00
Sporting and athletic goods	25.00
Patterns and flasks	24.00
Bungs and faucets	21.00
Plumbers' woodwork	20.00
Electrical machinery and apparatus	18.00
Mine equipment	17.00
Brushes	13.00
Dowels	12.00
Elevators	10.00
Saddles and harness	9.00
Playground equipment	9.00
Butchers' blocks and skewers	8.00
Clocks	8.00
Signs and supplies	7.00
Printing material	5.00
Weighing apparatus	5.00
Whips, canes and umbrella sticks	5.00
Brooms and carpet sweepers	2.00
Firearms	2.00
Artificial limbs	0.60
Tobacco pipes	0.50
Airplanes	0.07
Dry kilns	0.06

* The above table was compiled by the Office of Industrial Investigations of the United States Forest Service. The totals for each division represent averages that may be taken as typical, with the exception of such as have been given unusual impetus during the last two years, such as firearms, airplanes, shipbuilding, etc.

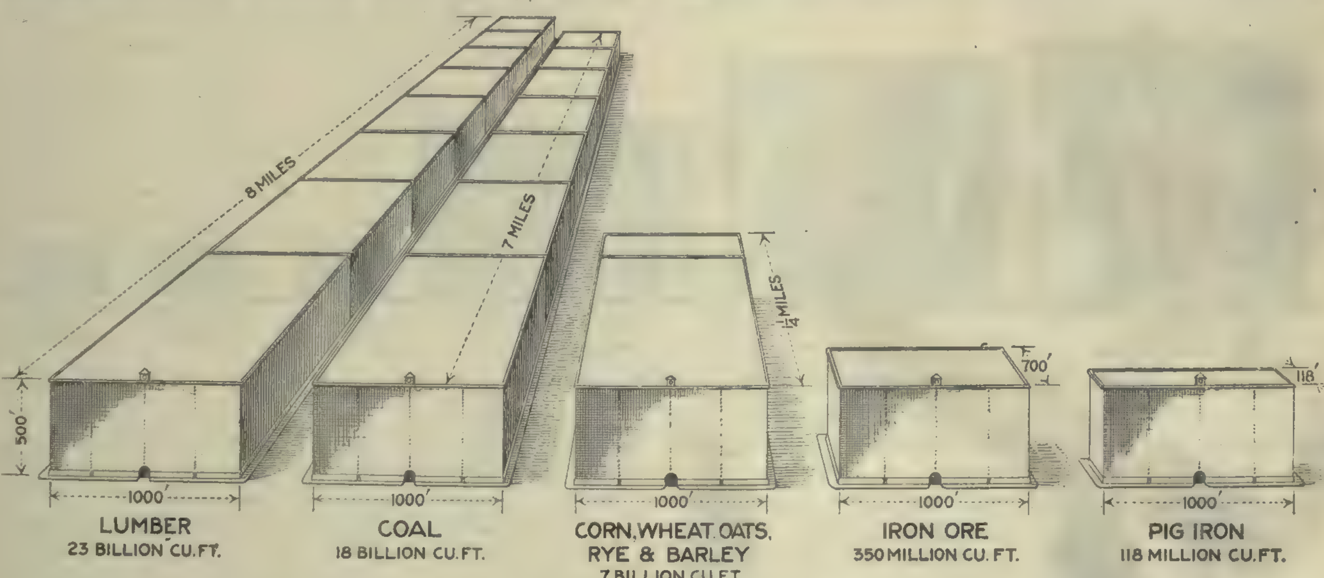


FIG. 2. THE RELATIVE BULK OF COMMON MATERIALS MEASURED IN CUBIC FEET, ANNUAL PRODUCTION, FROM 1914 UNITED STATES STATISTICS

Big figures are ornamental rather than useful. They all look alike when you get over a million—a few ciphers more or less do not make much difference to the imagination. The illustration in Fig. 2 may help you to grasp the significance of the 23 billion cubic feet of timber that is cut annually in the United States. Picture a string of warehouses as wide as two city blocks, as high as the Washington monument and *eight miles long.* You would need this capacity to store, packed solid, these 23 billion cubic feet. Machine shops must provide the means for annually converting this enormous mass of raw material into finished products.

During the last 40 years the ownership of American timber has changed from 50,000,000 citizens holding 75

per cent. of the total to some 200 private individuals holding 50 per cent. I do not recollect writing a receipt for my share of the proceeds and doubt if you did for yours. Most of this land was given away or sold at ridiculously low figures that have yielded 1000 per cent. profit. It is more blessed to give than to receive, but in this case the blessing went to the 50,000,000 citizens and the profits to the 200 individuals. The point of interest for the machinery builder in all this is the effect of this concentration of ownership on the buying of mechanical products.

FIG. 3. THE MARKET FOR WOODWORKING MACHINERY FOLLOWS THE FOREST AREAS

Monopoly causes high prices, and this tends to restrict output—in this case perhaps not an undesirable end, since we are even now cutting nearly four times as much timber as we grow. In spite of this unrestricted output there is still enough timber available to last us 55 years at the present rate. We can look forward with certainty to Government conservation reducing this rate during the next decade. And with the conservation of resources will come the prevention of waste in mechanical processes—something in which the machinery designer and builder will find food for thought.

There has been so much money made by owning timber that sawmill profits have been more or less overlooked. When the average timber owner saws his own lumber, his large total profits resulting from stumpage and mill combined have made it unnecessary to scrutinize sawmill efficiency too critically. The independent sawmill operator who saws another man's timber has been squeezed between the seller of timber and the buyer of lumber—as between two millstones. Perhaps it is as a result that the sawmill has come to have the name of a small-profit producer.

Even if this were a substantial fact, it would not make this market any less desirable, for the small-profit industry is really the Mecca of the progressive machinery builder.

The value of brains increases as the margin of profit shrinks.

Inventions and improvements assume their correct perspective only in the dead level of severe competition. During the past few years a number of the more progressive mills have brilliantly demonstrated the radical change that modern machinery can make in a credit balance.

One of the clearest glimpses of the handwriting on the wall is had in the spread of motor drive to sawmills and woodworking plants. Ten years ago—or even five—this industry that regarded its many and variegated boiler plants as a necessary convenience for the disposal of sawdust and refuse would have ridiculed the suggestion of an investment in motors and what goes with them. Today the future of electric drive and modern mill machinery is firmly established by the shining example of progressive sawmills that have made enviable and sustained records of low sawing cost per thousand feet board measure.

The restriction of lumber cutting in America will have two large results that will affect machinery building. One is the substitution of metal for certain wood products, and the other is the opening of untouched foreign resources with the consequent mechanical development of the countries involved and the consequent exchange of machinery for lumber and wood products. A study of Figs. 4 and 5 will show from where the lumber is coming and to where the machinery is going.

Russia, that country of marvelous trade potentialities, heads the list with the greatest timber resources. In addition, this is a continually increasing quantity, for Russia cuts but a little over a half of her annual growth. Some day, wooden products for American consumption may be largely made in Russia. Let us proceed with improvement and invention while we have the timber to do it with, so that when that day comes, Russian woodworking factories will be equipped with machinery of American make.

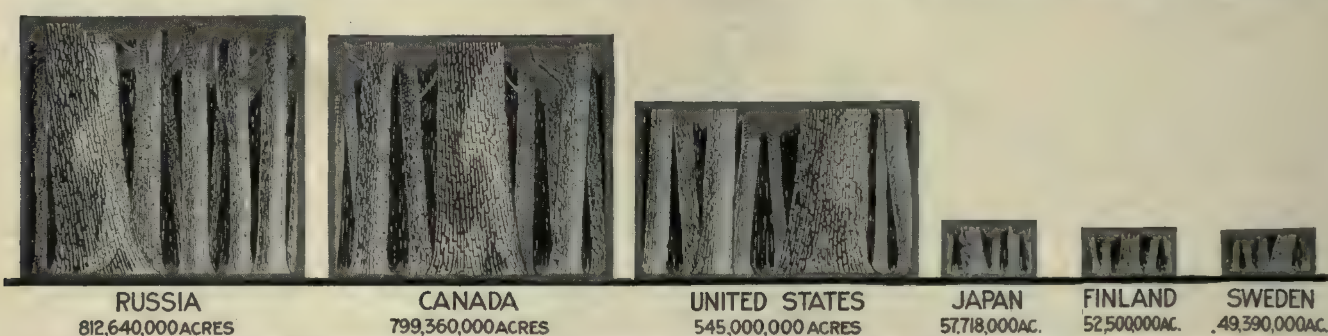


FIG. 4. ACRES OF STANDING TIMBER OF THE PRINCIPAL COUNTRIES THAT ARE HEAVILY WOODED

Canada has a large supply of timber. Some claim that the official figures furnished by the Canadian Forestry Department are in error and that Canada follows the United States in timber resources instead of leading it. But Canada will never furnish much timber (pulp wood excepted) to the United States, because England will eventually need all that Canada has.

South America—not shown in the statistical picture because accurate estimates are lacking—has enormous forest resources that will some day help to furnish the United

States when our home product proves insufficient. The forest resources of that country are probably a close second, if not equal to our own. The forests of Brazil alone cover an area equal to one-half of Europe. When the time comes to utilize these resources, American machinery must be on the job if we are to conserve the vast machine-shop business that comes to us indirectly, but certainly, through the sale and operation of these lumber and woodworking machines.

The following list of machine-shop products gives an insight into the close relationship existing between machine shops and the lumber and wood products industry, as far as *direct* products are concerned. But bear in mind that each one of these direct products causes the existence of an almost endless line of indirect machine-shop products. No more convincing proof is needed of the value of reciprocity and coöperation between the machinery-using and the machinery-building industries of our country. Boost the other fellow and you boost yourself!

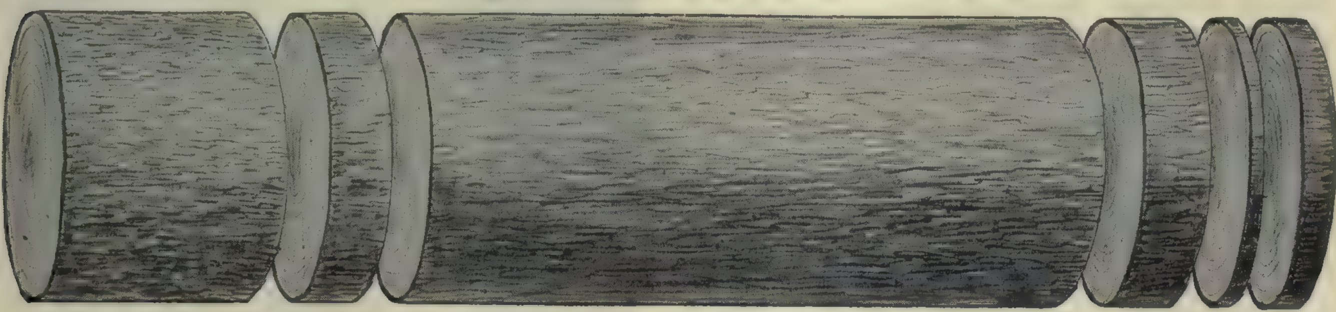


FIG. 5. RELATIVE AMOUNT OF TIMBER CUT ANNUALLY IN VARIOUS COUNTRIES

PARTIAL LIST OF MACHINE-SHOP PRODUCTS GOING DIRECTLY INTO THE WOOD AND LUMBER TRADES

Air lifts
Axles, car and locomotive
Bearings, ball
Bearings, journal
Belt clamps
Belt fasteners
Belt-lacing machines
Belt shifters
Belting, chain
Blowers
Boiler-tube cap-reseating machines
Boiler-tube cleaners
Boiler tubes
Boilers
Bolts and nuts
Boxes, tote
Cable
Casters, iron wheel
Chucks
Circuit-breakers
Clamps
Clamps, hose
Clocks, time
Clutches, friction
Cocks, blowoff
Cocks, gage
Cocks, steam
Compressors, air
Controllers and starters, electric
Conveyors and elevators (see elevators)
Countershafts
Counting machines
Couplings, shaft
Cutouts, electrical
Cutters, flue
Drills
Dust collectors
Ejectors
Electrical instruments
Electrical supplies
Elevating trucks
Engines, steam
Exhaust heads
Expanders, tube
Expansion joints
Fans, electric
Fans, exhaust
Fire extinguishers
Fittings, steel
Flanges
Flue cleaners
Forges
Fountains, drinking
Fuses
Gages, recording
Gaskets
Gears, cast
Gears, cut
Generating sets
Generators, electric
Governors, pressure
Governors, pump
Grates
Grindstones and frames
Hangers, shafting
Hoists, electric
Hoists, hand
Hoists, pneumatic
Hoops and bands
Lamps, arc
Lamps, incandescent
Lubricators, cylinder
Lubricators, force feed

Lumber and Woodworking Machinery

Bark-cutting machines
Barrel, keg stave, and heading machines
Barrel-sawing machines
Bits, hollow chisel and router
Bits, wood-boring
Blind-slat sawing machines
Borers, bung-hole
Boring machines
Boxboard machines
Box-nailing machines
Briar-pipe machinery
Broom-handle machinery
Cableways, logging
Canthooks
Carriages, sawmill
Cars, logging
Carts, logging and lumber
Carving machines
Chairs, log
Cheese-box machinery
Chippers and shredders
Chucking machines, wood
Cigar-box machinery
Cleat-sawing machines
Clothes-pin machinery
Conveyors
Cranes, logging
Crate machinery
Curtain-pole machines
Cutters, routing
Dado machines
Dogs, sawmill
Dovetail machines
Driers, lumber
Edgers
Engines and boilers, power-generating
Engines, logging
Floor-scraping machines
Floor-surfacing machines
Gang drills, wood
Gang rippers
Guides, bandsaw
Handle, blank-sawing machines
Handle, chucking and boring machines
Handle-polishing machines
Handle-tumbling machines
Headers, barrel
Heads, dado
Hogs, sawmill
Hooks, log, chain, etc.
Hooks, log-loading
Hooks, lumbermen's
Hoop machinery
Hub mortising and boring machines
Jacks, log
Knives, chamfer
Knives, spoke-lathe
Knives, stave-cutter
Knives, veneer
Lath bolters
Lath-mill machinery
Lathes, automatic novelty
Lathes, gun-stock
Lathes, handle
Lathes, knob-turning
Lathes, last
Lathes, spar
Lathes, spoke
Lathes, wood-polishing
Lock mortising machines
Log hauls
Log skidding and loading machines
Logging locomotives
Match machinery
Matching machines
Miter sawing and clamping machines
Molding sander machine
Nail-keg stave machinery
Neck, yoke and single-tree machinery
Paneling machines
Picket heading and pointing machines
Planing machines
Pneumatic wood-boring machines
Pointers (spoke)
Pole-handling machines
Pole-sawing machines
Porch-column boring machines
Presses (saw-tooth notching)
Rod pin and dowel machines
Routing machines
Sanding machines
Sash, door and blind machinery
Saw benches
Saw blades, band and jig
Saw retoothers
Saw sets
Saw sharpener
Saw slashers
Saw swages
Sawmills, band
Sawmills, circular
Sawmills, drag
Sawmills, gang
Saws, bilge
Saws, blind-slat
Saws, bracket
Saws, circular
Saws, cylinder
Saws, grooving
Saws, scroll
Saws, segment
Saws, shingle and heading
Saws, swing
Saws, tree-felling
Saws, veneer
Scarfing machines
Scroll-sawing machines
Shaft and pole machinery
Shapers, wood
Shingle-mill machinery
Siding-saw machines
Spindle-carving machines
Spoke-driving machines
Spoke-facing machines
Spoke-tenoning machines
Spoke-throating machines
Spool and bobbin machinery
Spool-stock sawing machinery
Stackers, lumber
Stave-cutting machines
Stave-equalizing machines
Stave-jointing machines
Timber-framing machines
Timber-gaining machines
Tools, logging and lumbermen's
Variety molding machines
Veneer-cutting machine
Wood-barking machines

Machine Tools and Minor Equipment

Angle plates
Arbors
Boring heads
Calipers
Chucks, drill
Chucks, planer
Clamps, machinist
Coilers, spring
Crankpin-turning machines
Cutters, milling
Die stocks
Dies, threading
Dogs
Dressers, grinding-wheel
Drill holders
Drilling machines
Drills
File handles
Files
Forges
Forging hammers
Gages, measuring
Grinders, tool
Keyseating machines
Lathe tools
Lathes, driving wheel
Lathes, engine
Milling attachment for lathe
Pipe cutting and threading machines
Pipe fitters' tools
Planers
Presses, wheel and arbor
Saws, hand hack
Saws, power hack
Steels, carbon and high speed for metal cutting
Taps and dies
Tool holders
Vises

Motors, electric
Nails
Packing, metallic
Pipe
Pipe fittings
Pulley blocks
Pulleys, metal
Pulleys, paper
Pumps, hydraulic
Pumps, pneumatic and steam
Rails
Separators, oil and waste
Shafting
Speed changers
Sprockets
Stamps
Steels, alloy
Steels, carbon tool
Steels, high speed
Track
Transformers
Transmission machinery
Traps, steam
Trolleys and tramways
Trucks
Tube cutter and expanders
Turbines, steam
Valves, automatic engine stop
Valves, gate
Valves, globe and angle
Valves, safety
Whistles
Wrenches, machinist
Wrenches, pipe

Driving Base Plugs by Power

By G. M. Strombeck

The illustrations show the machine used by the Root & Van Dervoort Engineering Co., Moline, Ill., for driving in the adapter plugs on 8-in. and 9.2-in. high-explosive shells.

Originally the plugs were driven in by hand. The shell was clamped in a pot chuck, and six to eight men at the ends of a long double lever screwed in the plugs. In addition to the straight pull and push, considerable coaxing was done by means of a sledge hammer. In this way 12 or 15 men worked hard for 10 hours to seat 50 plugs.

To simplify this procedure, the "plug driver" was designed. Shortly after its installation two men seated 100 plugs in 10 hours. Since that time the workmanship and the methods have been improved and revised, so that now one man alone on a machine can drive 400 plugs in 10 hours, and as many as 50 have been put in in one hour. A man and a helper can put in from 550 to 600 in 10 hours in an emergency, though, of course, this is more than can be regularly expected. One man to each of two machines, with two men doing preliminary hand fitting and a laborer to move the shells, easily handles 650 shells in 10 hours.

The plugs are driven in by means of the two steel pins shown at *A*, Fig. 2. These pins are 0.7 in. in diameter and made of the very best tool steel carefully treated in hardening. Even with these precautions they are sometimes broken, so heavy is the pressure. At these exceptionally

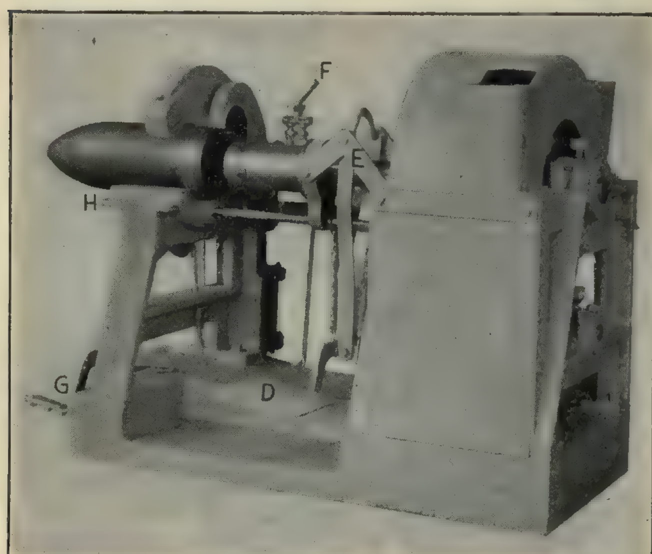


FIG. 1. GENERAL VIEW OF THE MACHINE

severe pulls the shell is held securely, and the rest of the machine shows no weakness.

The machine is essentially a powerful double-gear reduction (ratio 1 : 17.5) driving a sliding steel head through a heavy shaft, and a double toggle-operated hinged clamp for holding the shell. The power for operating the toggle is furnished by a single-acting air cylinder that at 80 pressure holds the shells absolutely without slip.

The end of the sliding head is a massive Oldham coupling dovetailed together and held from slipping apart under normal conditions by springs pressing against half-inch balls. This coupling equalizes the pressure on the two driving pins; and if one of these breaks, the only thing that happens is that the coupling slides apart. No strain is thrown on the shaft.

The treadle *D*, Fig. 1, operates the toggle *E*, which controls the movements of the driving head. At *F* is shown the air valve, and at *G* is shown a foot treadle for ejecting the shells. This treadle is used only when the machine

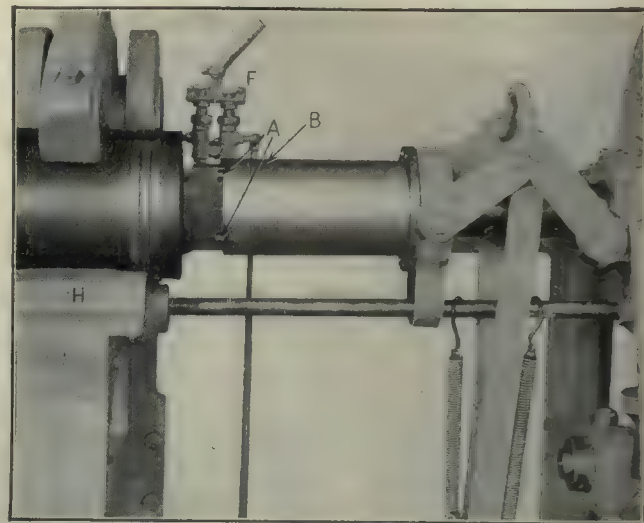


FIG. 2. CLOSE VIEW, SHOWING DRIVING PINS

is operated by two men. A notch is provided in the clamp housing at *H* for receiving the end of a plank platform, it being found easiest to keep the shells always at about the proper level and roll them on tables from one operation to the next. The gearing is fully inclosed, making the machine very safe for the operator.

Making Drawings for Patternmaker and Machinist

By C. Hecker

The method described in this article is in use in a shop in New England and has given satisfaction. The detail drawing, made on bond paper, gives all dimensions and information. Prints from this drawing are used for making the pattern. The drawing is kept as a pattern record, and the pattern is never altered until the change has been made on the drawing. A tracing of this drawing is made on tracing cloth, leaving off all pattern dimensions and giving only such dimensions and information as are necessary for machining. Prints from this tracing are used for machining.

One advantage in this method is that the machinist does not have to dodge a lot of pattern figures, as is the case when one print having all dimensions is used for such purposes. Another advantage is that the drawing may be traced, showing slight machining changes that do not require a change in the pattern. For instance, a pulley pattern might be used: and it could be machined to a different size of bore and a different length and size of hub, which has often been the case in the shop referred to. The same rule applies to many parts used on different machines with slight machining changes.

An objection has often been made that to accomplish this result two tracings must be made—one for the patternmaker and another for the machinist. This is not so with this method.

Drafting-Room "Stunts" for Saving Time

By Charles M. Horton

SYNOPSIS—Time-saving "stunts" may concern the doings of the individual draftsman or may affect the drafting room as a whole. Tracing a hurry-up job illustrates the first and hunting for the "family" shears the second.

The chief engineer of the Smellco Chemical Co., Unlimited, stepped hurriedly into the drafting room. He always stepped into the drafting room hurriedly. All chief engineers step into drafting rooms hurriedly. It is a way they have. No organization can move any faster than its engineering department, though a great number of organizations try; and because the chief engineer, by virtue of his job, is the first in line to get shouldered, he naturally hurries to pass the buck along as quickly as possible. The Smellco Chemical Co., Unlimited, was a "crowding" organization, and the chief engineer entered the drafting room this morning on a lope.

"Sparrow," he whipped out, thrusting a handful of small pencil drawings of odd sizes toward the chief draftsman, "I want separate tracings made of these at once! Our regular 9x12-in. size, you know. Crowd the boys—we've got to get the prints down to New York by the twentieth!" Whereupon the chief whirled and was gone, as he had come—hurriedly—and now with a twinkle in his eye. He had successfully passed the buck.

It was a rush job. Mr. Sparrow surveyed his tiny corps of draftsmen with a critical eye. Sparrow was a mild-mannered little man of but few words. He had three draftsmen. They were all busy, and Sparrow hated to break in on a job already under way. But orders were orders, especially those emanating from beyond the partition. Sparrow hopped out of his chair, fox trotted across the room, did a sort of buck-and-wing as he scattered the pencil drawings around on the three drafting boards, explained the nature of the rush—and told the draftsmen to go to it.

The Difference in Draftsmen

Now, note the difference in men. One draftsman, inclined to stoutness and shortness of stature and to deliberateness of speech and movement (excuse me for these undraftsmanlike words), after removing the job he was working on, tacked down one of the rush drawings, made a guess with the shears at the size of tracing he would require and presently was tracing the drawing. It took him perhaps five minutes to get under way.

The second man, who was tall and slender and quick in his movements, evidently possessed some initiative. He quickly tacked down not one, but three drawings, all in a row, covered the three drawings with a single large piece of tracing cloth and fell to work. The border lines, their penciling off and writing in, could and would be taken care of later. It took perhaps eight minutes for this man to get started.

And now for the third man. Having observed the methods exercised by his two associates, with a kind of sardonic grin on his usually sober face this easy-moving organism set to work, but not after the fashion of the others. He first counted the number of drawings that had been apportioned to him to trace. There were perhaps 12 of them. He then spread his whole board with a single piece of tracing cloth, carefully laid it off with a pencil in sections of 9x12 in. each, Fig. 1, inked in the border lines thus established and then cut up the sheets into their proper sizes. The sheets he laid to one side, after which his sardonic grin gave way to a look of earnestness. There was a moment's breathing spell, and then he tacked down as many of the small pencil drawings as his board would conveniently hold, covered each with a piece of tracing cloth—already cut to size and with border lines inked—and began, as the second man had done, to trace a whole batch at one fell clip.

Comparative Value of the Three Men

There you have a concrete example of how time may be saved—or lost—in the drafting room. The first man went at the job as he would go at any job of tracing and as he evidently had been going at every job since entering the game—doing it mechanically and without exercising thought—a man of slow intelligence. The second man seemed to have a hunch that the thing required special treatment, since he had tackled three drawings at one time, though this man had not allowed his brain thoroughly to compass the proposition. The third man certainly had made use of his head. Here was a special and rush order, he evidently had decided—one that must be handled in a special and rush way and in complete forgetfulness of how any or all other drawings were handled. He was an independent thinker and worth the $17.50 per week the organization thrust into his paw every Saturday. He went on up, later in life, carving his way to the top with these same sure methods. When a job was presented to him, he let himself forget every other piece of work he had ever done and the way he had done it and brought to bear upon the problem in hand a complete and free exercise of gray matter that permitted him to tackle the job as if it were the only one that had ever come his way. He was a man of original mind.

But this is an article on things and not beings—on cuts to save time in the drafting room.

Many of the larger organizations have completely done away with the work of making standard sizes. The task is given into the hands of a printer. With the different sizes decided upon, together with the width of the borders and the size and design of the title, the job is sent outside to be printed. The sheets come in in lots usually of a hundred, all nicely set up as to border lines and titles, and a good many dollars are thus saved. This applies only to large drafting rooms, of course, where the material used is considerable and where it has been found that the draftsmen's time thus saved for actual drawing more than covers the printer's bills. However, it is another drafting-room stunt for saving time, and it might be well also for smaller organizations to look into the subject.

All draftsmen at some time or other suffer from spilled ink. The tipped-over bottle is the draftsman's bugbear. Naturally, he schemes to obviate this trouble; and save in those offices that supply the regulation metal stands for holding the tiny bottles secure, every draftsman has his own little individual stunt for protecting himself. Some

of these—in fact, most of them—take the form of cardboard cut out to embrace the bottle, with the bottom of the cardboard spread out and tacked down to the board with thumb-tacks. However, this method has its disadvantage in that it makes the bottle stationary, and draftsmen frequently have need to change the location of the bottle.

One of the neatest rigs for security in this way came under my observation not long ago. The draftsman had cut out a circular piece of cardboard about 5 in. in diameter, Fig. 2, with a hole in the center large enough to be forced down over the protruding bead around the top of the neck of the ink bottle. That was all there was to it. The disk when in place around the neck of the bottle acted as a sort of protecting skirt, permitting the bottle to tip, to be sure, but also preventing it from tipping completely over. The bottle might dip, but the outer edge of the cardboard disk, coming in contact with the board, stopped all further calamity. This ingenious little stunt likewise permitted the draftsman to pick up his bottle of ink and set it down again whenever and wherever he pleased, without the formality of breaking off a couple of thumb-nails and dexter finger-nails in prying up thumb-tacks. Yes; I know there are cute little tack lifters on the market for this purpose, but some men are in a hurry generally, and tack lifters are usually where they are not expected to be.

How Steve Winthrop Helped the Kid

Steve Winthrop—I have already told you something about Steve—once doped out a stunt for saving time in the drafting room which certainly will bear mentioning here. It was a trick that had to do with standard sizes in their relation to tracing cloth. Up to the time when Steve exercised his gray matter in this particular direction the chief draftsman had been accustomed to let the kid lay off the standard-size sheets on a roll of tracing cloth and, between errands, ink in the border lines and trim the sheets to size. The sheets were then neatly laid away in drawers for use. The kid hated this job; and Steve, observing as he was by nature and with a heart in him that could entertain sympathy for a stick of misused belt dressing, decided to save the kid further torture in making standard-size sheets. And he did.

The next roll of tracing cloth that was delivered into the drafting room witnessed a change in method of treatment. Steve took the roll just as it was—it was 36-in. material—and placed a rule along its length. He lightly pointed off from one end 8 in. and 10½ in. and 16 in.—the three sizes in use in that drafting room. Then, with the kid eyeing him in wonderment, Steve nonchalantly carted the roll down into the pattern shop, strode purposefully to the bandsaw, started her up, and—zip—zip—zip—shoved the roll of tracing cloth through on the points nicked off with the pencil. When he returned to the drafting room, bearing three short rolls of tracing cloth in his hand instead of one long one, Fig. 3, the kid joyfully offered to "square things" with Steve some day, if it took a suspender.

And that is another time-saving stunt to be considered. The short rolls still had their length, to be sure; but that matter was taken care of by the draftsmen themselves, who would cut the desired length as needed. And the kid had more time for horseplay than otherwise had been his lot. And kids like to play—a fact Steve well understood because circumstances had compelled him to be a kid once himself.

Steve once came to the rescue in another place. It was a hit-and-miss establishment without strong organization, and like many such places, the drafting room was a catch-all for every bolt, nut and casting that for any

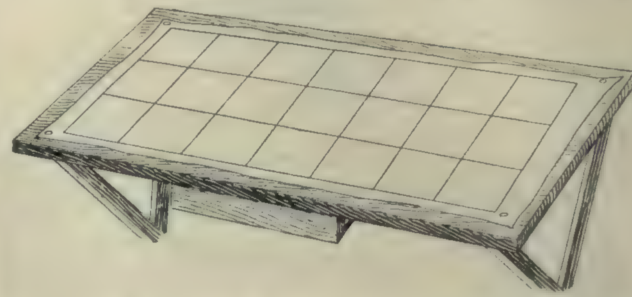


FIG. 1. THE WAY THE THIRD MAN LAID OUT HIS SHEETS

cause had ever been lugged in from the shop. Once in, the thing was doomed to remain, because nobody ever thought of carting it out again. As a consequence the drafting room was dirty to the point almost of grime, and while the Polack sweeper out in the shop was supposed to give the drafting room at least a once-over every so often, he rarely got around to this duty. Polack sweepers usually have more than they can attend to in one ordinary life time, what with slinging castings, running drilling machines, oiling shafting and bringing in the beer—I speak now of the small shop—and this suffering son of persecution was a true Polack sweeper.

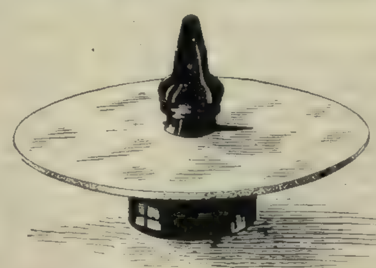


FIG. 2. INK-BOTTLE PROTECTOR

Steve found early that the roll of drawing paper was kept standing upon one end and leaning against some greasy pipe in one corner of the drawing room. Whenever he wanted a sheet of paper he had to unroll about two

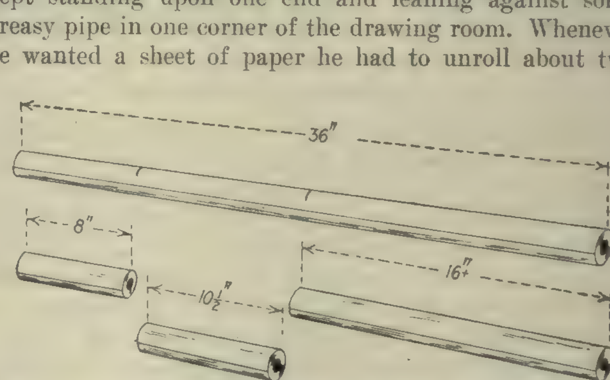


FIG. 3. THE ROLL OF TRACING CLOTH—BEFORE AND AFTER SAWING

yards of the stuff before there came to light a piece clean enough for drafting purposes. Steve grinned, but said nothing. He had long since learned that some systems, even the kind known as no system, hate to be disturbed by a newcomer. So Steve bided his time. He did not have to wait long. Observing the general manager standing around one afternoon with a kind of mild, encouraging, well-how-do-you-like-us light in his eye, Steve quietly got off his stool and went to the roll of drawing paper

standing in one corner against the sweating pipe. He proceeded calmly and coolly—right under the manager's eye—to unroll a sheet to work on. He purposefully rolled out the paper slowly, so as to give the manager a chance to see the condition of it, and then he cut off what he actually required, crumpling up about three yards of dirty and therefore useless paper and tossing it into the waste basket. No; not into the waste basket. Steve tossed it at the waste basket. The basket had been full to overflowing a month or more already—and was quite ready to get up and dump itself of its own accord.

But that little stunt did the trick. Steve was asked for suggestions; and, also under the eyes of the manager, he drove a stout nail into each end of the wooden rod inside the roll of tracing paper, which he deftly swung from two crudely improvised brackets that he constructed out of thin metal and fastened to the wall. See Fig. 4. Thereafter, whether the sweeper came in to sweep or not, the drawing paper was fairly clean, and the waste from dirt became almost negligible. Not a big stunt, this, nor an important one, but certainly it saved time and

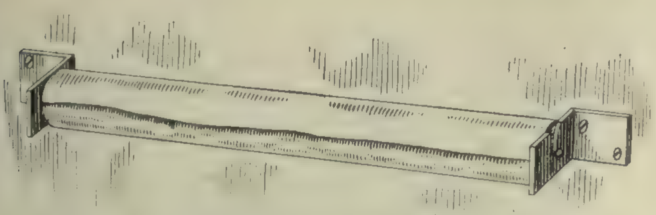


FIG. 4. STEVE WINTHROP'S WAY TO SAVE DRAWING PAPER FROM DIRT AND GREASE

money in that organization—time, in that Steve was spared the labor of unrolling paper more than he otherwise would have done; money, in the cost of paper, which, as everybody knows now, costs like—well, ask the publisher of the *American Machinist!*

The Little Nail To Hold the Shears

But the greatest stunt for saving time in any drafting room and, incidentally, the best and biggest aid in saving other things in drafting rooms—notably souls—is the little nail in the wall for the purpose of hanging up the shears. Get me? Little enough in itself and, on the surface, of petty importance, the case of the missing nail and the lost shears is one of the most noteworthy in drafting-room history. Like the water in the well, you never miss the shears till you want them, and then you surely want them mightily. More good natures have been spoiled, more bitter and far-reaching epithets started, by one's inability to locate the shears when wanted than through any other known source of irritation in the work. Still the shears remain unsuspended, still the nail for supporting them remains undriven, and still the chief cusses and swears!

The Ache-me Manufacturing Co. (I mention no names; should there be an Acme Manufacturing Co. it is without my knowledge or sanction) was an organization employing seven draftsmen. The chief was an excitable Canadian, much given to voluble explosions, and like many men of this temperament, in his cool moments he was airily free from worry as to how things were arranged, in so far as order was concerned, in his department. A drafting room carrying seven men contains at least seven drafting tables, and usually more, two or three for purposes of reference. Seven, eight or nine drafting tables generally have an equal number of drawings or blueprints scattered around on each of them or near them, and every last drawing or blueprint, as will readily appear, offers a splendid hiding place for the shears. So much for the setting—and now for the plot.

There was no tiny nail in sight anywhere for the purpose of receiving the shears. There never had been, and there never would be, so far as the matter entered the thought of anybody employed there. And yet there were tracings to be trimmed and blueprints to be cut up in that drafting room, as in any drafting room. When a draftsman wanted the shears, he usually set out leisurely to hunt for them. This brought him into gossipy touch with one or more of the other men; and under ordinary circumstances he would forget what he had started after, in the more important subjects of the day—the latest score made by the Reds or Cornell's chances of cleaning up Yale on the gridiron. The little nail in the wall—or rather, the missing nail in the wall—cost that firm hundreds of dollars annually in wasted time, because the hunt for the shears usually developed into a mob-sally not unlike that of certain citizens in the South on the rampage for an un-law-abiding negro. All it lacked was the hounds, though it had the driver in the shape of the chief draftsman himself when cognizant of the trouble.

One day there came to work in this drafting room a quiet individual who with the first need for the shears, after locating and using them, drove a nail into a cabinet near the door and hung them up. He did more than that. He informed the entire force of what he had done. There was more or less interest shown, but this very soon subsided. The chief was not in the room, and therefore he was, for the time being, in ignorance of the nature of the overwhelming revolution that had taken place. When he did come in, he went about his duties airily; and nobody thought to acquaint him with the facts. Therein lay the fault. Somebody surely ought to have told him about so portentous a change in the system. Nobody did, though—alas!

Result of the Change

And then it happened. It happened while the new man was downstairs measuring a broken casting. The chief came boiling into the drafting room on one of his usual excited hunts for the shears. He had a little drawing that he wanted to trim. Excited, as always under similar circumstances, he contrived, as always also, to get the men in a nervous state of petulant searching. As a result everybody forgot the innovation introduced by the new man. Drawings were jerked hither and yon, blueprints filled the air in wild confusion, every last man among them was hopping to the irritable tune of the chief—all in frenzied search for the missing shears, which could not be found. Hunt high, hunt low, those shears could not be unearthed. All the while the chief bellowed remarks, and all the while the perspiration stood out upon the brows of the searching draftsmen, and all the while the innocent author of it all was bending silently over a casting in the shop, trying to figure out the actual dimensions of the casting when it was originally made—dimensions long since lost and only ascertainable from this worn piece.

Suddenly in the drafting room there was heard a noise like that made when the plug is removed from an air tank or when the air brakes go off from the wheels of a

freight-car that has at last come to a full stop. The draftsmen turned. The noise had ascended from the chief draftsman. He was standing in front of the cabinet near the door, with his mouth and eyes wide open, gazing in a kind of daze at a nail that had been driven into the wood. Also, he was gazing straight at the missing shears. The draftsmen all gazed too. Some of them were so unkind as to muffle a snicker, whereupon the chief came to life again. Whirling, he faced the group indignantly and demanded, "What — fool hung up those shears?"

Securing Any Kind of Fit Desired

To obtain the right kind of fit and to be able to manufacture the parts in quantity are problems that have caused many production managers no little amount of worry. It is not an uncommon thing to find supposedly uptodate American manufacturers maintaining three different kinds of fits in the assembling department—namely, loose fit, wringing fit and arbor fit. Many mechanics are glad to obtain these three fits for their manufactured product and are thus enabled to keep the scrap pile small.

There is no reason why any mechanic in the producing, inspecting or assembling department should be frightened when 5000 parts of a certain size are to be made up with just a "proper wringing fit." It does not require the close accurate work that the average mechanic will strain himself to produce when making the fits practically all alike and the parts interchangeable by measurement. Scientific production has come to the rescue of the mechanic who tries to make the fit "exact." The limit system relieves the man of working too close, for with a "go" and "not go" gage the difficulties of obtaining certain fits vanish.

One difficulty in many shops is to make men realize that they can work to any practical limit of accuracy when provided with the proper instrument for measuring or gaging the parts. Too many become frightened when small tolerances are mentioned, and do not realize that the greatest difficulty is in knowing when the right size has been secured.

Five different kinds of fits can be easily "manufactured" for a bearing with a tolerance of 0.0012 in. without using a tolerance closer than 0.0005 in. Many European factories are daily producing as many as fifteen different kinds of fits for one particular size. To bring about such a situation in modern manufacturing plants requires careful study. The first problem is to determine what tolerances will give the best results in the finished machine. The next, the economical method of producing such parts and, third, the proper inspecting and assembling systems for maintaining the necessary fits and limits.

Many manufacturers spend considerable time experimenting before they can determine the proper limits necessary to obtain the fit they desire. Theory and practice have joined hands and produced tabulated figures that are now being exclusively used in Europe to obtain any desired fit for any imaginable size by simply referring to a tolerance table.

A striking illustration of the ease of securing definite tolerances, which means that any desired grade of fit can be had with certainty, is given by the Swedish Gage Co., of New York City, in a sort of demonstration set of limit gages and plugs. The case contains a bushing bored to ¾ in. and used as the base from which five different kinds of fits have been made. The bored bushing represents the bearing and beside it in the case is a "go" and "not go" tolerance plug gage. The two ends of the plug gage are ¾ in. minus 0.0006 in. and ¾ in. plus 0.0006 in., thus indicating a tolerance of 0.0012 in.

There are five plugs in the case, representing five different kinds or grades of fits—loose, sliding, running, push and force fits. The loose fit is used for rapid assembly where exact fit is not essential; the sliding fit also allows rapid assembly, but insures no vibration. The running fit is used for moving bearings, but without vibration and without being too snug to cause an undue amount of wear. The push fit is used for a snug assembly where the leakage of steam, water, air, etc., is involved. The force fit is suitable for holding work on a mandrel, or for assembling at the arbor press. For each of these plugs there is a limit snap gage, and in no fit is the tolerance smaller than 0.0006 in. The parts demonstrate the ease with which five fits may be obtained by applying the limit system.

From the figures stated it can be seen that there is a dividing line between the loose fits and the tight fits at the plus and minus part under the push fit. Naturally, all fits less tight than a push fit are given to minus limits. For example, to obtain a running fit for ¾ in. size. or 0.750 in., the "go" size of the gage would be set to 0.7592 in. (minus), while the "not go" size would be set to 0.7497 in. (plus). Since the bored bushing is used as the base and the size is ¾ in., or 0.750 in., the limits are 0.7506 in. (plus) and 0.7494 in. (minus). From this illustration the reader can see that each fit has been theoretically worked out, and the desired result can be obtained by accurately maintaining the proper limits on the working gages. The limits of these gages are as follows:

Loose	Sliding	Running	Push	Force
—0.0028	—0.0014	—0.0008	—0.0002	+0.0014
—0.0016	—0.0008	—0.0003	+0.0004	+0.0026

To secure any of these fits it is only necessary to use the limit snap gage for the particular fit desired; any shaft that goes between the outer gage points and does not go between the inner gage points is the desired fit. Any one of the other four plugs will either pass both sizes or not pass either size. It is possible for a person to pick the sizes out in the dark, since the limit gages give absolute security for the desired fits, independent of the skill or even the sight of the operator. It is possible for a small boy to pick out the proper fits with the same degree of certainty as a skilled mechanic would select them by using any other method. The demonstration forcibly impresses on one the great difference between measuring and gaging.

The day of producing parts in quantity by measuring as close as the skill of the operator or inspector will permit is being rapidly replaced by a system of gaging in which the personal element is almost entirely eliminated. One thing is certain, and that is, that any kind of fit desired can be produced within limits; and the successful manufacturer who would have a small scrap heap in rapid production of interchangeable parts that will assemble, must give the subject of gaging and gaging methods careful study.

Methods Followed in the Manufacture of Carburetors

By Robert Mawson

SYNOPSIS—Carburetor parts are small and are produced in large quantities. The principal operations, tools and machines used in making the float valve, needle valve, lift lever and bowl cap are shown, also a peening fixture for a cam, a soldering device for the air valve, a special screw-slotting fixture, a countersinking machine and a binding-post tapper. Production is given for each operation described. The final test benches are also illustrated.

An extensive line of carburetors for motorcycles, for small and large high-speed gasoline engines and for automobile engines is manufactured by the Wheeler-Schebler Carburetor Co., Inc., Indianapolis. As the successful running of a gasoline motor plant depends largely on a proper gas mixture, carburetors must be carefully designed to give the correct mixture of gas and air whether the engine is running at low, intermediate or high speed. The mixture must not be either "lean" or too rich, and the adjustments must be minute and sensitive. To meet these conditions with mechanical apparatus means that it must be not only carefully designed, but skilfully and accurately made. Some of the manufacturing practice of the Wheeler-Schebler company is given in this article.

The float valve is one of the most important parts of any carburetor, as it controls the admission of the gas ready for mixing. Cones for the Schebler float valves are rough formed and cut to length in a small automatic. They are then taken to the bench lathe, Fig. 1, where a hole is drilled, countersunk and the end faced. During this operation the cone is held in a chuck, and the three cutting tools are secured in the multiple head *A*. This head is provided with an indexing lever *B*, which fits into three holes in the movable member to obtain the correct position for the tools. At the left end may be seen a pipe through which air is forced when the operator releases the valve *C*, so that the chips are blown out of the chuck after the piece is finished. The production for this machine operation is 200 cones per hour.

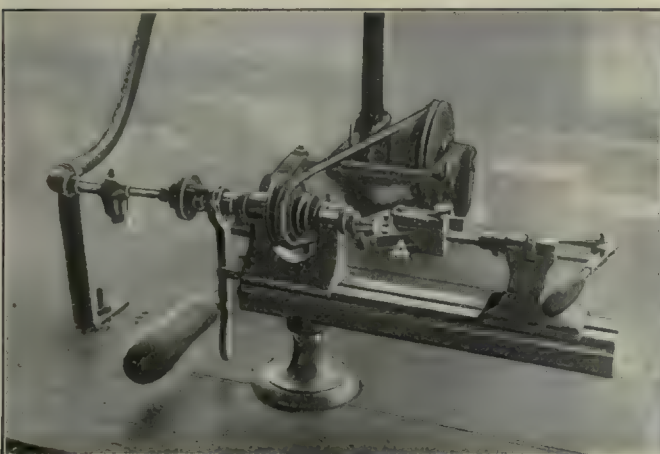


FIG. 1. MACHINING FLOAT-VALVE CONE

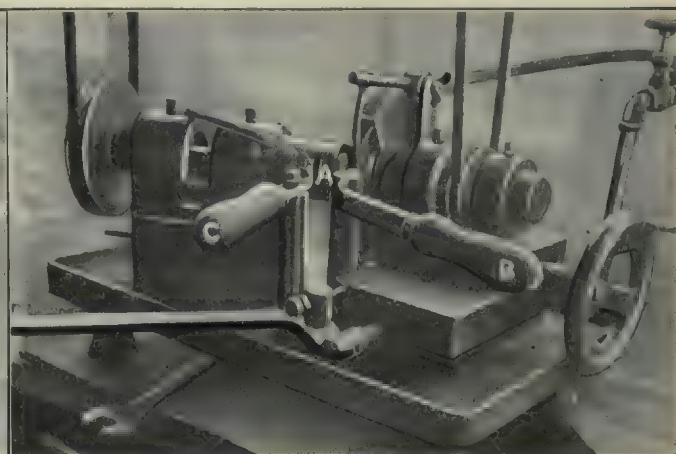


FIG. 2. GRINDING POINT OF VALVE CONE

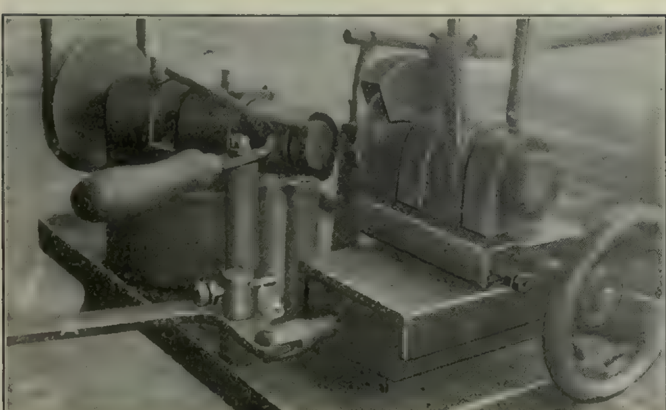


FIG. 3. GRINDER WITH SETTER REMOVED

FIG. 4. ASSEMBLING FLOAT VALVES

The cone is then ground in the machine seen in Fig. 2. The piece is slid onto an arbor held in the chuck *A* by the lever *B*, and the grinding operation is performed by hand traverse. The head carrying the chuck is placed at an angle to give the correct cone point. After the piece is ground, the handle *C* is pushed back, which forces off the ground cone.

In Fig. 3 is shown the grinder with the setting lever removed. It will be seen that the arbor is in position to receive the cone, with the grinding wheel in position for use. The carriage on which the wheel is mounted is drawn forward by means of a handle on the lever *A*, the correct distance being obtained with the stop *B*, production of the assembling press on the float valve is 1000 pieces per hour. Should it be found necessary to remove the cone from the spindle, the hand fixture at the right in this view is used. A float valve is placed in the fixture, as shown, and the lever *C* is pushed back. The movement forces the cone from the spindle without trouble.

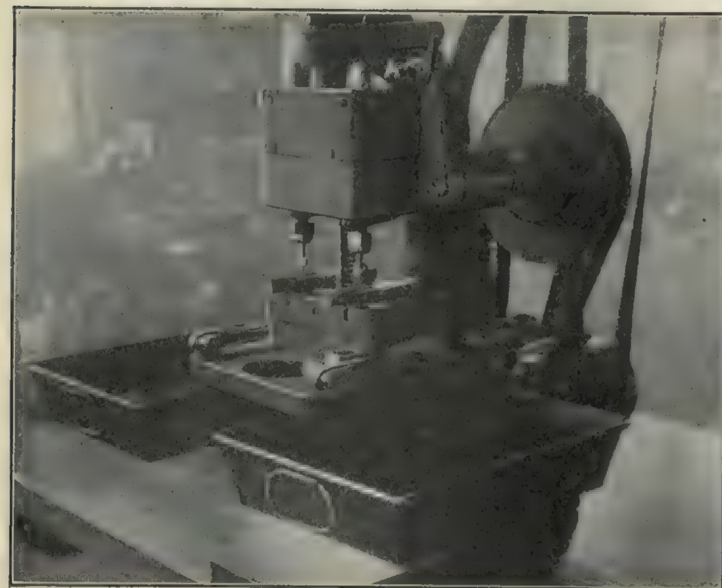


FIG. 5. LAPPING FLOAT VALVES

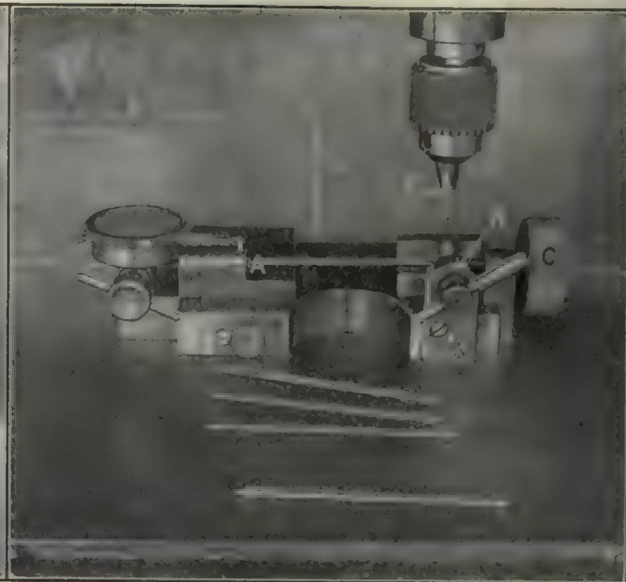


FIG. 6. DRILLING NEEDLE VALVES

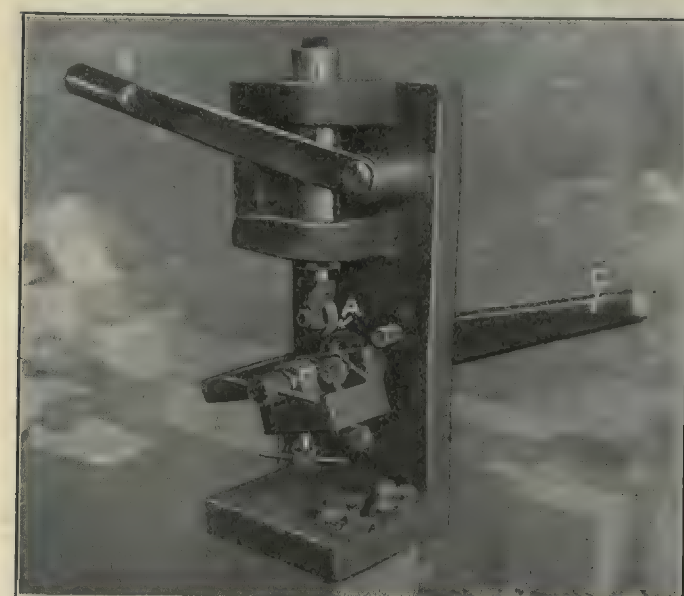


FIG. 7. PEENING IN THE CAM TRACK

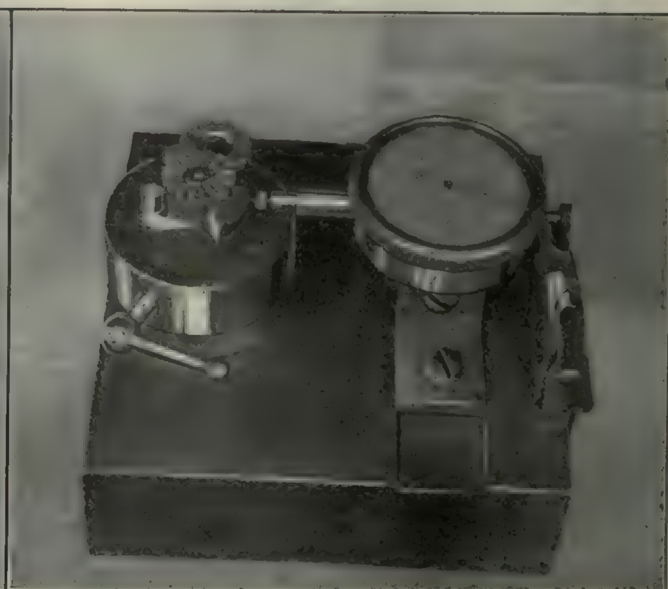


FIG. 8. INSPECTING THE CAM TRACK

against which the outer end of the carriage comes in contact. The production from this machine for this operation is 200 pieces per hour.

The float-valve spindle and ball are assembled and pinned together in a manner similar to that which will be shown in a later part of this article when describing the manufacturing of the needle valve.

The cone is assembled on the float-valve spindle in the press shown in Fig. 4 at *A*. The cone is placed in the fixture, and the spindle is slid in from the top. The operator then draws down the ball lever *B* and forces the spindle down into position in the cone. At the right of the press may be seen trays on which are a number of cones and float-valve spindles ready to be assembled. The

The machine illustrated in Fig. 5 is used to lap the float-valve cones. The spindle of the valve is slid into a chuck, as shown. This chuck, which is made of steel, is provided with serrations, and drives the spindle, which is made of brass. The machine is provided with an oscillating mechanism *A*, which operate cams placed at the upper end of the work-arbor spindles so that these are raised and lowered alternately. The lapping medium is No. 00 emery cloth, with a small quantity of oil. The cloth is held in the jaws, which are provided with holes of the shape of the cone being lapped. About 900 valves can be lapped in an hour.

The needle valve provides the positive setting for the carburetor and is raised or lowered whenever it is tem-

porarily desired to make either a "lean" or a rich mixture. The valve may be moved from the steering column or dash control lever on an automobile or by simply raising it alongside the carburetor. On some types of carburetor made at this factory, however, it is not necessary to touch the needle valve after it has once been set, a dial adjustment being provided for the various conditions met.

The cam mechanism is the device that automatically controls the carburetor for various speeds from low to high. It is made with a cam surface over which a roller moves. This cam path must thus be in the proper location for all points of its surface; otherwise a correct mixture for various speeds will not be obtained. In Fig. 7 is shown the machine used for peening in the cam path.

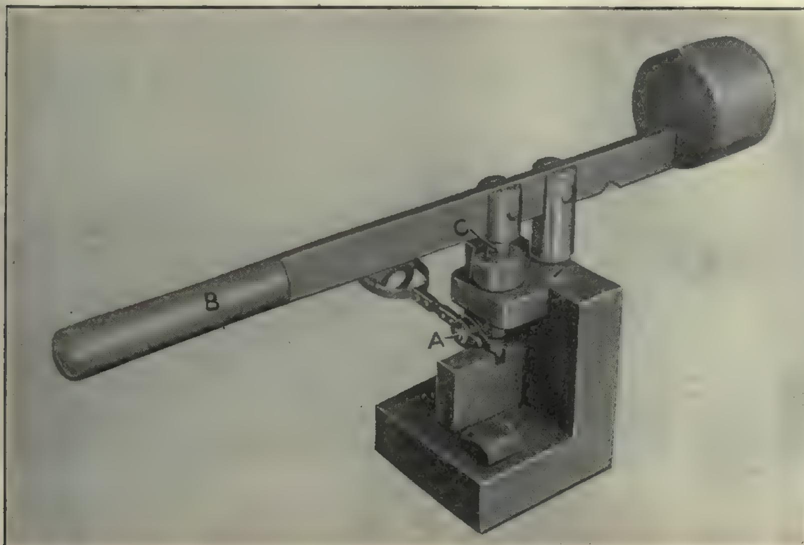


FIG. 9. TESTING SMALL END OF LIFT LEVER

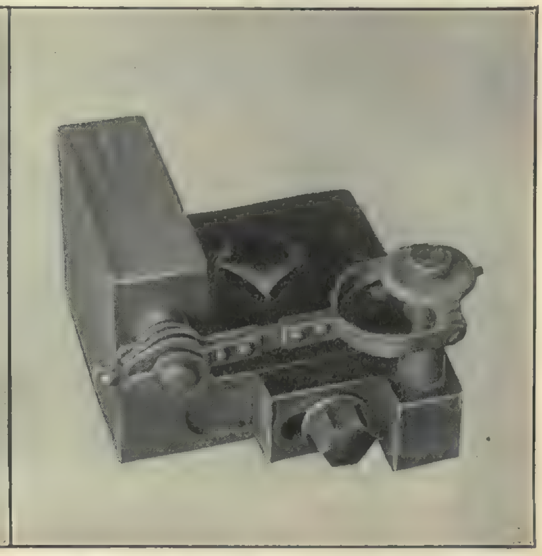


FIG. 10. INSPECTING HOLES OF LIFT LEVER

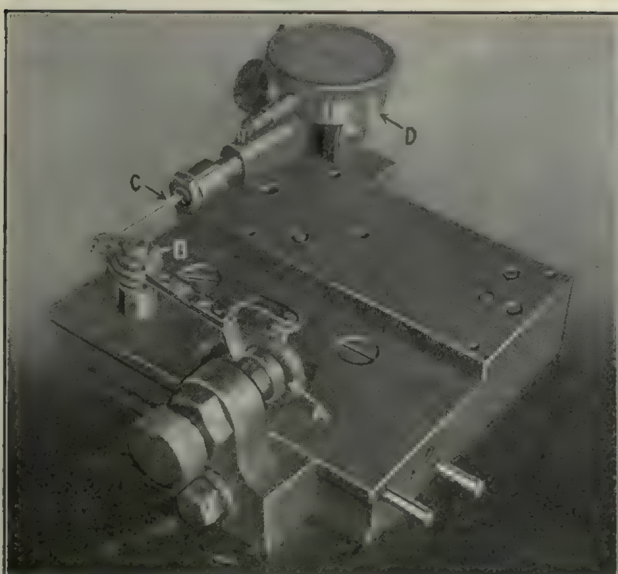


FIG. 11. TESTING THE LIFT LEVER

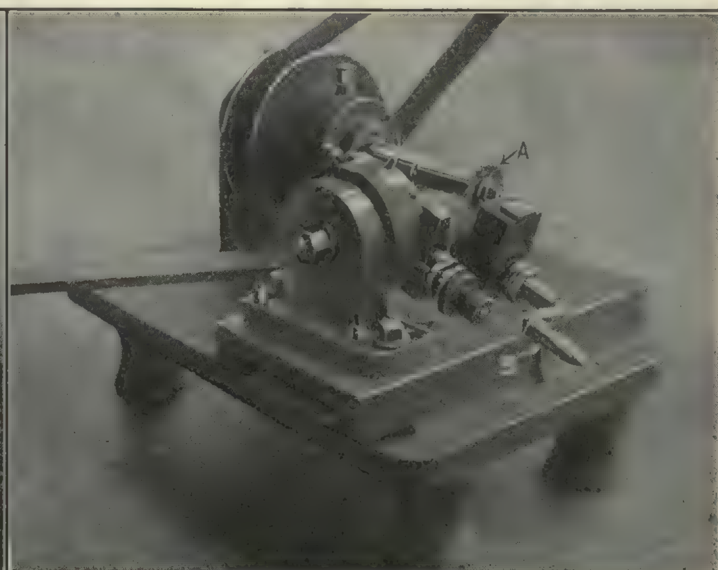


FIG. 12. MILLING CAM POINT ADJUSTER

The needle valve is made of a brass composition. Fig. 6 shows the jig that holds the ball and spindle in position while the hole is drilled through them. The spindle has been ground at the cone end in a manner similar to that shown for the float valve. This cone end is placed in the center at *A*, with the ball slid on the spindle. The ball is held in a screw-operated chuck at *B*. The end of the spindle is pushed through the ball with the knurl-head screw *C*, until the dial indicator *D* registers zero. The hole is then machined through the ball and the spindle with the drill *E*. By this method all the needle valves are the same distance from the cone point to the ball, which is the determining factor in setting the needle valve. The production for this operation is 300 pieces per hour.

The cam body is machined with a slight undercut surface on each side. The path—a separate piece—is then placed in the cam and in the fixture, as shown. It is located on pins that accurately fit two reamed holes. The knurl *A* is then brought into contact with the projecting edges, which are knurled or peened in, thus holding the path securely in the cam body. The knurl is held down by the handle *B*, and the cam is oscillated by the handle as shown at *C*.

The cam track is then inspected with the gage, Fig. 8. The cam is located on pins; and as it is rotated against the point of the dial indicator, it must register between certain predetermined readings on the dial. The production for assembling rolling in the cam path and inspection is 33 pieces per hour.

The fixtures devised for testing the assembled needle-valve lift levers are interesting and will be described next. In Fig. 9 is shown the fixture used to test and form the small end of the lever. The piece is placed on a pin *A*, and the lever *B* is drawn down. This pushes down the plunger *C*, the end of which comes in contact with the lift lever, which is pushed into the height block so that the working end of the lift lever will be in the correct location with regard to its free end.

The fixture for testing the alignment of the holes in the lift lever may be seen in Fig. 10. This tool is designed with two pins that are a good sliding fit in the holes of the piece. The piece must slide on to the two pins in order to have the holes in the correct alignment.

In Fig. 11 is illustrated the fixture for testing the alignment of the ball seat of the lift lever. The piece is placed on the pins *A* and *B*. The spindle *C*, which is made with a ball similar to that of the needle valve, is slid into the ball seat in the lever. If the needle-valve lift lever is in the correct alignment, the gage indicator dial *D* will register properly. If any error is found, it is corrected. The production for assembling and inspecting the lift levers averages somewhere in the vicinity of 100 pieces per hour.

The special machine for milling the spiral thread on the cam point adjuster is shown in Fig. 12. The piece is held in a threaded chuck, which is made to suit the threaded end of the adjuster. It is then fed against the saw *A* by the handle *B*, which operates a screw. As the fixture is tilted at an angle, as shown, the desired pitch of the spiral thread is milled. Should it be desired to change this pitch, the fixture is tilted to give the desired angle. The saw revolves at 600 r.p.m., and the number of pieces machined at the ordinary rate of production is 300 pieces per hour.

FIG. 13. SOLDERING NEEDLE-VALVE LIFT LEVER

FIG. 14. SOLDERING NEEDLES IN AIR VALVES

FIG. 15. WASHING AIR VALVES

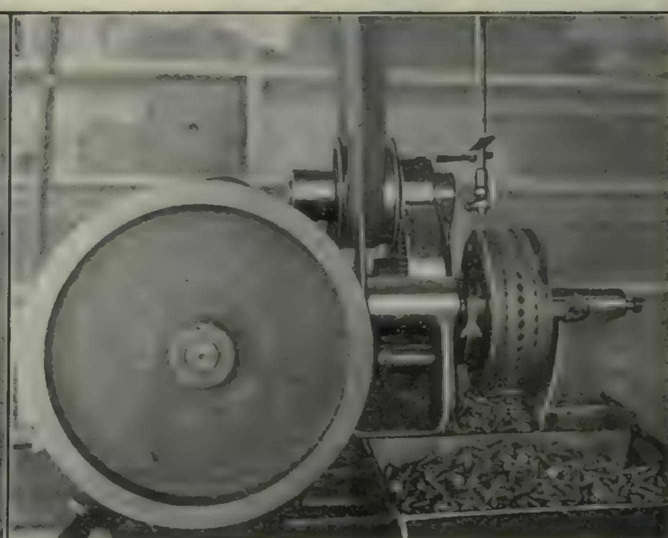


FIG. 16. SLOTTING FIXTURE FOR SCREWS

An assembling and soldering operation on another type of needle-valve lift lever is illustrated in Fig. 13. The lever is placed in the fixture *A*, which is held in a vise, and a ball and spring are inserted in a machined hole. The action of these two parts is to hold the needle valve in tension so that it will always drop back to its position after being raised by the lift lever. A box containing a number of the balls is shown at *B*, and a box of springs at *C*. After the ball and spring are in position, the operator solders the hole on the entering side.

The lift levers are then placed on the rack above, and the end of the knurled screw is soldered so that it will not work out when assembled in the carburetor. The production for the assembling and two soldering operations is 78 pieces per hour.

In Fig. 14 is shown the fixture used in soldering the needle in the compensating air valve. The purpose of

this valve is to change the quality of the gas mixture by allowing either more or less air to enter the mixing chamber. After the machining operations have been performed on the air valve and needle, the valve is placed in one of the holders of the fixture, as shown. A needle is then dropped into its hole, the lower end resting on a stop to determine the correct projection out of the valve. A piece of solder is placed at the upper end, as shown. A gas jet is allowed to play on the solder from the pipes A—two valves being thus soldered at one setting. The fixture is then revolved to the next setting and the operation repeated. Positions for the indexing around of the fixture are determined by the pawl B, fitting into notches of the revolving member of the fixture. With this fixture and following this method, 200 valves may be completely soldered and finished in about one hour.

The air valves are then washed, so that all oil and grease are removed before the valves are assembled in the carburetor. In Fig. 15 may be seen the tanks for this purpose. The valves are placed in the tray, the needles fitting into holes, as shown. Tray and all are dipped into a hot solution of sal soda in the proportion of one part soda to four parts water. The tray is then lifted and dipped into the second tank, which contains water heated to about 210 deg. F. After cooling, the valves are ready for assembling in the carburetor body.

A machine and fixture used in slotting the heads of screws may be seen in Fig. 16. The screws are placed in the holes of the revolving fixture, which is fed around against a rotating saw, the motion of the fixture being continuous. It will be observed that a plate A bears against the side of the fixture. This plate has a cam surface. A roller at the rear forces the fixture back at the cutting point, so that the screw is held firmly during the sawing operation. However, as the slotted screws in the fixture come opposite the cam plate A, it is allowed to slide back sufficiently to permit the finished slotted screws to drop out. The number of screws that may be slotted in this machine with this device is 2000 per hour.

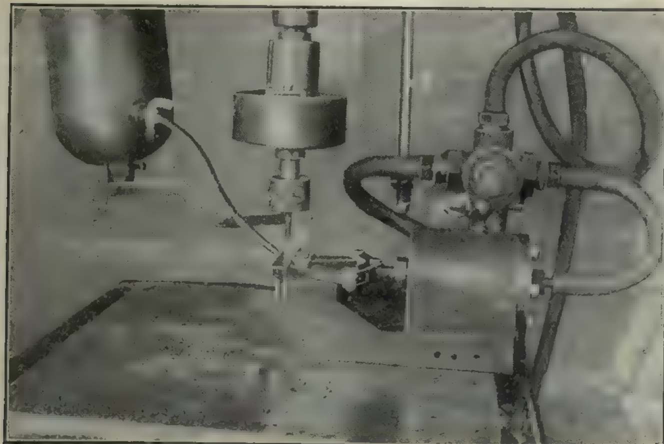


FIG. 17. TAPPING BINDING POSTS

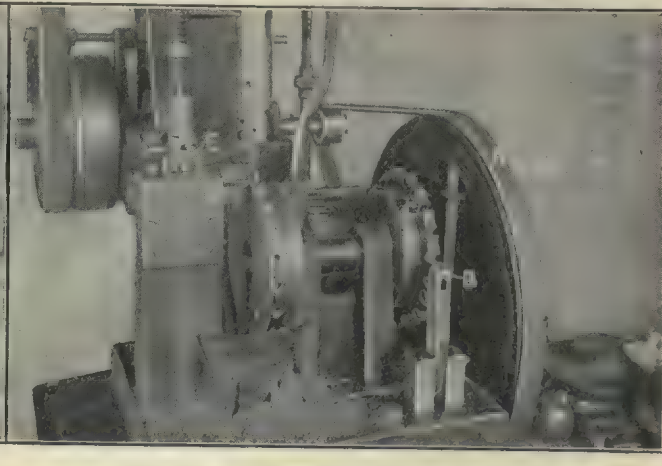


FIG. 18. COUNTERSINKING MACHINE

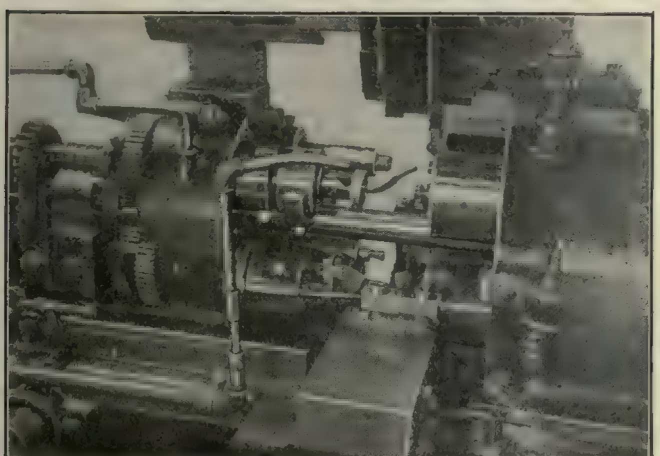


FIG. 19. MACHINING BOWL CAPS ON AUTOMATIC

FIG. 20. TESTING ASSEMBLED CARBURETORS

An air-operated chuck, which is used in tapping binding posts, is shown in Fig. 17. The piece is placed in the fixture A; and as the tap is fed down, the lever B opens the valve C and allows air to enter the cylinder. The piston, being forced out, operates the toggle arms, which grip and hold the binding post during tapping. After the piece is tapped, the tap is raised, air is again shut off and the toggle arm slid back by virtue of the piston returning in the cylinder. The piece drops out of the fixture, which is ready for the next one to be placed in position. The production is approximately 1000 posts per hour.

In Fig. 18 are shown a special machine and fixture for countersinking small machine parts. The illustration shows the set-up for countersinking lift-lever rollers. They are placed in the recesses seen on the fixture faceplate, the fixture being revolved by means of the gears at the rear, driven by the belt A. The proper locations

for the countersinking positions are determined by the roller *B*, fitting in concave notches on the periphery of the drum *C*, as shown. A clamp *D*, which may be operated by the plunger *E*, holds parts whose shape prevents their fitting in recesses on the periphery of the fixture. The production from this machine is 2000 pieces per hour.

An automatic tooled up for manufacturing bowl caps is shown in Fig. 19. The parts are made from brass bar, and the production is 250 pieces per hour. The sequence of operations is: Form outside and drill; counterbore, face inside and knurl; thread, form recess and cut off with tool on cross-slide. The cutting-off tool is made with a concave form, to machine the correct shape on the face of the piece.

The two racks seen in Fig. 20 are used to give the assembled carburetors a final gasoline test. The carburetors are screwed on the threaded connections, and gasoline is forced into them at 3 lb. pressure. Should any slight leak appear, the defect is repaired by peening. A large defect would scarcely be possible, as all the bodies are tested under hydraulic pressure before being machined and also after that operation. The carburetors are left under a gasoline test for one hour, and if at the end of this period they have not developed any leaks they are passed by the inspector.

When passed, the carburetors are unscrewed from the threaded connections, drained and conveyed to the shipping department where they are packed preparatory to shipping to the various engine manufacturers and dealers for whom they are intended.

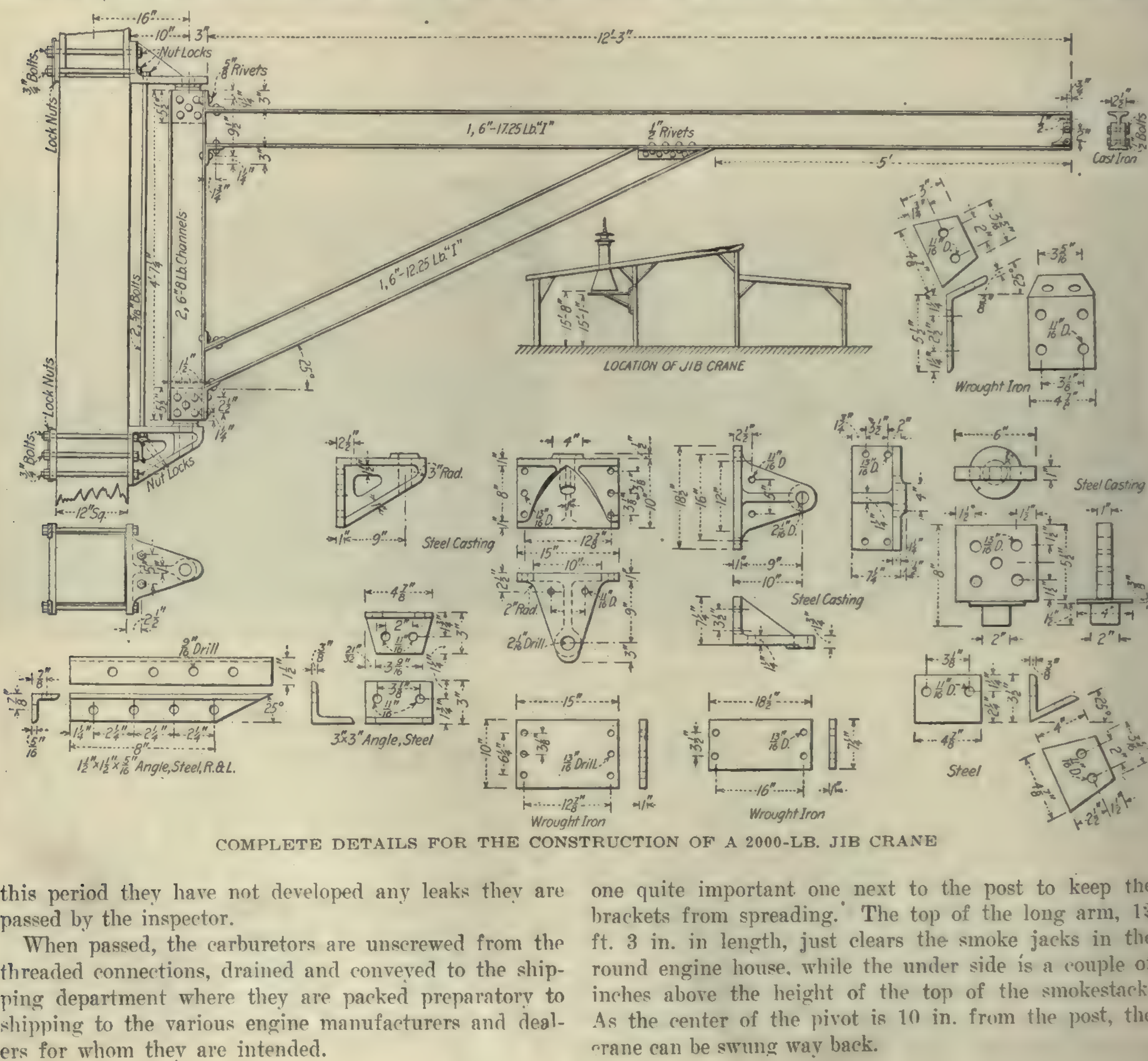
How To Build a 2000-Pound Jib Crane

By Joseph K. Long

It sometimes happens that a small jib crane is wanted where, for some reason or other, it is not easy to buy one. For these cases the design of a 2000-lb. crane that has proved successful in several railroad shops may be of real value, as full details are given.

Nearly all roundhouses are built from similar design, with two or sometimes with three 10x12-in. square posts supporting the structure between the inner circle and the outer wall. These posts can also support a crane of this type. In order to lift or remove piston valves, steam chests, pistons, cylinder heads, front ends, etc., we built and put in use several of these cranes.

The brackets are steel castings. The lower bracket is securely bolted to the post by six ¾-in. through bolts, while the upper bracket has four. Each bracket has bosses; and the piece, which is set in them, forms the pivot for turning the crane. Two 6-in. 8-lb. channels are riveted to the pivot. Both the long top arm and the brace are secured to these channels by ⅝-in. rivets and angles, as shown. Two long ⅝-in. rods are used and one quite important one next to the post to keep the brackets from spreading. The top of the long arm, 12 ft. 3 in. in length, just clears the smoke jacks in the round engine house, while the under side is a couple of inches above the height of the top of the smokestack. As the center of the pivot is 10 in. from the post, the crane can be swung way back.



COMPLETE DETAILS FOR THE CONSTRUCTION OF A 2000-LB. JIB CRANE

Relative Accuracy

BY WILLIAM S. AYARS

SYNOPSIS—While absolute accuracy is unattainable, relative accuracy can be attained; but the relative accuracy that is quite close enough for one class of work may be too close for a second and not close enough for a third.

The problems of the draftsman, the designer and the machinist are so nearly allied today that no hard-and-fast line can be drawn between them. Attention has been directed to this fact in the title to the new edition of Halsey's handbook, which now states that the book is for "shopmen" as well as for the drafting room. The writer, as a teacher of mechanical and electrical subjects, has noted this for years, and has also good reason to believe the dictum of the scientific management clan, that today the best foreman must also be a good teacher.

The man who has taught the same subject for many years soon gets to know that certain things, and those not often intrinsically difficult, are inevitable stumbling blocks, and for this reason will warn his students in advance that such and such a page or paragraph is worth special care and drill. This sometimes calls forth superior smiles from the warned, but sooner or later he trips, just the same. So simple a thing as the shrinking of one part on another often catches the unwary. A would-be young designer once presented a drawing that looked something like a stud sticking out of a casting, only it had no threads on the embedded portion. When asked how the stud was gripped by the casting, he explained that a hole was drilled in the casting, the stud heated red hot and dropped in the hole, and then doused with cold water. "That will make the stud shrink tight in the hole, and it will never come out!" was his confident explanation.

ISOLATED CASES PROVE NOTHING

But isolated cases do not always prove the point, and the real object of this paper is to discuss rather the sort of trail that runs through a whole course; and the particular thing in mind is relative accuracy. When is "about 6 ft." close enough and when "4.003 in."? And even on the 4.003 in., how much over or under is allowable? When should this amount be stated in rigid terms and when is it sufficient to say "an easy fit," "a snug fit," "a running fit," etc.? I have known steam-engine designers to figure and draw over several square yards of paper in determining sizes, weights, etc., for an automatic cutoff governor; and then when the governor was built, make all sorts of adjustments possible in order to regulate it on the running engine. If it is necessary (and it surely is) to provide the completed governor with means for changing the tension and attachment points of the springs, to vary the weights and to make the parts move with more or less reluctance or sensitiveness, surely a great deal of the preliminary calculation was useless.

Take one of the simplest and most logical of rational formulas, that for determining the strength of boiler shells, etc., the so-called "thin cylinder" formula. This is written $Pd = 2\ ft$; meaning pressure in pounds per square inch times diameter in inches equals twice the stress in pounds per square inch times thickness in inches. In applying this to an actual case, the designer has t for his unknown quantity. Also he must take into consideration the type of riveted joint he means to use, the ultimate or breaking strength of the material and the factor of safety. Now both the ultimate strength of the steel and the efficiency of the joint are guesses, so far as close work is concerned. It is customary to assume the ultimate stress as 60,000 for good shell-plate steel; and a good modern boiler should have a triple butt-riveted joint, whose efficiency averages about 85 per cent. And for good workmanship a factor of safety of 5 is common. The formula then becomes, t being the unknown:

$$Pd = 2\ ft$$

$$t = \frac{Pd}{2f}$$

$$t = \frac{P \times d \times 5}{2 \times 60{,}000 \times 0.85}$$

Let us assume a boiler 78 in. in diameter and a working pressure of 125 lb. Then

$$t = \frac{125 \times 78 \times 5}{2 \times 60{,}000 \times 0.85} = 0.47794+$$

Working this by the common 10-in. slide rule, I read it 0.478; and of course this means ½-in. plate, since we are not engaging rolling mills to make plate 0.47794 in. thick, or even 0.478 in. Yet if such a problem were presented to the average young college-taught draftsman, or to the student himself in college, he would in nine cases out of ten answer to four or five decimal places.

This case is presented as a fine example of straining at a gnat and swallowing a camel. Figuring indicated horsepower is another. Many men will turn in a set of cards figured out as say 73.268+, when they might just as well have said 75 and been done with it. Perhaps they used a standard spring stamped 40, when a careful calibration of the spring would have shown 39.63 or 40.27; and yet the manufacturer was perfectly fair in marking that spring 40, as it may have been almost exactly a 40 when first made. And there is always a chance of slight error in the drum motion; leakage past the indicator piston; sticking; stretch of the cord; and so on. I am speaking now of ordinary tests on running engines, and not of elaborate acceptance tests on a new plant on which heavy penalties or bonuses may be dependent. Here, of course, everything should be in the finest order, springs calibrated, etc., as one never knows when the results of such a case may get before a jury and the test engineer be put on the stand. The writer has had this experience himself, and must confess that few things have given him more joy than to have a lawyer, whose knowledge of engineering was considerably "less than any assignable quantity," try to tangle him up on his own ground. The introduction of the lawyer recalls the tale of the machinist who was on the stand as a witness at a murder trial. He had given damaging evidence against the defendant, and the latter's lawyer was endeavoring to rattle him by cross-examination. Suddenly he asked:

"Now will you tell the jury how far you were from where you say the accused struck the victim?"

"I was just exactly 25 ft. 11⅞ in.," replied the witness.

"Ha! gentlemen of the jury, observe the accuracy of the witness! In all the excitement of the moment, he claims he was exactly 25 ft. 11⅞ in. from the defendant. How do you know, sir, that you were exactly 25 ft. 11⅞ in. from this spot?"

"Well," responded the witness slowly, "I just knew some damn fool lawyer would ask me, so I measured it!"

Well, after all, you never know when "some damn fool" is going to ask you, and accuracy in figures up to the worth-while limit, is a great thing. You will observe, though, that the witness did not attempt to go closer than ⅞ in.; and possibly he might have been quite within the limits if he had said 26 ft. But if he had said "about 25 or 30 ft.," the story would have lost most of its point—it wouldn't have been close enough to check up with a tapemeasure.

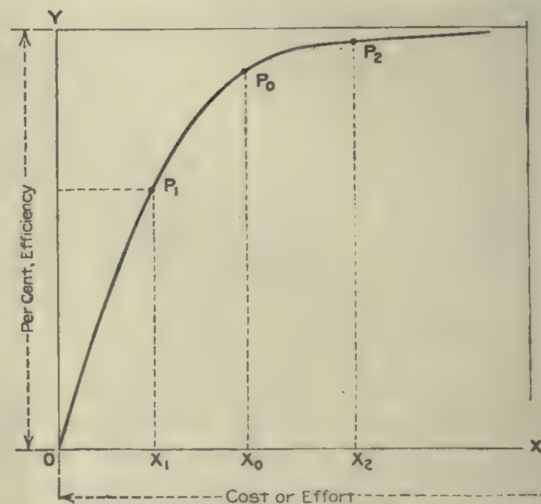
There are plenty of cases, however, where "about 25 ft." would be close enough, and it is the duty of the designer or foreman in such cases to let that fact be known. The writer remembers vividly an informal talk by the late James Mapes Dodge in which the latter suddenly remarked, "but never attempt to be 100 per cent. efficient!" This called forth some discussion, and Mr. Dodge illustrated his statement by that ready reference of all engineers—a curve. This is shown in the illustration. The horizontal distances represent cost or effort required; the vertical, the resulting efficiency. The horizontal line represents absolute perfection, or 100 per cent., and may be likened to the asymptote of the hyperbola; a line which the curve always approaches but never reaches. Suppose a certain cost produces an efficiency shown by X_1P_1 of say 70 per cent. By increasing the cost from OX_1 to OX_0, which is about doubling it, the efficiency is raised to say 90 per cent. Trebling the cost, to OX_2, increases the efficiency to X_2P_2, or about 92 per cent. Was this worth while? Most decidedly not, unless for some very special purpose—or for "the government."

How Far Should the Curve Be Followed?

To the writer's mind, it is extremely essential that the designer, or foreman, or writer of a set of specifications, should have a very clear idea of just how far out on this curve he wants, or is required, to go. It is a curve that shows up in all sorts of work. To the electrical engineer it is the well-known curve of magnetic saturation, and the point P_0 where the curve takes a decided bend is the "knee" of the curve and the limit of practical working. The writer recently had occasion to purchase a certain salt from a druggist and was given a ¼-lb. tin at 20 cents. A fair knowledge of elementary chemistry enabled me to tell the druggist that this salt was a very cheap article; and he replied that if I wished the coarse commercial article, I might have a 5-lb. bag at 37 cents; but that for medicinal purposes he would most strongly recommend that I take the super-refined article in the sealed tin, and I did so; thinking at the same time that here was another case where it was worth while to go some distance out on the "efficiency" curve.

Again, one can buy a fairly good and remarkably sturdy and foolproof watch today for a dollar. A fine jeweled and adjusted movement will cost from $20 up, to say nothing of a suitable case, and it is entirely up to the buyer to decide whether the slightly increased accuracy of the better watch is worth the relatively enormous increase in price. The railroad man believes it to be decidedly worth while; and the navigation officer of a modern ocean liner has chronometers that are regulated to a fraction of a second to the week, and then has them "rated" every time he gets into port for a few days.

The passion for accuracy or efficiency *per se* frequently leads to almost absurd results. There was once a wealthy lumberman of the writer's acquaintance who built a huge and uptodate sawmill far out in the woods, and was one day exhibiting this plant with pride to a group of visitors. One of the latter was a shrewd old Scotch-Irish engineer, and he asked the owner why he had put in a fine Corliss engine and condensing plant for such a purpose. The reply was, for efficiency and economy. The engineer then pointed out that since he had pure water hard by in abundance, and was using slabs and sawdust for fuel, he could not see where the economy came in—especially as the supply of fuel was so plentiful that a large excess was being burned in the open to get rid of



THE EFFICIENCY CURVE

it. Now if this owner had said that he loved fine machinery for its own sake, and was proud of his handsome engine room as a show place and could afford to gratify his fancies, he would have told the truth and had nothing to be ashamed of. But he was certainly on the wrong track when he pleaded efficiency and economy as the excuse for his expensive and showy plant.

The writer was once told by a well-known management expert that the slow, accurate workman was much harder to train to speedy production than was the naturally quick but careless man, to accuracy. This seems contrary to all experience, but my own observation has proved its truth, especially among young women in office work. The worker with figures, for instance, is just as liable to slip a figure in the thousands column as in the units column, and here at any rate is one place where it is safer to depend upon the slow and accurate than upon the quick and careless. But the quick and careless can be taught to handle a calculating machine in much less time than the slow and accurate, and the machine makes no mistakes. Exactly the same thing is true in the machine shop. If a cast-iron block were to be made say 2x4x8, tolerance 0.005 over or under, it would take an exceedingly good bench hand to make this block by chipping, filing and scraping. But any man or boy

with a little experience on a good miller could turn out dozens of them while one was being made by hand, even though he was not of the slow and accurate temperament. He might spoil a few at first, but a heart-to-heart talk with the inspector would have its result in most cases; and before long the blocks would be coming from the machine with promptness, accuracy—and speed.

It is always an eye-opener to the mechanical man to be thrown into contact, violently or otherwise, with the architect or builder. He seems to have a scorn, amounting almost to contempt, for close work. If his work never had to tie-up with that of the mechanical or electrical man, he might "gang his own gait" uncriticized; but nowadays in practically all buildings, the engineer has to work with the architect, and many a time he is badly "stung," especially when he depends upon the plans of a partly constructed building for dimensions. It is customary now for all agreements as to installing machinery for the engineer to specify that any cutting of walls, etc., necessary to get the machinery into place be at the expense of the buyer, for many new buildings are rushed to semicompletion without the architect making the slightest provision for installing boilers, engines, generators or elevator machinery, even though he knew from the first that such machinery was to be an integral part of the building. The writer has particularly in mind a large department store building in a Western city, where it was necessary not only to tear out a piece of the foundation wall, but to excavate nearly four feet inside on account of lack of headroom in order to set the boilers. And these boilers were of a well-known water-tube type at that, and were built to order in the lowest and broadest arrangement possible. They were also shipped very little assembled, and their assembly in the cramped and dark basement entailed further heavy expense which would have been saved by factory assembling.

Alter Drawings If Necessary

Every man who has to do with complicated structures in the making knows that conditions arise in the shop, erecting floor or field that make a deviation from the drawings highly advisable. Very well; let it be done by all means, but immediately notify the engineer or chief draftsman in charge, so that he can alter his tracings to suit, recall every blueprint that has been sent out, and where required issue new ones in their places. A large city building is practically certain never to be duplicated; so that the architect or builder rarely bothers to correct the drawings to suit changes of plan, provided such changes are satisfactory to the owner. In many cases this makes no particular difference, but occasionally it makes a great big and expensive difference. Whenever you are called upon to estimate on putting in new equipment, changing or removing old, running shafting, installing a crane—don't trust any drawings sent you by or from the architect who drew the original plans. Go yourself or send a reliable man with a steel tape, and take all you own data "from the work." The burnt child dreads the fire, and the writer has been scorched more than once.

It is only a step from land to marine architecture, and here the trouble is much more acute, for a large steel steamship may be not only duplicated, but called for in fours or even half-dozens. Naturally each ship is a complete structure, and many months are consumed in building it. American shipyards contain many foremen and superintendents who came from Scotch or English plants, and they brought with them a strongly developed tendency to "improve" upon the drawings sent out from the office. There is no doubt that many such changes really are improvements, but the evil thing is the fact that the changes are not often reported back to the office for the revision of the tracings, destruction of superseded prints, etc. And finally the first of say six sister ships goes upon her trial trip, and as a result a number of further and unrecorded changes are made in the second.

This process will continue until all six are built and at sea; and no two of the lot will be duplicates in all respects. And finally one of them comes into port some thousand miles away with some expensive and bulky portion badly broken. The builder is telegraphed to get out a new part and ship at once; which he does, using the drawing that the chief draftsman fondly imagines was used when the broken part was made—and the rest is easily imagined, because probably four different men got hold of the original piece in the shop and altered it for better or for worse, and not one of the lot sent word to the office.

Following Drawings Known To Be Wrong

In sharp contrast to the preceding is the equally harmful tendency for the shopman to follow a drawing exactly when he knows it to be wrong. This may be done through ignorance occasionally, but more often it is done either through the old doctrine, "obey orders if you break owners," or from a petty desire to injure the designing office in the eyes of the management. Nowhere are coöperation and mutual helpfulness more necessary than between the drafting room and the shop; if either tries to put the other "in bad with the boss," there is loss, delay and trouble every time. The writer well remembers the time, a good many years ago, when he was entrusted with the design of a big locomotive boiler, and how he got badly muddled over stay-spacing and similar details. One day the old layer-out came in from the boiler shop and the writer asked him to come over to his board and tell him some things. He was not only willing but eager to do so, and the writer learned more about locomotive boilers in half-an-hour with him than he ever had known before. He told the writer always to give the number of rivets in a girth seam a multiple of four; and that it was not necessary to mark the center of each stay or even the exact pitch, but simply mark clearly the limits of the area to be stayed and the total number of stays, and he himself would space them. As he said, he had to lay out the sheets, so what was the use of having them layed out first? He also said that to avoid giving a pitch in decimals, to state rather the number of rivets to go into a given distance; which is precisely in line with the use of the diametral pitch in gear work.

To sum up what in the writer's experience seems to be the crux of the whole matter: Accuracy in the abstract may be regarded like 100 per cent. efficiency, as a nearly impossible ideal. But accuracy up to a well-defined limit is an entirely attainable end, and it is very much up to the designer or buyer to state this end or limit distinctly. On a drawing this is best shown by clearly written figures. For instance, a dimension of 15 in. should not be given as simply 15 in. unless it is clearly known just how near 15 in. will be acceptable. If $\frac{1}{8}$ in. either way will pass,

mark it 15 in. $\pm 1/8$ in.; if 0.003 in. either way will pass, mark it 15 in. ± 0.003 in. And, similarly, in calculating the sizes of parts, don't bother with four or five places of decimals when you base a lot of your data on more or less approximate quantities, and particularly when you mean to use material that comes to you in certain standard weights or dimensions anyway, as in steel plate, structural shapes or shafting. The 10-in. slide rule will give close enough results for 95 per cent. of all the purely technical calculation you may be called upon to do; and as to figures of costs or estimates, the chances are that if you failed to land a job on which you bid \$15,650 you would not have landed it had you bid \$15,647.38¼. Furthermore, the man who holds you down to a tolerance of a few thousandths on an overall of 15 in. must expect to pay for it, even when he calls for a big output of pieces; and if he only wants one or a few of these pieces, he must expect to pay relatively a great deal more. It is well that this last warning should be borne in mind by the anonymous gentlemen who grind out munition specifications, but there is little probability that it ever will.

Movable Surface Plate

Most shops are content to place their surface plates directly on one end of a work bench. This method has its disadvantages, for if for any reason the plate has to be moved, its very shape and weight make it a difficult job.

The Reno-Kaetker Electric Co., Cincinnati, Ohio, mounts its surface plates as shown, so that they are easily

MOVABLE SURFACE PLATE

moved from place to place, taken to a job or pushed back into a corner out of the way. The frame is made principally of angle and strap iron, and the cast-iron rollers are held to the shafts with cotter pins.

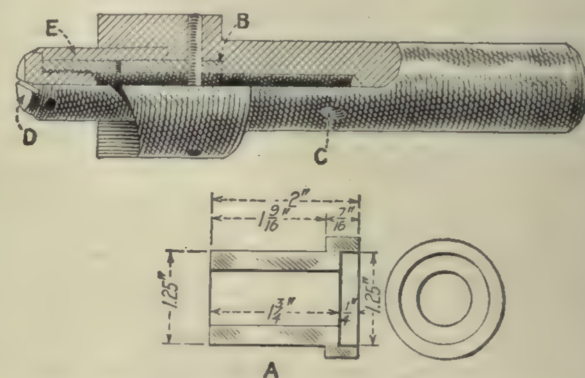
Revolving Pilot Counterbore for Use on Automatics

By F. F. Bowen

The tool shown in the illustration is a counterbore to be used on automatics and hand screw machines. It is made to do such work as shown at A and is made with a revolving pilot.

Solid pilots on this type of tool are a constant trouble, as they cut or freeze unless a considerable amount of clearance, which generally prevents accurate work, is allowed.

This danger is entirely done away with in the revolving pilot E, and it is possible to get a pilot accurately ground almost to size, which will just enter and revolve with the



THE REVOLVING PILOT COUNTERBORE AND WORK

work around the master pilot B. The master pilot B is hardened and ground, and is lubricated through the oil hole C.

It will be noticed that the screw D holds the pilot in place; it is set in so as to prevent grit from reaching the master pilot B. The tool has four teeth with large chip clearance. This allows fast and accurate work to be done at a small cost per piece.

Chart for Quickly Determining Cutting Speeds and Feeds

By J. B. Peddle*

On page 405, Vol. 45, an article appeared by Prof. W. A. Knight on the subject of cutting speeds and feeds. In the article was given the formula $V = \frac{K\sqrt{E}}{T_s \sqrt[3]{DF^2}}$. This formula has been developed in chart form and is here given. It will save considerable time in determining any required feeds and speeds.

To use the chart, take for an example $Ts = 48$ tons, $E = 16$ per cent., $D = 1/2$ in., $F = \frac{1}{16}$ in. and $K = 50$. Then join the quantities given on E and Ts and find the intersection with the axis A; also join the quantities on D and F and find the intersection with axis C. Join the two points found on A and C and find the intersection with axis B. Join this point on B with K and extend to V, which will show the required cutting speed. For the example taken, the result is 33⅓ ft. per min.

*Professor of Machine Design, Rose Polytechnic Institute.

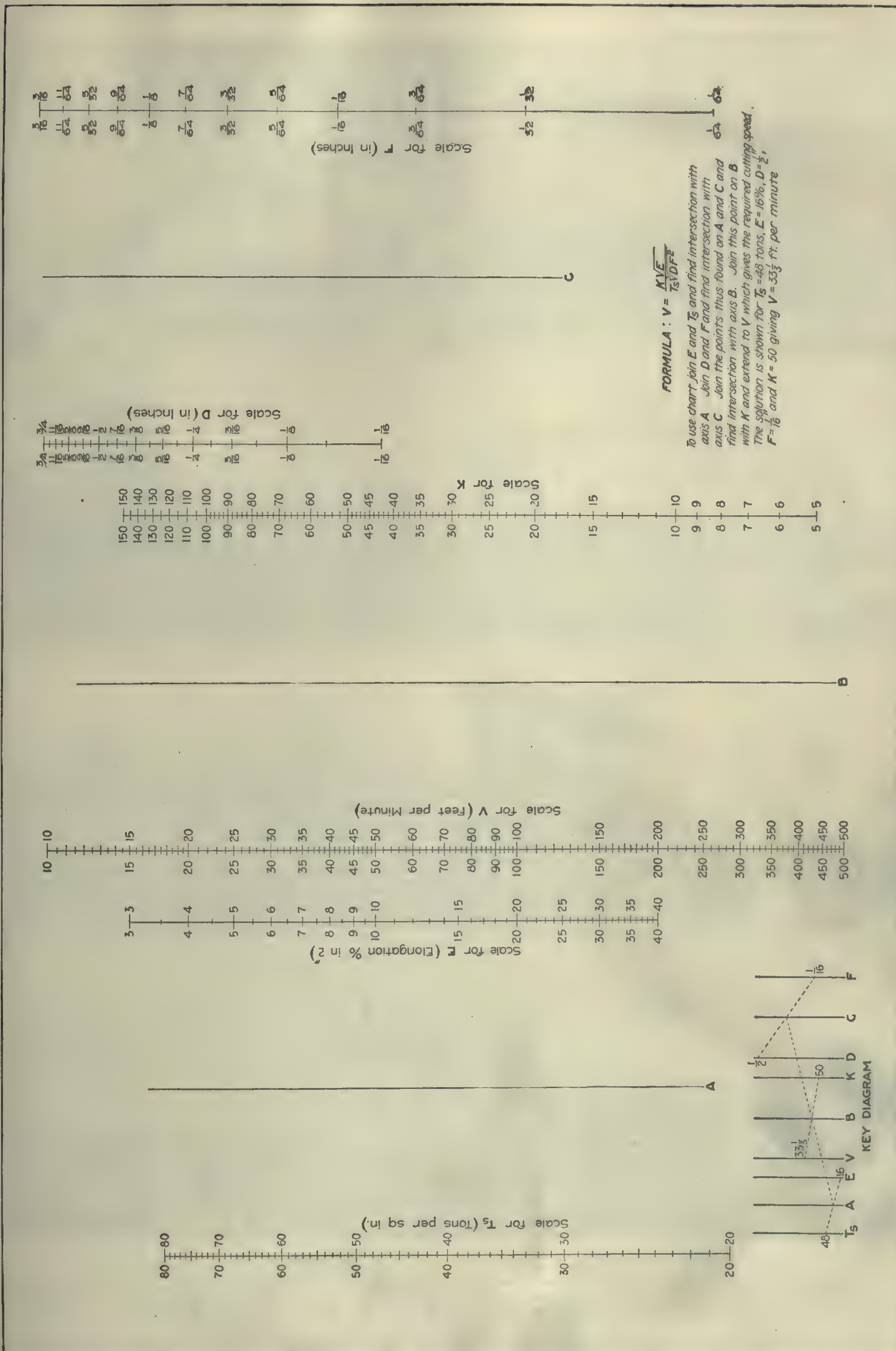


CHART FOR THE DETERMINATION OF CUTTING SPEEDS AND FEEDS AS GIVEN BY THE FORMULA OF PROF. W. A. KNIGHT

FIGS. 1 TO 8. UNITED STATES ARMY TESTS OF HOLT CATERPILLAR TRACTORS

Fig. 1—Loading itself on flat-car. Fig. 2—How it crosses railroad bridges. Fig. 3—Hauling 4.7-in. gun caisson; weight of load, 17,000 lb. Fig. 4—Drawing 4.7-in. gun through mud; gun weighs 8800 lb. Fig. 5—First pulled itself out of mud, then drew gun after it. Fig. 6—Crossing railroad trestle with 4.7-in. gun and caisson; weight of load, 17,000 lb. Fig. 7—Easy going with same 4.7-in. gun, caisson and gun crew. Fig. 8—Same gun and crew leaving highway to ford a stream

United States Munitions*

The Springfield Model 1913 Service Rifle

Movable Stud—Front Sight and Movable Base—I

SYNOPSIS—These smaller parts involve the use of small jigs and fixtures of interesting design, to accommodate work which must be finished all over.

One of the interesting fixtures is shown in Fig. 1432. Here the pieces are located by the studs *B* and *C* in the swinging arm *A*. After the pieces are located against the stops, they are clamped by the jaws shown and the stop swung out of the way. Another fixture of interest is seen in Fig. 1442, where the movable stud *A* is forced into the holding jaws by the levers *B* and *C* and cam *D*. The movable base, seen in Fig. 1455, is rather a difficult piece.

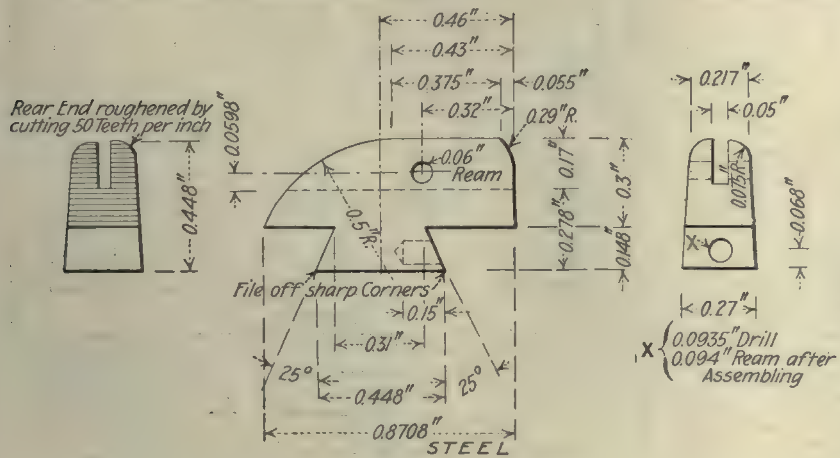


FIG. 1426

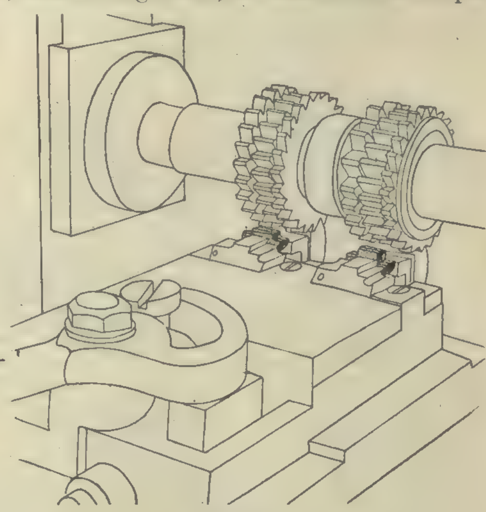


FIG. 1430

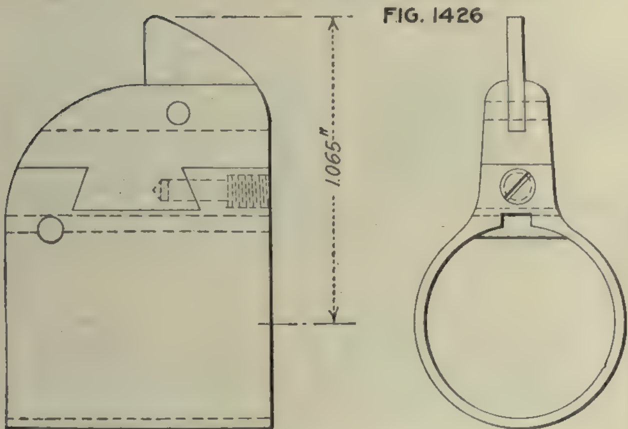


FIG. 1427

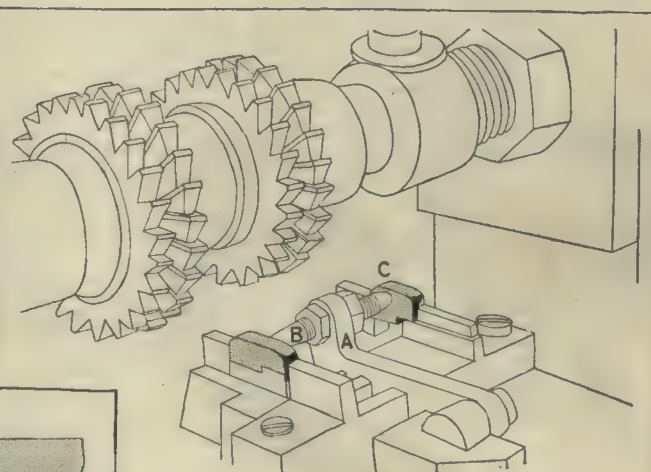


FIG. 1432

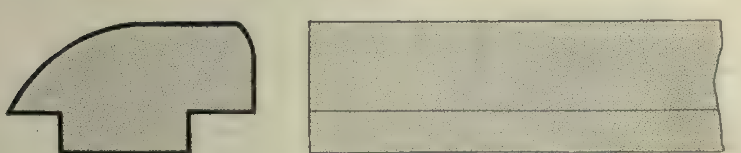


FIG. 1428
OPERATION A

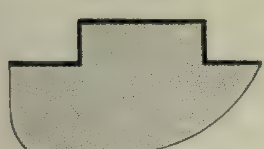


FIG 1429
OPERATION 2

FIG. 1431

OPERATION 3

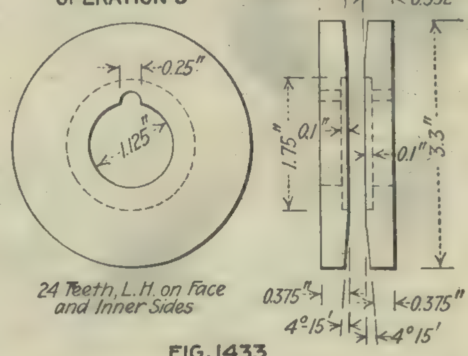


FIG. 1433

OPERATIONS ON THE MOVABLE STUD

Operations	
A	Forging from bar
C	Annealing
D	Pickling
B	Trimming
2	Milling bottom crosswise
3	Straddle-milling both sides
4	Milling across top
4½	Burring for operation 4
5	Profiling dovetail
5½	Filing and cornering for operation 5
7	Drilling and reaming pin hole
8	Slotting for front sight
9	Milling serrations on rear face of stud
10	Filing to finish
11	Polishing
12	Bluing

Operation A. FORGING FROM BAR

Transformation—Fig. 1428. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—400-lb. Billings & Spencer drop hammer. Production—200 per hr.

OPERATION 3. STRADDLE-MILLING BOTH SIDES

Transformation—Fig. 1431. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise jaws, Fig. 1432. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1433. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, dropped from tube. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width. Production—60 per hr.

OPERATION 4. MILLING ACROSS TOP

Transformation—Fig. 1434. Machine Used—Pratt & Whitney Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special fixture, Fig. 1435. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1436. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Form. Production—60 per hr.

OPERATION 4½. BURRING FOR OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs left by cutters in operation 4. Apparatus and Equipment Used—File. Production—300 per hr.

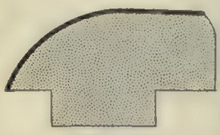


FIG. 1434

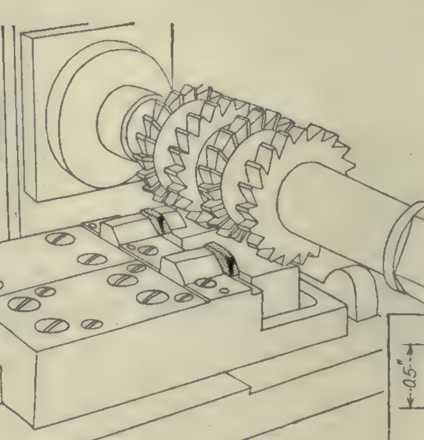


FIG. 1435

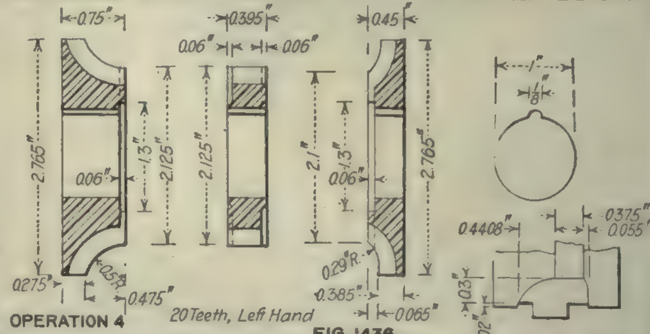


FIG. 1436

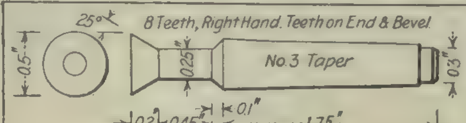


FIG. 1439


FIG. 1441

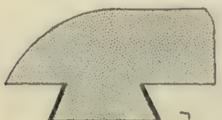


FIG. 1437

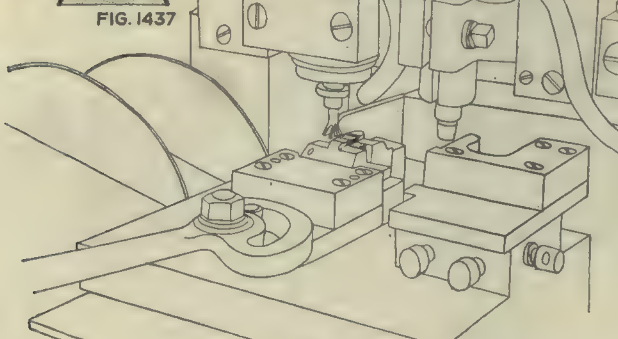


FIG. 1438

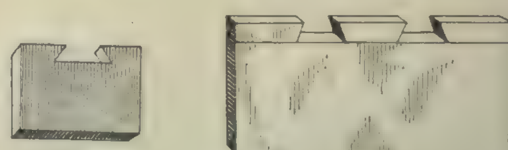


FIG. 1440

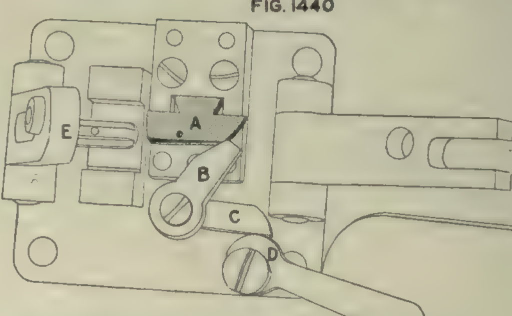


FIG. 1442

FIG. 1437, 1438, 1439 & 1440 OPERATION 5
FIG. 1441 & 1442 OPERATION 7

OPERATION C. ANNEALING

Description of Operation—Same as all annealing. Apparatus and Equipment Used—Same as all annealing.

OPERATION D. PICKLING

Description of Operation—Same as before. Apparatus and Equipment Used—Same as before.

OPERATION B. TRIMMING

Machine Used—Perkins 3-in. stroke press. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch. Dies and Die Holders—Dies held by setscrew in shoe; shoe bolted to bed of press. Stripping Mechanism—Punched down through die. Production—700 per hr.

OPERATION 2. MILLING BOTTOM CROSSWISE

Transformation—Fig. 1429. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise jaws, Fig. 1430. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed per minute. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Length. Production—60 per hr.

OPERATION 5. PROFILING DOVETAIL

Transformation—Fig. 1437. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Special vise and jaws, Fig. 1438. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter, Fig. 1439. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1440. Production—35 per hr.

OPERATION 5½. FILING AND CORNERING

Number of Operators—One. Description of Operation—Filing edges and corners. Apparatus and Equipment Used—File. Production—200 per hr.

OPERATION 7. DRILLING AND REAMING PIN HOLE

Transformation—Fig. 1441. Machine Used—Pratt & Whitney three-spindle 16-in. vertical drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1442. Tool-Holding Devices—Drill chuck. Cutting Tools—Drills and half-round reamer. Number of Cuts—Three. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$ in. stream. Average Life of Tool Between Grindings—200. Gages—Plug. Production—60 per hr.

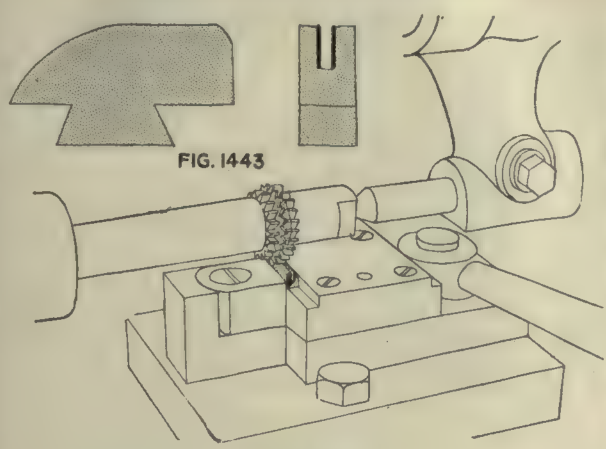


FIG. 1443

FIG. 1444

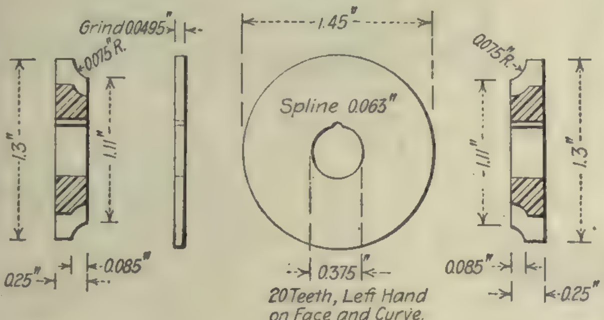


FIG. 1445
OPERATION 8

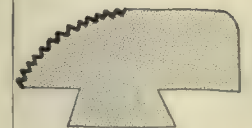


FIG. 1446

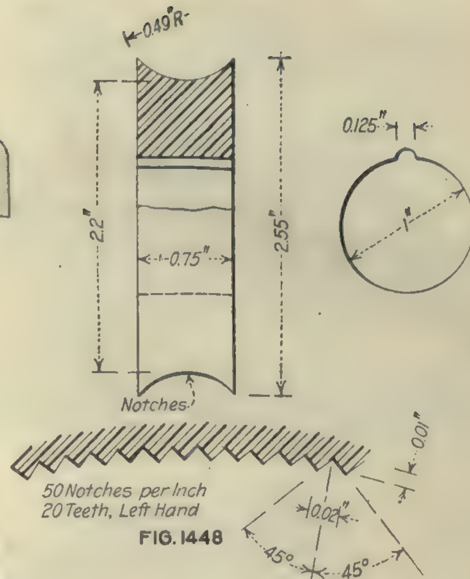


FIG. 1448

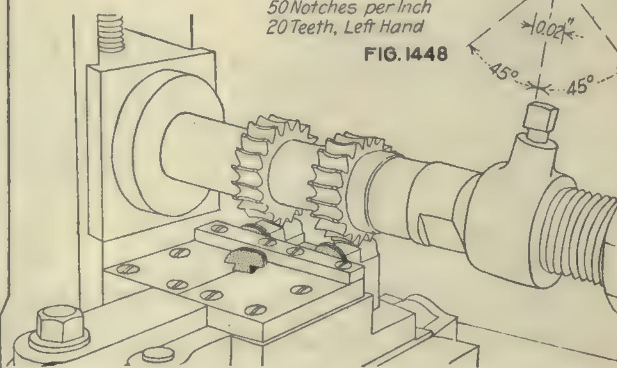


FIG. 1447
OPERATION 9

OPERATION 8. SLOTTING FOR FRONT SIGHT

Transformation—Fig. 1443. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Special vise jaws, Fig. 1444. Tool-Holding Devices—Standard arbor. Cutting Tools—Slotting cutters, Fig. 1445. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width of slot. Production—75 per hr.

OPERATION 9. MILLING SERRATIONS ON REAR FACE OF STUD

Transformation—Fig. 1446. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise jaws, Fig. 1447. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1448. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—60 per hr.

OPERATION 10. FILING TO FINISH

Number of Operators—One. Description of Operation—File off burrs from milling cutters. Apparatus and Equipment Used—File. Production—200 per hr.

OPERATION 11. POLISHING

Number of Operators—One. Description of Operation—Polish all over. Apparatus and Equipment Used—Polishing jack and wheel. Production—50 per hr.

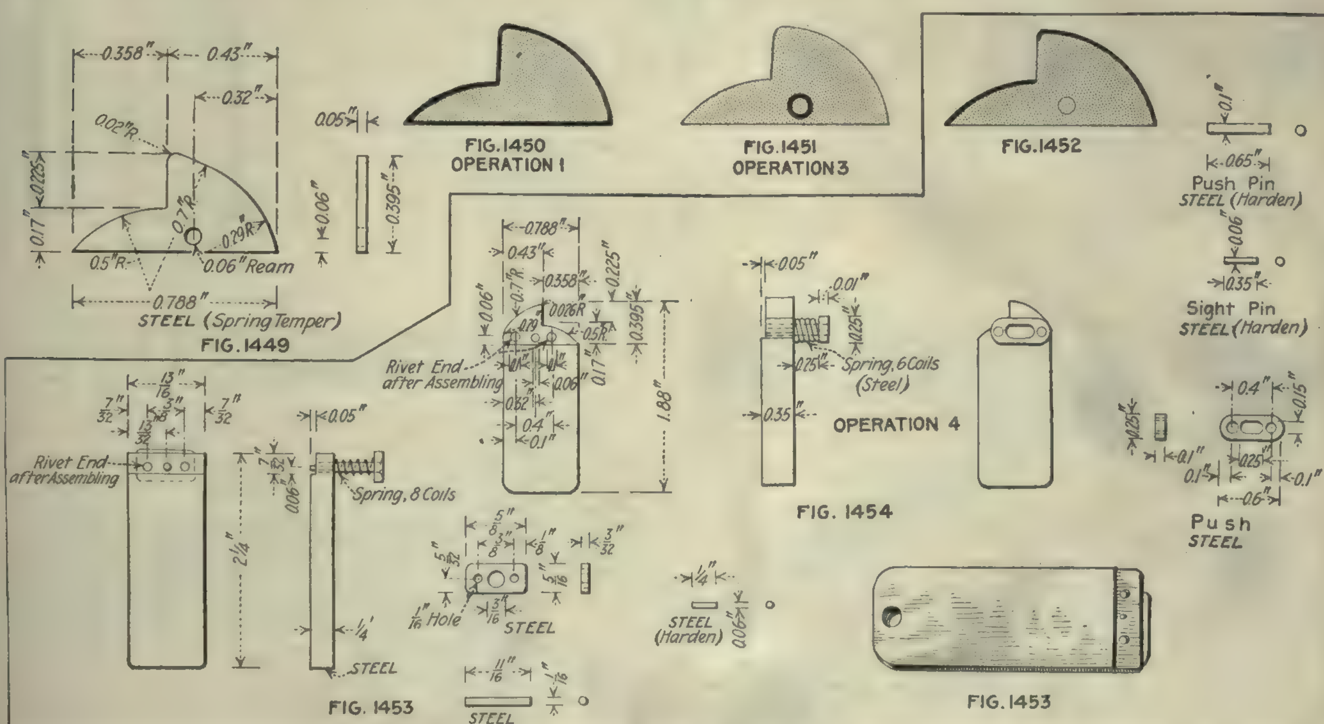


FIG. 1449

FIG. 1450
OPERATION 1

FIG. 1451
OPERATION 3

FIG. 1452

FIG. 1453

FIG. 1454

FIG. 1453

OPERATION 12. BLUING

Description of Operation—Same as previous bluing operations. Apparatus and Equipment Used—Same as before.

OPERATIONS ON THE FRONT SIGHT

Operations
1 Blanking from sheet cast steel
3 Punching pin hole
4 Pressing top and bottom to shape
5 Jig-filing top edges to finish height and shape
6 Jig-filing to finish thickness
7 Spring tempering

OPERATION 1. BLANKING FROM SHEET CAST STEEL

Transformation—Fig. 1450. Machine Used—Perkins punch press with roll feed. Number of Machines per Operator—Two. Punches and Punch Holders—Square-shank punch. Dies and Die Holders—Die held in shoe by setscrew. Stripping Mechanism—Steel stripper screwed to face of die. Lubricant—Stock in coils is oiled with cutting oil. Production—1,250 per hr.

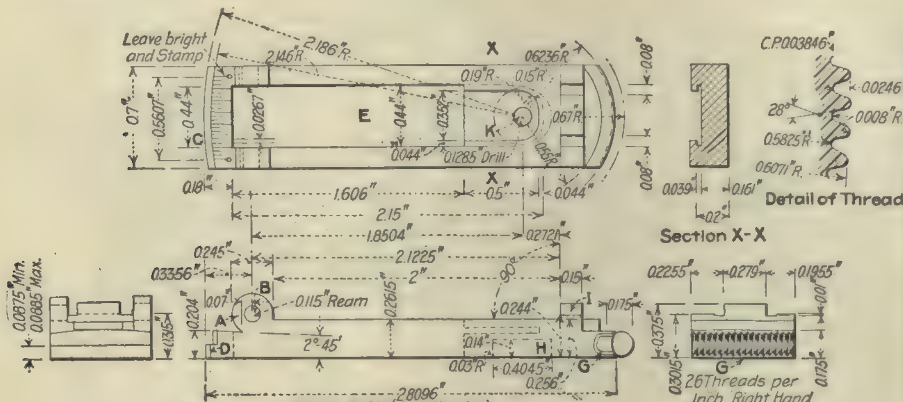
OPERATION 3. PUNCHING PIN HOLE

Transformation—Fig. 1451. Machine Used—Perkins No. 19 press, 1½-in. stroke. Number of Machines per Operator—One. Punches and Punch Holders—Square-shank punch. Dies and Die Holders—Die held in shoe by setscrew. Stripping Mechanism—Steel stripper screwed to face of die. Gages—Pin. Production—600 per hr.

The Movable Base

OPERATIONS ON THE MOVABLE BASE

Operation
A Forging from bar
B Annealing
B-1 Pickling
C Trimming
D Cold dropping
1 Grinding bottom
2 Milling right edge and rear end
3 Milling left edge
AA Removing burrs left by operation 2
BB Removing burrs left by operation 3
4 Drilling joint and small hole for pivot
5 Reaming joint and drilling pivot hole, roughing
CC17½ Chambering pivot hole
6 Milling upper surface crosswise to finish
DD Removing burrs left by operation 6
7 Hand milling stud, roughing
9 Hand milling spring opening
10 Shaving spring opening
FF Removing burrs left by operation 10
10½ Straightening
GG Removing burrs from joint hole, reaming



FORGED STEEL (Case Harden)
FIG. 1455

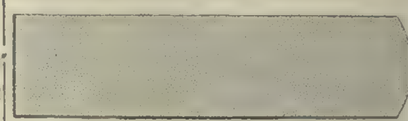
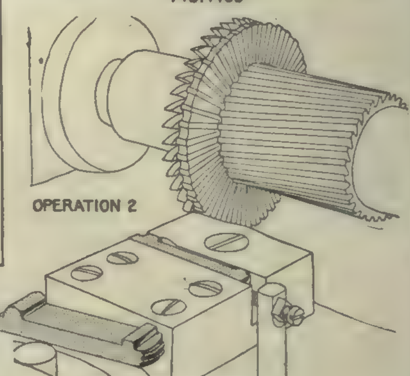


FIG. 1458


OPERATION 2
FIG. 1459

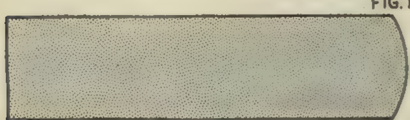


FIG. 1456
OPERATION A


FIG. 1457
OPERATION 1


FIG. 1460
OPERATION 3

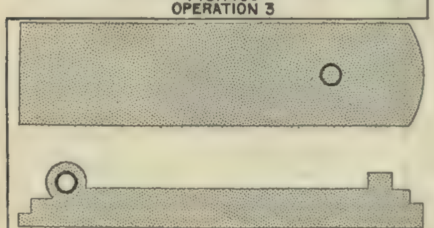


FIG. 1461

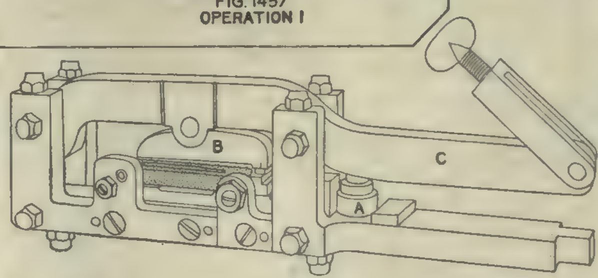


FIG. 1462

OPERATION 4

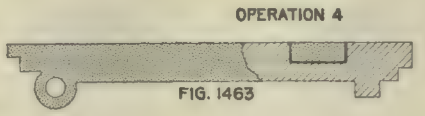


FIG. 1463

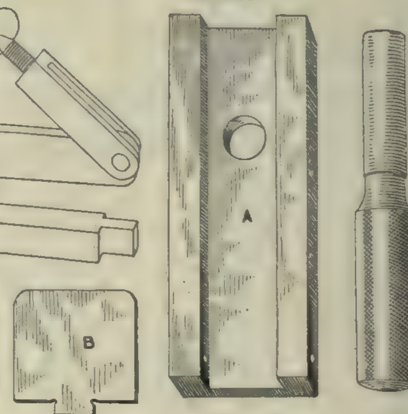


FIG. 1464

OPERATION 4. PRESSING TOP AND BOTTOM TO SHAPE

Transformation—Fig. 1452. Machine Used—Punch press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch and holder. Dies and Die Holders—Shoe bolted to bed of press; piece to be pressed is laid in die, which shapes the top of the sight. Stripping Mechanism—None. Gages—Form. Production—350 per hr.

OPERATION 5. JIG-FILING TOP EDGES TO FINISH HEIGHT AND SHAPE

Number of Operators—One. Description of Operation—Filing upper edges to match gage. Apparatus and Equipment Used—File. Gages—Fig. 1454. Production—80 per hr.

OPERATION 6. JIG-FILING TO THICKNESS

Number of Operators—One. Description of Operation—Filing to correct thickness. Apparatus and Equipment Used—Filing and jig for holding the work. Gages—Thickness. Production—175 per hr.

OPERATION 7. SPRING TEMPERING

Description of Operation—Heating and quenching in usual manner to secure the desired amount of temper. Apparatus and Equipment Used—Muffle furnaces, oil burning; quenching tanks.

12 Hand milling spring seat, roughing; drilling spring seat, roughing; profiling spring seat, upper cut
13 Profiling spring seat, under cut
15 Profiling joint and rear end, top and bottom roughing
14 Hand milling rear of joint
HH Removing burrs left by operation 14
16 Stamping graduations
17 Reaming joint and pivot hole to finish
23 Hand milling rear end to finish
24 Hand milling front end to finish
20 Milling stud to finish
22 Threading front end for windage screw
JJ Removing burrs left by operation 24
16½ Filing bottom and burring spring seat
15½ Filing rear of joint for graduations
25 Polishing sides
26 Filing top between ears to gage and general cornering
27 Spinning in machine
28 Cleaning graduation
29 Casehardening
30 Polishing graduation
31 Assembling with spring
32 Straightening
33 Assembling with slide

FIG. 1465

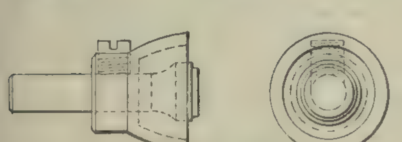


FIG. 1466

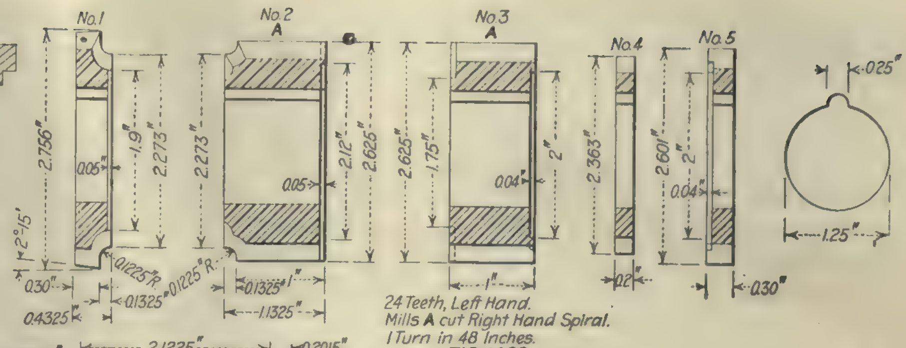


FIG. 1469

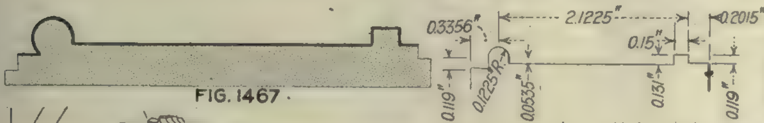


FIG. 1467

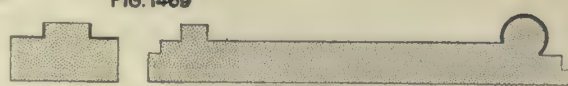


FIG. 1470

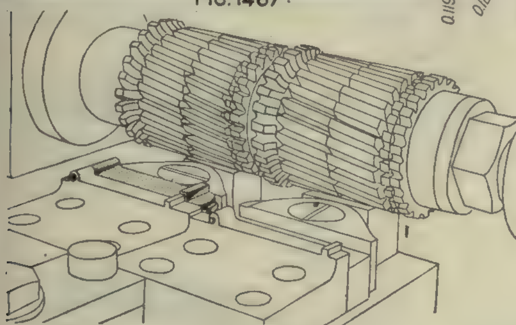


FIG. 1468

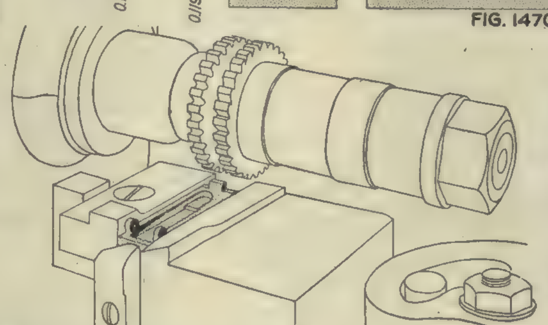


FIG. 1471

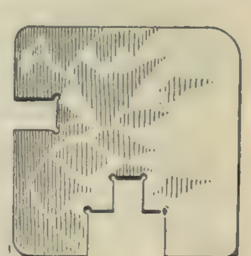


FIG. 1472

FIG. 1465 & 1466 OPERATION 17½, FIG. 1467, 1468 & 1469 OPERATION 6, FIG. 1470, 1471 & 1472 OPERATION 7

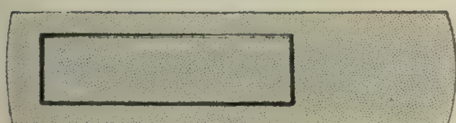


FIG. 1473

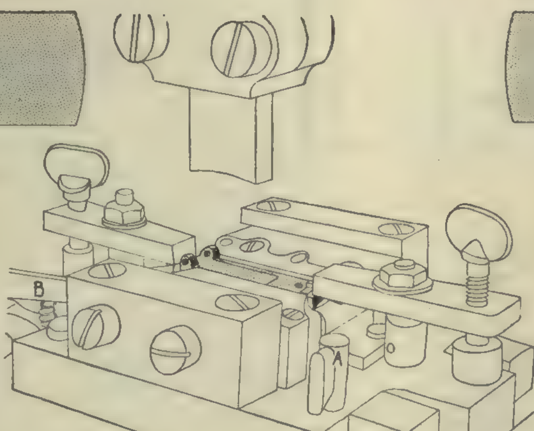


FIG. 1476

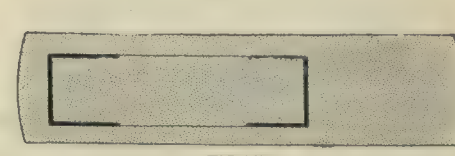


FIG. 1475

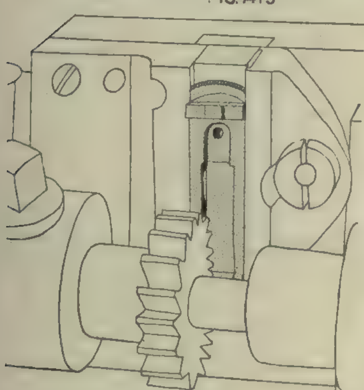


FIG. 1474

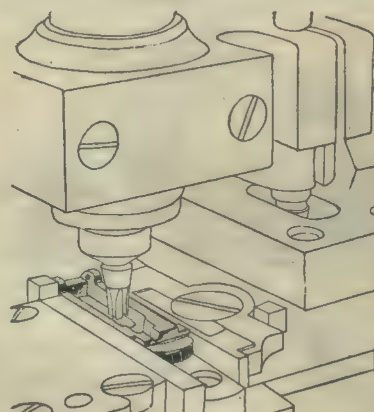


FIG. 1479

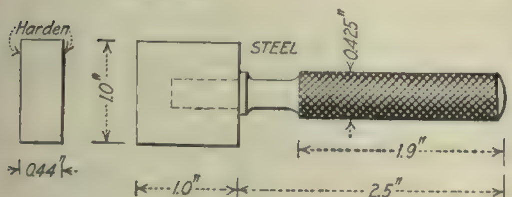


FIG. 1477

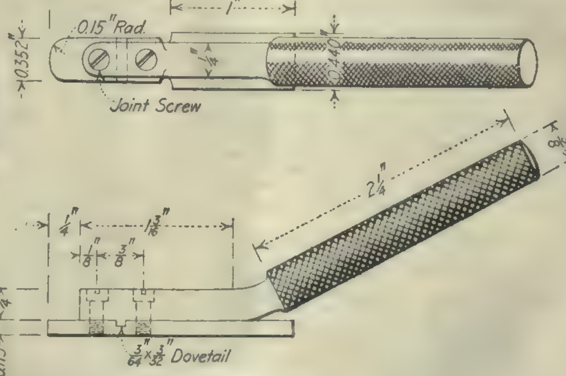


FIG. 1481

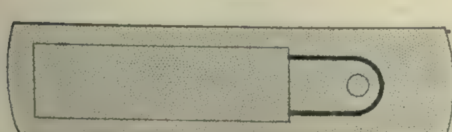


FIG. 1478

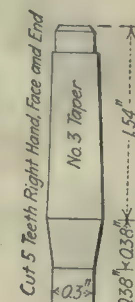


FIG. 1480

FIG. 1473 AND 1474 OPERATION 9, FIG. 1475, 1476 & 1477 OPERATION 10, FIG. 1478, 1479, 1480 & 1481 OPERATION 12

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1456. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 600-lb. drop hammer. Production—125 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal, heated to 850 deg. C. (1,562 deg. F.), left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner, powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then in the pickling solution, which consists of 1 part sulphuric acid to 9 parts water; left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

OPERATION C. TRIMMING

Machine Used—Perkins No. 19 press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Setscrew. Stripping Mechanism—Pushed through die. Average Life of Punches—15,000 pieces. Production—450 pieces per hr.

and Equipment Used—File. Production—Grouped with operations 2 and 3.

OPERATION 3. MILLING LEFT EDGE

Transformation — Fig. 1460. Machine Used — Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Same as Fig. 1459, except reversed. Tool-Holding Devices—Standard arbor. Cutting Tools—Slab milling cutter. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width. Production—40 pieces per hr. per machine.

OPERATIONS CC AND 17½. CHAMBERING PIVOT HOLE FOR PIVOT

Transformation—Fig. 1461. Machine Used—Sigourney Tool Co. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1462; work is forced to place by the cam A and held down by the floating lever B, while the arm C is locked by the swing link. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—See Fig. 1464. Production—60 pieces per hr.

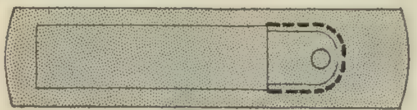


FIG. 1482

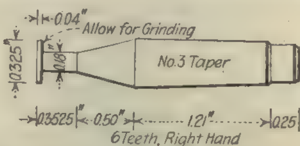
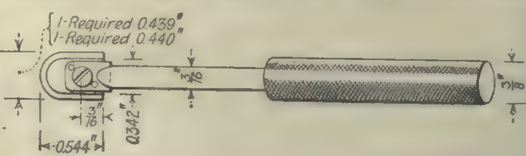


FIG. 1484



OPERATION 13

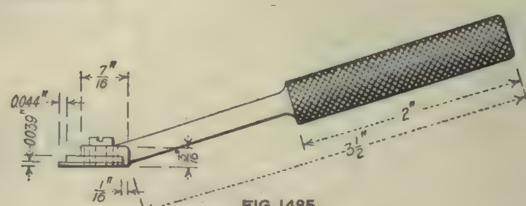


FIG. 1485

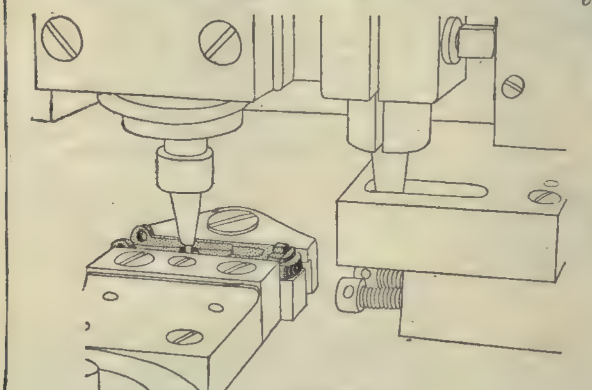


FIG. 1483

FIG.1485

FIG.1486

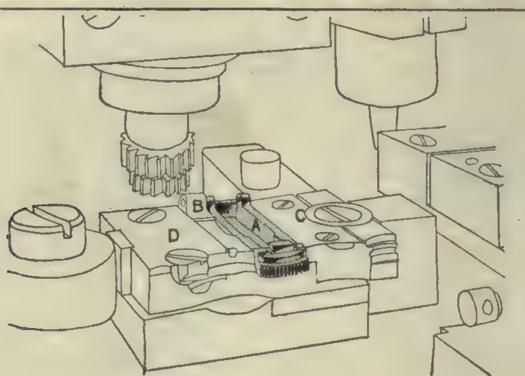
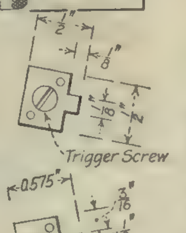


FIG.1487



OPERATION 15

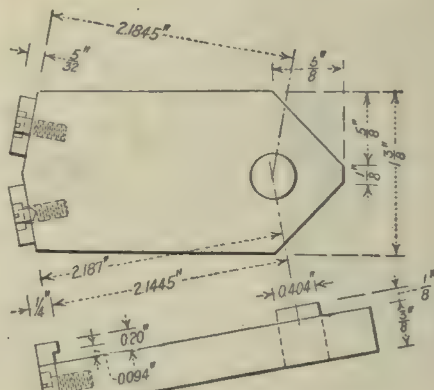


FIG. 1488

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

OPERATION 1. GRINDING BOTTOM

Transformation—Fig. 1457. Machine Used—Pratt & Whitney vertical grinder. Number of Operators per Machine—One. Work-Holding Devices—Held on a 30-in. magnetic chuck, between strips of steel. Tool-Holding Devices—Vertical spindle. Cutting Tools—14-in. wheel. Cut Data—1,500 r.p.m.; 15-in. feed. Coolant—Water. Gages—None. Production—250 pieces per hr.

OPERATION 2. MILLING RIGHT EDGE AND REAR END

Transformation—Fig. 1458. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Clamped by special vise jaws, Fig. 1459. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—40 pieces per hr. per machine.

OPERATIONS AA AND BB. REMOVING BURRS LEFT BY OPERATIONS 2 AND 3

Number of Operators—One. Description of Operation—Removing burrs thrown up by operations 2 and 3. Apparatus

OPERATION 5. REAMING JOINT AND DRILLING PIVOT HOLE, ROUGHING

Transformation — Fig. 1463. Machine Used — Pratt & Whitney No. 2 four-spindle upright drill. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, same as Fig. 1462. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer; also, square-pointed drill for pivot hole. Number of Cuts—Two. Cut Data—Reamer, 650 r.p.m.; bottoming drill, 450 r.p.m. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 1464; A, location and diameter of holes; B, depth. Production—60 pieces per hr.

OPERATIONS CC AND 17½. CHAMBERING PIVOT HOLE

Transformation—Fig. 1465. Number of Operators—One. Description of Operation—Rounding corner and burring pivot hole. Apparatus and Equipment Used—Bench lathe and chamfering tool, Fig. 1466. Production—500 pieces per hr.

OPERATION 6. MILLING UPPER SURFACE CROSSWISE TO FINISH

Transformation—Fig. 1467. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held on pin, clamped with vise, Fig. 1468. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1469. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil,

put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Form, outline gaged from pin hole in ear; location of all holes. Production—40 pieces per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 6. Apparatus and Equipment Used—File. Production—500 pieces per hr.

OPERATION 7. HAND MILLING STUD, ROUGHING

Transformation—Fig. 1470. Machine Used—Pratt & Whitney No. 2 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Pushed to stop, clamped with vise jaws, Fig. 1471. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1472, form. Production—115 pieces per hr.

OPERATION 9. HAND MILLING SPRING OPENING

Transformation—Fig. 1473. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held vertically by vise jaws, Fig. 1474. Tool-Holding Devices—Standard arbor. Cutting Tools—Two ½x½-in. milling cutters. Number of Cuts—One. Cut Data—350 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gage—Thickness of side wall. Production—120 pieces per hr.

OPERATION 10. SHAVING SPRING OPENING

Transformation—Fig. 1475. Machine Used—Snow-Brooks No. 2. Number of Operators per Machine—One. Work-Holding Devices—Held on fixture by finger clamps at each end, Fig. 1476; removed by knock-out levers A and B. Tool-Holding Devices—Held in clapper box of press. Cutting Tools—Shaving tool. Cut Data—80 strokes per minute. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1477, size of opening, thickness of wall and distance from pivot hole to spring slot. Production—80 pieces per hr.

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 10

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 10. Apparatus and Equipment Used—File. Production—400 pieces per hr.

OPERATION 10½. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening. Apparatus and Equipment Used—Lead block, straight-edge and hammer. Production—175 pieces per hr.

OPERATION GG. REMOVING BURRS FROM JOINT HOLE, REAMING

Number of Operators—One. Description of Operation—Removing burrs thrown around hole. Apparatus and Equipment Used—Hand reamer. Production—500 pieces per hr.

OPERATION 12. HAND MILLING SPRING SEAT, ROUGHING; DRILLING SPRING SEAT, ROUGHING; PROFILING SPRING SEAT, UPPER CUT

Transformation—Fig. 1478. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Centered on side pin, clamped by vise jaws, Fig. 1479. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1480. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Fig. 1481; thickness of spring seat; length and width of spring seat; side location of spring seat with side of spring opening. Production—50 pieces per hr.

OPERATION 13. PROFILING SPRING SEAT, UNDER CUT

Transformation—Fig. 1482. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Centered on side pin clamped by vise jaws, Fig. 1483. Tool-Holding Devices—Taper shank. Cutting Tools—Under-cut milling cutter, Fig. 1484. Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, 1/18-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1485; thickness of spring seat; thickness and width of undercut; side location of undercut. Production—60 pieces per hr.

OPERATION 15. PROFILING JOINT AND REAR END, TOP AND BOTTOM ROUGHING

Transformation—Fig. 1486. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held by vise jaws, Fig. 1487. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1488; two thicknesses of end; front end from pivot; rear end from pivot; groove for hobbing; finishing for same. Production—80 pieces per hr.

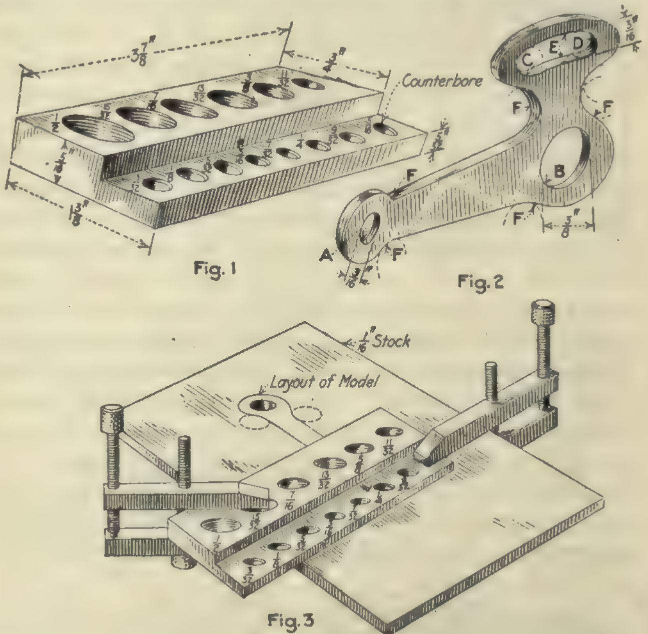
Drill Plate and Its Uses

By Hugo F. Pusep

Every mechanic knows the difficulty of drilling and reaming a perfectly round hole in thin sheet steel, more especially if the hole to be drilled is many times larger in diameter than the thickness of the stock.

As an example, let us assume that a hole $\frac{3}{8}$ in. in diameter is to be drilled in stock $\frac{1}{32}$ in. thick. If the drill is properly ground and relieved on both flutes to a sharp point in the center, it will cut well until the point begins to break through the stock; then the trouble begins. After the drill has gone through the stock and has been withdrawn, the hole it has produced will be anything but round. The reason for this, no doubt, is the fact that just as soon as the point of the drill breaks through the stock, there is no support left for the cutting edges, and the drill chatters. This chatter can be eliminated to a certain extent by grinding a slight clearance on the cutting angles, thereby causing the drill to act as a sort of burnisher in conjunction with its cutting action.

Then there is another difficulty that causes a lot of annoyance in connection with drilling holes in thin stock, and that is to drill a hole accurately within a scribed circle. In plants where adding machines, typewriters, cash registers, etc., are manufactured, work of this kind is a daily occurrence in experimental and model depart-



FIGS. 1 TO 3. DRILL PLATE AND ITS APPLICATION

ments and also in tool and die making. A die maker very often has to make his own model, from which to lay out the die. In nine cases out of ten a model has one or more holes that have to be accurately spaced in relation to each other and to the outline.

A handy little tool and a great time saver in work of this nature is the drill plate, Fig. 1, which is used extensively in experimental and die-making departments of several plants specializing on small, accurate, sheet-steel parts. I have never seen a drill plate used to any extent outside of these plants, but knowledge of its possibilities makes me believe that a few facts concerning its application will no doubt be of interest to readers of the *American Machinist*.

The drill plate is made of tool steel, hardened and ground. The holes are lapped after hardening to plug-gage sizes. In Fig. 2 is shown a model of an adding-machine part, made of $\frac{1}{16}$-in. stock. It has two holes and a circular slot, the correct locations of which are very important. This is an example of work for which the drill plate has few equals.

The method of procedure is as follows: The $\frac{1}{16}$-in. stock is blued, and the various center lines are laid out with the height gage. From the intersections of the lines the circles *A*, *B*, *C*, *D* and also the circular slot *E* are

scribed with a pair of dividers. The outline is now laid out, using both the dividers and the scriber. A kink worth remembering in setting dividers for scribing accurate circles is to scribe a line on any sheet stock that may be handy and then test the setting of the dividers by scribing a full circle on this straight line. Lay a good scale on the line; through a magnifying glass any error in the setting of the dividers is easily detected, and corrections of adjustment can be made accordingly. As any error in the radius of a circle is multiplied twice in its diameter, an error must be negligible if it cannot be seen through a good magnifying glass.

Having laid out all the circles for holes to be reamed, the next step is to set the drill plate on the stock so that a hole in the drill plate coincides with a circle in the layout, both of course being of the same diameter. The stock and the drill plate are held together with clamps, as shown in Fig. 3, where the $\frac{3}{8}$-in. hole in the drill plate is in position over the $\frac{3}{8}$-in. circle *B*, Fig. 2, in the layout of the model. All that is necessary now is to spot with a $\frac{3}{8}$-in. drill, then drill right through the stock with a drill 0.010 or $^1/_{64}$ in. less in diameter than the finished hole, and finally finish the hole with a $\frac{3}{8}$-in. machine reamer. The drill plate is then removed and set over the next circle, and the same method of procedure is followed till all the holes are reamed. The radii *F*, Fig. 2, of the outline can of course be finished by the same method.

In action the holes in the drill plate serve as bushings to guide the drills and reamer, and a first-class job is the result. All chattering is entirely eliminated; and when sufficient care is taken in scribing the circle and setting the drill plate, very accurate work can be produced. Nor does the usefulness of the drill plate end where thin stock is concerned. I have used it for drilling and reaming holes in small perforating and progressive dies, leaf jigs, plate jigs, etc.

In conclusion it might be well to say that the small holes in the drill plate, Fig. 1, such as $\frac{3}{32}$, $\frac{1}{8}$ and $\frac{5}{32}$ in., should be counterbored from the top a little way with a larger drill in order that the small circle on the work may be easily seen through the hole in the drill plate. A magnifying glass should be used in rapping the drill plate in position. When it appears through the magnifying glass that the circumference line of the scribed circle has been cut in half at all points, then the drill plate is in correct position for drilling. The drill plate shown in Fig. 1 will take care of any ordinary class of work, but drill plates with special holes can easily be made to suit different classes of special work.

Demagnetizing High-Speed Steel

By A. D. Hallett

I have had trouble in demagnetizing high-speed steel tools that have been surface-ground on a magnetic chuck. The grinding is followed by a turning operation where the tools are held collectively in a gray-iron fixture, and as the turning progresses the chips cling more and more to the work. I have tried to demagnetize with a demagnetizer that works all right on machine and nickel steels, but it does not help very much when used on the high-speed steel.

Perhaps some other reader has had the same difficulty and found a way to overcome it.

Burning the Candle at Both Ends

By A. Towler

Once in a while I get into a shop where system is conspicuous by its absence. A short time ago I came across such a shop. The designs were all made by the owner—some on tracing cloth, others on brown paper and others on parts of the shop walls. A piece of chalk served for the drafting instruments. When the "designs" came through to the workmen in the shop, the only work they had to do was to chase up the casting or a chunk of steel and make the part. I say advisedly chunk, not piece, as the policy was to have the bar stock large enough to meet any case rather than have a variety of bar-diameter sizes.

It is true that work was put through, but it is easy to imagine what would happen if the boss of this shop should happen to stay over Monday on a fishing trip. There would be a grand full stop of everything, as he carries all the system and ordering department under his Stetson. Of course, he has one advantage—he is never troubled with any office boy wanting to go to the ball game and using the old grandmother's-funeral story. Neither does he have any stenographer performing an elopement act and leaving him all at sea. But with these advantages he is a long way from being mentioned in any of the various technical papers as an ideal beehive of industry.

A friend of mine told me a little story illustrating the other extreme. This man has a shop employing about 80 men. With these men and a system built up during a business period of 20 years, he is fairly prosperous. A short time ago one of those systematizing professors called at the shop and said that by installing a certain system of which he was father or some other relative a wonderful organization would result, which would be far superior to the existing one.

This friend of mine gave the professor permission to go into the shop and see what he thought about the shop system as it was then in use. The professor took a rapid whirlwind walk through the shop and in 20 minutes was back in the office. He saw the 20 years' development in 20 minutes.

"Well," said the professor, "you need my system, and I can install it for about $5000."

"Of what will the system consist?" was asked.

"Oh," the professor said, and then he commenced to show cards of various sizes and almost as many colors as the spectrum possesses. These cards, with the addition of a number of clerks and chasers were all that was necessary.

"What increase in production do you guarantee by the use of your system?" was then asked of the professor.

"Oh, no increase. We only guarantee you a system," was the answer.

Well, to make the story short, the system was not adopted at this shop. Now I do not wish to say that I am opposed to system. I am in favor of it, but any system that is of the unbending, casehardened, cast-iron order is unusable in a shop.

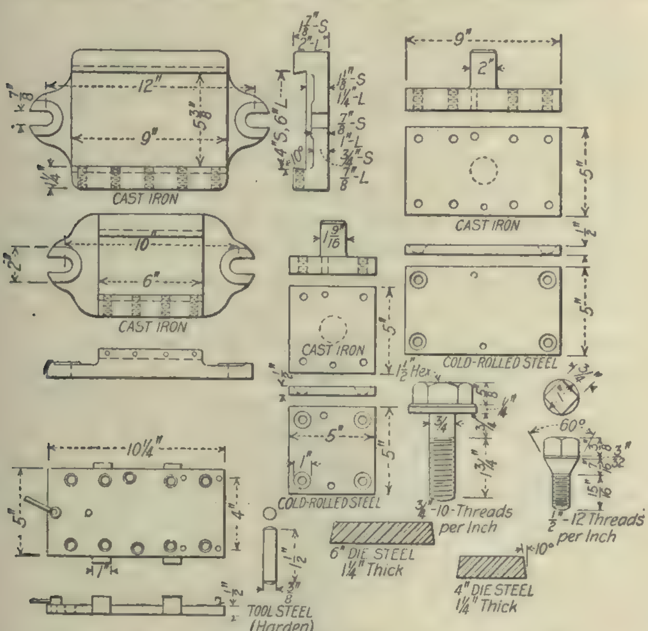
The first case I mentioned needs system; but it will be of a different order from the second, and each will have to be flexible so that it can adjust itself to changing conditions. Get system; but if your system is interfering with production, kick the system out.

Letters from Practical Men

Standard Die Shoes and Punch Holders

Observations in the average pressroom in establishments using punch presses will disclose that the bolsters usually appear as though shrapnel had exploded in close proximity to the press. Screw holes are spread all over indiscriminately, to fit the various dies. To overcome this and other disadvantages, a system has been developed wherein only eight holes are drilled and tapped into the bolster plate.

The tapping is done through the bolster, so that no dirt or punchings can lodge at the bottom, but must fall through, thus keeping the holes clear at all times. The



DIE SHOE, PUNCH HOLDER AND DRILL JIG

die shoe is made of cast iron and has ears at both ends with open elongated slots that have ample clearance, so the bolts enter readily. This also permits adjustment of the die after the shoe containing the die has been placed upon the bolster plate. The holes are so positioned that the shoe may be placed either from front to back or from right to left on the press.

Only two sizes of shoes are in use where this system has been developed. These accommodate 4- and 6-in. width die steel that has been planed in 10-ft. lengths with a 10-deg. bevel on each edge and from which pieces are sawed off to the lengths required. These die-steel pieces are held in the die shoe by dog-point tool-steel setscrews that pass through the sides of the die shoe at the same angle as the side edges of the die—10 deg. The 4-in. shoe is fastened to the bolster by two ¾-in. special-head screws to holes that are tapped 10 in. apart on the bolster, and the 6-in. shoe into holes 12 in. apart.

The punches are mounted on ½ in. thick by 5 in. wide cold-rolled steel plates made in two lengths—5 in. and 9 in. These cold-rolled steel punch plates are fastened to cast-iron punch holders of the same length by four special taper-headed casehardened screws, as shown in the drawing. Two dowel pins assist these screws to prevent any shifting of the punch plate.

By mounting punches in the cold-rolled steel prior to fastening to the cast-iron punch holder it is evident that not only is it possible to do more accurate work, but also the shank of the holder cannot interfere in the positioning process, as in the old-style methods. With this system only two punch holders are required for each press instead of one for each die in use. The die shoes and punch plates are interchangeable on all presses. A drill jig must be provided, as in the drawing, and it will be observed that there are removable pins and an eccentric clamp with which both sizes of punch plates and punch holder are drilled. The hardened-steel dowel pins shown are a driving fit into the punch holders and remain in them at all times.

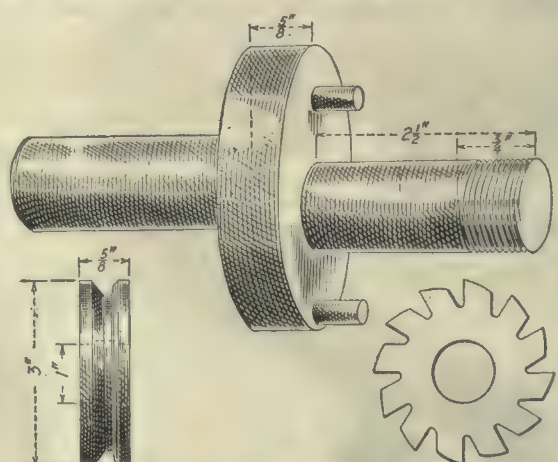
It has been learned that this method saves over 20 per cent. of the cost of making the punches and dies, and after that the saving in the pressroom is beyond estimate.

Two Rivers, Wis. WILLIAM L. WEBER.

Circular Relieving on the Lathe

The illustration shows an eccentric-relieved formed milling cutter and the special mandrel for producing the relief.

After the cutter is turned up and the gashes milled, it is placed on the mandrel between centers of the lathe.



BACKING OFF MANDREL FOR CUTTERS

The two ¼-in. pins are for locating the cutter and fit in the gashes, insuring the proper location for relieving each tooth. The cutter is then backed off tooth by tooth, by pulling the belt and taking light cuts, making it a handwork proposition throughout.

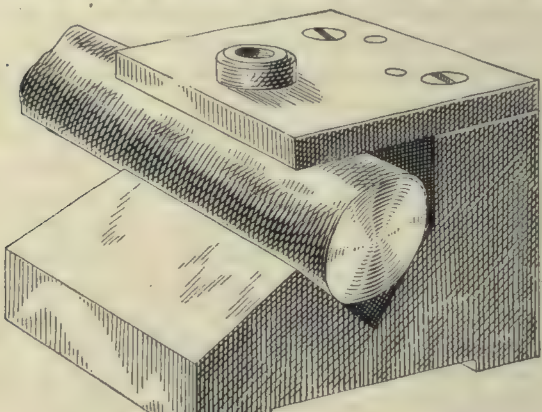
The time taken to relieve this cutter was about 8 hr. Where the amount of this class of work is small and there is no other means of relieving, the outfit is valuable.

Brooklyn, N. Y. EDWARD J. RANTSCH.

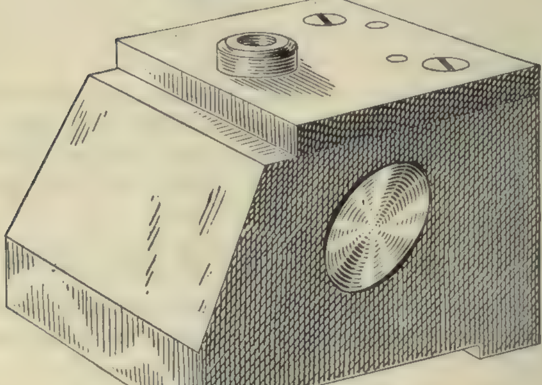
A Jig Change That Resulted in a Saving in Scrap

Some years ago, while doing jig-repair work, I came across one particular jig that kept coming back, and always with the same complaint—it drilled off center.

It was a V-block jig used for drilling a crosspin hole in the shank of a forging. This jig would drill cold-



A



B

THE ORIGINAL AND THE REBUILT JIG

rolled round stock central, and it would drill some forgings central, but not all. Then, too, some forgings that calipered central would not take the crosspin after assembling. Changing the angle of the V in which the work rested did no good. Finally, I came to the conclusion that the error existed because the work was not round, which left a high side as shown exaggerated at *A*.

The jig was rebuilt like *B*, the V being replaced by a hole the same size as the one into which the forging was to fit when assembled. This divided the error and made no more scrap. It also sorted out forgings too large or lopsided to assemble. H. W. Johnson.

Poughkeepsie, N. Y.

Reducing a Part To Make It Stronger

I have lately seen several examples of making a piece of machinery stronger by reducing the cross-section of certain of its parts.

One was a jackshaft in a mill drive. It was originally made as shown in Fig. 1. Being subject to heavy intermittent stresses and a considerable starting torque, it gave great trouble by continually breaking, usually at about the point marked on the sketch. Finally, the design shown in Fig. 2 was tried, the shaft being made of slightly higher carbon steel. Care was taken to produce a smooth, even radius, and a shallow keyway was cut. It resulted in no more broken shafts, some of the new ones being taken out and the journals trued up three or four times before they finally had to be thrown away.

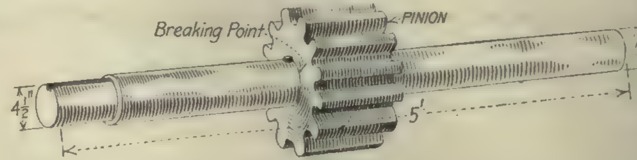


FIG. 1

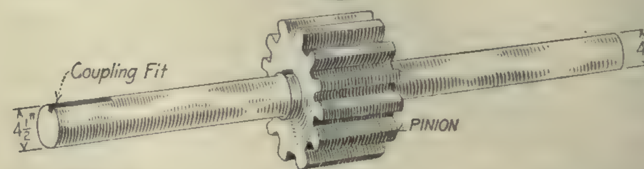


FIG. 2

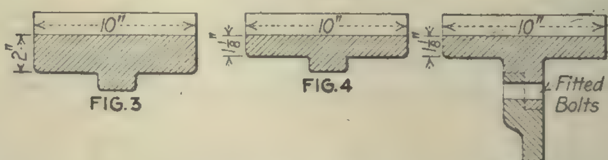


FIG. 3 FIG. 4 FIG. 5

FIGS. 1 TO 5. EXAMPLES OF WORK MADE LIGHTER TO PREVENT BREAKAGE

Another case was a large cast-steel gear in the same mill. It was 46 in. in diameter, 1½ diametral pitch and ran 120 r.p.m. The break in this case used to occur across the rim, a cross-section of which is shown in Fig. 3. Evidently someone had already been experimenting by making the rim thicker; so the other way was tried, and a gear with a rim as shown in Fig. 4 was cast. This stopped the breaking, but the drive was more noisy than before. Finally, a gear with a separate rim bolted on a web center was evolved, as shown in Fig. 5. This type was found to be better than either of the others and was installed in all the drives of that kind.

Buffalo, N. Y. E. W. Wrigley.

Danger in Two-Wheel Universal Grinders

According to my experience the two-wheel universal grinder is about the most dangerous piece of machinery in the toolroom. Some years ago I was operating one that was guarded with angle-iron guards, according to law. In grinding a reamer with a long shank and watching the wheel that was doing the work, it was necessary to hold the shank with the right hand. While indexing the reamer to the next blade I fed the front knuckle of my right hand into the other wheel, cutting a bad gash and leaving the tendon and a portion of the joint in plain view. A year or so elapsed and then, while watching the wheel that was doing the work, I fed my wrist into the same wheel.

Of course, orders were to keep on only the wheel that was being used. This plan worked well for a while, but proved to be too bothersome. After that, I cut a notch in the top part of the angle-iron guard, which enabled me to turn the guard around and leave the opening on the rear side. In this way the danger was entirely eliminated. J. A. Raught.

Janesville, Wis.

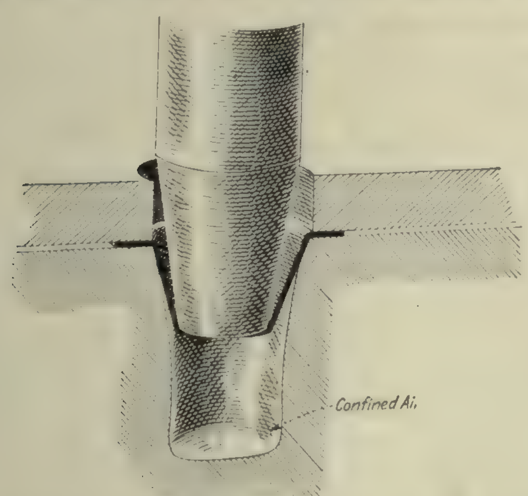
Discussion of Previous Question

Hydraulic Drawing of Sheet Metal

Referring to the article by Mr. Smith on page 27, it seems that some of his claims may have a tendency to mislead rather than assist the novice die maker. For example, a press with ten tons' ram pressure would seem rather light for the 22x38-in. tray. The flat blank for this will have a surface of nearly 1100 sq.in. This large surface limits the water pressure to about 18 lb. per sq.in., and with such a limit one would hardly feel safe in connecting to a pipe carrying the usual hydraulic pressures. But in forming the ball shown at *G*, page 29, the area of the mouth will be much less and the pressure proportionately greater. In this case we might be able to connect to the hydraulic pipe system.

Of course, we can use bolts to clamp the dies together when the press is not strong enough. But a ten-ton press is almost no press at all when compared with the 100- and 5000-ton presses that are being used.

While this hydraulic process has not had wide publicity, it has been known to a few for several years and was brought to the writer's attention some two decades ago. One can recognize a certain relation between this and the art of blowing glass in dies. In making articles such as



PIECE WITH FLUID UNDER PRESSURE ON THE OUTSIDE

drawn-steel water pitchers and stew-kettles, a block of rubber has sometimes been used inside to form the bulged portion.

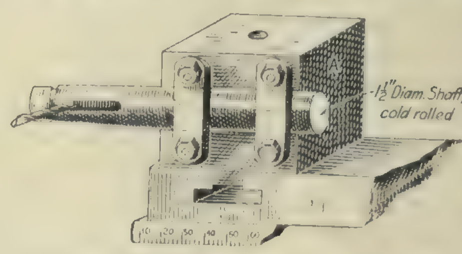
A designer can sometimes make good use of fluid pressure on the outside of an article, as in the case of a tapering pail or an article similar in shape to an ordinary drinking glass. In some cases it will be sufficient to close the bottom of the lower die and confine what air is under the plate (as shown in the illustration), while in many other cases compressed air may be admitted through pipes after the work is clamped. The purpose in this is to keep the work against the tapering punch and prevent wedging into a tapering die. JOHN D. RIGGS.

Lebanon, Ind.

Cutting Keyways in the Lathe

Reading some articles on cutting keyways, I recall how some years ago I used the lathe for this purpose with very good results.

There were two driving shafts to each electric service wagon of the Philadelphia Electric Co. These shafts were $1\frac{1}{2}$ in. in diameter and tapered on each end, with a



CUTTING A KEYWAY IN THE LATHE

$\frac{5}{16}$x$1\frac{1}{2}$-in. keyway cut to secure a gear on one end and a sprocket on the other. The illustration shows how the keyways were cut.

A V-block *A* was clamped in the toolpost slot and the shaft fastened in it as shown. The compound rest was swiveled to the angle of the taper on the shaft.

A $\frac{5}{16}$-in. drill was ground on the end to cut like a flat drill; clearance was also ground on the sides. This was chucked in the spindle.

After the shaft was fed to the proper depth on the drill, the carriage was locked and the crossfeed made use of to get the necessary length.

A comparison of this method with the one previously employed showed that the new plan saved much time. By the old method two $\frac{5}{16}$-in. holes were drilled at each end of the keyway and the extra metal removed by shaping. GEORGE F. KUHNE.

East Rutherford, N. J.

Drafting Room Versus Shop

On page 117, C. M. Horton describes some of the "mistakes" made by draftsmen. His article reminds me of a similar occurrence. Certain plans for a machine consisted essentially of a heavy copper cylinder 12 in. in diameter revolving in a strong magnetic field upon a set of rollers. All parts except the electromagnets were required to be of copper or bronze, thus calling for an expensive construction.

In the preliminary layout it was decided to make the copper tube 30 in. long, but difficulties arose in the assembly on account of the fixed dimensions of the foundation. It was found, however, that by increasing the length of the cylinder by $\frac{1}{2}$ in., or making it $30\frac{1}{2}$ in. long, all the rollers, their bracket bearings, the driving mechanism and other parts would fit together nicely and little trouble would be involved in the change.

The working drawings were made, and a complete set of blueprints was turned over to a small concern in the

vicinity, with orders to build a machine exactly according to the plans. When these people attempted to assemble the finished parts, they were rather surprised to discover that things would not go together. Well, somebody must have made a mistake. Who? Why, the man who drew the plans, of course. Plans were unnecessary anyway, so they would go ahead and fix things up. For some reason, though, things would not fix up; it would be necessary to send for the fool draftsman and make him swallow his mistakes.

The guilty one was summoned and confronted with the evidence and the solemn accusation of the builder: "You made a mistake!" It was indeed a strange sight that met his eyes—only the copper cylinder remained to identify the original conception of the machine. "Emergency" castings had been made; bearings, shafts and rollers had been sawed, chipped and filed away in a vain attempt to make the cylinder revolve and the rollers roll.

It did look dark for the nonplused designer, who racked his brains to find a way to clear himself. The blueprints were checked up and found correct; but as he transferred his attention to the deformed machine before him, the builder naïvely remarked that they "had made the copper cylinder 30 in. long; ½ in. would make no difference anyhow." In going over the plans they had noticed that the designer had shown an unnecessary (?) ½ in. on the cylinder, and they had ordered one 30 in. long to make things come out even!

But troubles never come singly, for upon installing the reconstructed machine and turning on the 110-volt magnetizing current the magnets would not magnetize. The same unlucky designer had superintended the installation of the apparatus and therefore "he must have ordered the connections made wrong." So once more an examination was made, and it was discovered that the electrical firm that wound the coils had marked the beginning and end of each coil, except that on one of the two they had marked the beginning as the end and the outside end as the beginning or inside. When the coils were connected up according to the marks, horseshoe-magnet style, the current flowed in the same direction in each and so practically neutralized the magnetic effect.

Oakland, Calif. H. H. Parker.

I was much interested in reading the article entitled "Drafting Room Versus Shop," on page 147, and perhaps am better fitted than some to offer an opinion on the subject, owing to the fact that I have spent about eight years in one and ten years in the other with a further period of 2½ years on the commercial side. One cannot feel that Mr. Horton's remarks are absolutely correct, in the main, with the exception, however, of his diagnosis of the cause of inter-departmental friction and dislike. This diagnosis I think is correct so far as it goes, but it is incomplete. Furthermore, no solution is offered whereby the condition may be improved.

I would like to add my idea of the cause of this undeniable hitch in the mechanism of many shops and also give a solution for the difficulty.

Why does Draftsman Smith seem to agree so poorly with Machinist Jones? The answer to this question carries us far into the depths of human nature, not only as found in machine shops, but everywhere.

To begin with, we all have a more or less pronounced dislike for two classes of people—those who think themselves superior to us and act accordingly and those who we think have an easier job than we have. The machinist imagines he finds both these classes personified in the draftsman and welcomes an opportunity to "get even." He sees the draftsman coming to work an hour later than himself, sitting all day on a stool, enjoying many privileges denied the man in the shop and on friendly terms with managers and foremen. Envy rises within his bosom. When, in addition, the draftsman acts as if the machines and the mechanics in the shop were much the same class of article, is it any wonder that the machinist's feelings toward the draftsman are not of the kindest?

Another factor is the innate tendency in all of us to mistrust and dislike those who are strangers to us, only to find as we get to know them better how mistaken we were in our first impressions. This factor acts both ways in the case we are considering. Machinist Jones hardly knows Draftsman Smith and consequently cares little for him—and *vice versa.*

Mr. Horton speaks of the fact that the draftsman's mistakes falling on the shop causes some of the feeling. But no such feeling exists between the assemblers and the machine hands, where a somewhat similar set of conditions obtains. That is, the lathe and drillhand's errors often have to be corrected on the assembling floor, yet these two classes of workmen are not often found at loggerheads.

Having been on both sides of the fence, I can also understand a slight feeling of irritation on the draftsman's part when he is hauled from his quiet retreat (?) to the rush and roar of the shop to rectify some trivial error. He wonders, perhaps, why so much fuss should be made about such a mistake and resents it, not having considered that little plants sometimes have long roots.

But what of a remedy? Realizing somewhat the force of what has just been stated and conscious of the usual trouble and loss incident to putting a new class of work through the shop, Mr. Viglin, chief engineer of the Foster Machine Co., Elkhart, Ind., has devised a plan that has been in operation long enough to demonstrate its advantages. It is as follows: When a new style of work is to be started in the shop, the drawing room is notified and the draftsman most familiar with the particular job, usually the one who drew it up, is deputed to go out into the shop to see that everything goes as planned—that the castings conform to the drawings, that the jigs and special tools are used in the manner intended and that the workmanship and limits are up to the standard required. In case there are any errors in the drawings they are discovered and easily corrected.

The draftsman stays in the shop only long enough to insure that everything is being carried out as planned and that all doubtful questions are cleared up. He then returns to his work in the drawing room. He only goes into the shop when he is called for or when some new piece is about to be started on one of the machines. The draftsman thus becomes acquainted in the shop and friendly feelings are engendered between him and the workmen. By this method the draftsman sees the weak and strong points of his designs and learns more rapidly than by any other means what designs are easy for the shop to manufacture and what are difficult. And most important of all, the tendency is fostered for the drawing room and the shop to work in harmony.

Elkhart, Ind. S. M. Ransome.

The Kind of Work for a Trade-School Shop

The article by Entropy, on page 10, is on the most important subject in the world—education. It would be well for the country if this article, which should be read carefully by everyone connected with trade schools and general education, were placed in the hands of all manufacturers and public-spirited people. I have long been connected with education and in charge of manual-training work; therefore, I have some right to speak on the subject.

Entropy makes a most important point when he calls attention to the use of public moneys for higher education. In most of the constitutions of the states of our country will be found about the following expression, "the state shall provide for all its inhabitants, between the ages ——— a good common-school education." It is only by certain legislative acts, therefore, that high schools and normal schools can be legally carried on with public moneys. There is a strong drift today to have this fundamental idea (a common-school education) adhered to, and it will be well for the country when it is followed.

When individuals give sums of money, it is of course their right to dictate for what and how it shall be used. No one could or should object to such private funds being used for the higher branches of education. Such branches must be, however, for the good of a small minority. I do not dispute that such schools are of value, but I feel positive that taxes cannot be wisely employed for such purposes. What is needed for the great mass of people is the celebrated three R's. On this foundation can be built any education of which the individual is mentally capable. In the United States any healthy, well-brained person can attain through his own efforts to almost any height without detriment to his health. The trade schools, in my opinion, are no place for tool designing, jig and fixture making or anything but the plain trade without any of the frills. But then comes the question, What is the plain trade?

Taking the machinist's trade as an example, the trade school should teach the proper names of all machine tools and appliances as well as the names and uses of the most common small tools. It should show the differences in the various metals used in the trade and their peculiarities. It should instruct in the handling of measuring tools. The reading of drawings and the making of rough sketches constitute part of the necessary information that should be given the student or the apprentice.

Cutting off stock with a hacksaw, cutting it off in a cutting-off machine or by means of another machine tool, even to nicking around the stock and striking it over an anvil, are also necessary. Centering pieces in a workmanlike manner, and not so that one end of the stock will look like the crater of an extinct volcano while the other end is a No. 50 drill hole only, is part of the necessary instruction.

Dogging and turning this stock, selecting the tools proper for the job and deciding upon speeds and lubricants must be commented upon and their importance shown. Chucking work without springing it, and swinging it up on an angle plate follow. The student should be shown that there are three kinds of ordinary lathe chucks—the independent, the universal and the combination; and his attention should be especially drawn to the fact that a large percentage of mechanical men and machinists order a universal chuck when they really want a combination chuck.

It is of course necessary that all the functioning of the various machine tools should be made clear, as well as the simple operation of shifting a belt without getting squeezed fingers. Cutting screws and chasing nuts are also operations that belong to the fundamentals of the machinist's trade and should of course be taught. The lathe, it should be clearly shown, belongs to a class that permits various speeds, while planers, with rare exceptions, have fixed speeds; further, that a cut taken on a revolving piece to the depth of $\frac{1}{8}$ in. removes $\frac{1}{4}$ in. of stock, while a tool that removes stock from a plane surface reduces the piece only to the amount of the cut taken.

In drilling-machine work the point to be aimed at is to drill a hole where it is wanted, with the drill running at its proper speed and feed; and if the drill is not drilling the hole where it is wanted, it can be drawn to do so. It is of course necessary to show clearly how work should be clamped or bolted for safety and without springing or otherwise distorting.

When it comes to grinding, where a very little stock is to be removed and generally to very close dimensions, instruction should be given as to the most suitable grade of wheel, the speed, etc. Attention should be called to the fact that a sharp corner cannot be ground; also, that where a close ground measurement is to be made, nervous energy should not be used up in rough grinding, but the time to hold your breath is when you get down to the last cut; and further, that because a grinder is a machine of precision the operator must not consider himself justified in taking any amount of time to do the job.

Miller work, including instruction in the use of the index or dividing head, is of course part of the machinist's trade, as well as cutting spur gears. Years ago, to know how to file flat and chip a surface was of great importance, but it is of little moment today. However, some instruction should be given in both these operations.

There is practically no mathematics required in the machinist's trade, if proper drawings are given to the workman. It is not a part of the machinist's duty to add up a lot of figures in order to get the total length of a shaft. Any school boy who has gone through the sixth grade can add, subtract, multiply and divide sufficiently well to figure out any odd pitches of thread or the outside diameter of a gear blank.

I do not think that cutting bevel gears or developing either the involute or the epicycloidal tooth is essentially a part of the machinist's trade, but it should include a good working knowledge of how to harden, brighten and draw ordinary cutting tools, but not such articles as reamers. The machinist should at least be able to forge the simpler forms of lathe and planer tools as well as to grind them at proper angles with correct clearance for the usual run of work.

Suppose now that the trade-school pupil has been taught—or more properly to express it, shown—all this; he is not yet skilled. In order to become so he must, as Entropy says, have repetition work; and here is one place where trade schools almost always err.

Forming character is a part of the trade-school work, and sticking to work that is not exactly to one's liking shows character. It is true that boys like to see things

go around. It awakens their interest and pride. But besides having the thing go around, the young man, if he has anything in him, likes to see it go around smoothly and not bump around.

Bricks and mortar, lathes and other machine appliances will never alone make a thoroughly good trade school—that lies in the hands of the all-important instructors. The combination in one man of thorough practical knowledge and the ability to impart it, at the same time tactfully handling young men and perhaps a board of directors, is extremely rare and difficult to find.

What trade schools need to do and what the taxpayers have a right to expect that they should do is to turn out young men fitted to become plain tradesmen in a very short time, leaving the higher branches to the individual, who should gain his knowledge at his own personal expense or by the good nature of machine-shop proprietors, but never at the cost of the taxpayer.

All that has been here outlined can be thoroughly well imparted in one year, or at the longest eighteen months, in a properly equipped and managed trade school. But it must really be a year or eighteen months, not a nine months' school year with a number of holidays and vacations. Then the young man is ready to perfect himself in the trade, working under instruction and giving at the same time a substantial return to his employer.

New London, Conn. W. D. Forbes.

Re-Centering Reamers for Grinding

Three ways of centering reamers for grinding are shown on page 1044, Vol. 45. We have a standard practice for this, as well as for grinding twist drills that are used to drill slightly undersize holes, either for reaming or for a drive fit on a pin. The end of the drill or reamer is tinned for a distance of ¾ to 1 in. from the point. A small circular mold of a larger diameter than the drill or reamer is made of fireclay (by plastering it up around a short piece of cold-rolled steel) about 1¼ in. deep. This is filled with solder or babbitt, and the drill held in it vertically, a little way off the bottom, until the metal has congealed.

The drill or reamer is then steady-rested, the one end fastened back against the head center, the solder turned off and a center put in. It does very well for grinding and has saved delay and expense in obtaining special sized drills, as well as salvaging reamers and facing tools.

Waterloo, Iowa. H. E. McCray.

Forming an Awkward Radius in Sheet Metal

Referrring to the kink by W. D. Forbes, on page 178, on "Forming an Awkward Radius in Sheet Metal," I would say that if the same job were put up to me in the manner described by Mr. Forbes I would tackle it in this way: First, I would bore out a steel bushing to the proper inside and outside diameters, in order to give the radius exact measurements; then, I would split the bushing, insert a piece of shafting, clamp the whole in a vise and roll back all of the bushing except the part it is desired to hold for the curved end of the piece.

I consider this a simple, quick, accurate and economical way of working up this difficult-looking piece.

Pittsburgh, Penn. Charles E. Miller.

Machinery and Tools for Garage Equipment

In answer to the request for information on garage equipment, Vol. 45, page 1042, I submit the following for consideration.

Each man should be furnished with a vise and about 5 ft. of bench room, also a tool drawer for his own use. Each man should have in his tool kit: Mill and large bastard files, bastard half-round and medium three-cornered files and a file card. If all the men have access to the toolroom, it will be cheaper in the end to furnish each with small drills up to ½ in. and hold each responsible for his own.

The wrenches that will be found indispensable are a medium and a larger flat steel monkey wrench and a Stillson. A complete set of socket wrenches should be available and also the following miscellaneous equipment: Hacksaws, extra files, thread chasers from 24 to 8, U. S. and S. A. E. dies and taps from ¼ to 1 in., a set of machine-screw taps and dies, heavy chisels, medium and heavy sledge hammers, a crane wheel puller, heavy steel clamps, a soldering kit and an acetylene-welding outfit. For reamers the adjustable kind is useful, as it gives a large range. If there are a number of wristpin jobs, a Morse expansion reamer will no doubt prove to be of great value.

A lathe with a swing of about 24 to 30 in. and 6 ft. between centers is essential. This will take all the rear axles, the crankshafts for straightening and the flywheels. A second-hand one in fair condition will do, and the money saved can be put into a good one about 16 in. by 8 ft., with a taper attachment that will take care of all the accurate work. Get a strong one that will pull a good chip.

Next in importance is a miller. A good universal will do all the work that a repair shop will get in the line of gear cutting, as bevel gears are rather a large proposition for a shop of this kind. Cutters from six to sixteen pitch are about the only ones needed, also a few end mills, side and face cutters, key-way cutters from $\frac{3}{16}$ to ½ by sixteenths and a set of Woodruff keys.

A sensitive drilling machine with sliding table and cup and V-centers, and a large drilling machine with a 20- to 24-in. table, back geared, should also be installed. A power hacksaw is convenient, but it can be dispensed with at first. There should be a large grinder for heavy work and a small one for tools. There is good money in cylinder and crankshaft grinding, if enough work can be obtained to keep a man going, and this equipment should be the best that can be bought.

The following equipment should also be included: Blacksmith forge, anvil, gas burners for preheating work, odd pieces of structural iron for clamping frames in straightening, a husky press for removing flanges and gears and having a wide table for straightening shafts (this should be wide enough between supports to take a wheel for pressing out the hub).

In addition there is the usual jobbing-shop equipment of micrometers (to 5 in. inside and out), tool holders, surface gages, thread gages, jacks, chain hoist, horses and blocking. A soda kettle would be a fine investment. An electric drill of ½-in. capacity should not be forgotten as it will prove to be almost invaluable.

Boston, Mass. W. M. Clark.

Editorials

The Value of Traveling Instructors

It is said that the lack of gages was the real cause for the long delay in the great drive of the Allies last year, and that the failure to make these gages on time was the true reason why shells were not supplied as promptly and as continuously as they were needed at the front. This, then, is one of the vital points in the preparedness program and one that should carefully be considered and provided for.

The great business of the past two years has been responsible for the birth of a number of small tool- and die-making shops in many sections of the country. Some of these have grown to large proportions in a remarkably short time and contain the potential preparedness of knowing how gages are to be made. This knowledge, though it is not equivalent to having the gages ready for use, greatly reduces the time necessary for their manufacture. But there is another way in which the work of gage and toolmaking can be accelerated, and that is by employing instructors to show how work of this kind can be done accurately and quickly, a method that is being adopted in the best manufacturing shops for securing production. In other words, to pass on all the little kinks and short cuts that long and varied experience has proved are useful.

With this end in view it has been proposed to select what might be called "traveling instructors," whose work it will be to go to such shops as are making gages and tools for the Government and show them the best methods. These men would, of course, be mechanics who had proved themselves to be competent in every way and able to adapt the equipment of different shops so as to produce the desired results, and naturally would be selected from shops already doing the best and most efficient work.

The idea is not new or startling, although it is not so common as it should be. The British Government has sent several men to this country, to visit shops making fuses and similar material for the Allies, to see what could be done to assist production. These men were not to find fault with the product, or even to inspect it, but were to impart all the information possible as to the best methods used in other shops, to suggest changes that might increase the output, and be of such general assistance as their experience made possible.

This same idea, if carried out in shops making gages and tools for Government work, would greatly assist in securing such work rapidly and economically. The fact that gages wear out much sooner than many seem to realize makes it imperative that means be taken to keep an adequate supply always on hand, so as to avoid delays in production, delays which might cost a hundred times more than the expense of the gages and the wages of the men needed for this work.

This is a time when so-called shop secrets and all personal knowledge must be dragged from their hiding places and made to contribute to the welfare of the nation as a whole.

An Agreeable Kick-Back

Here is an incident which proves that real service is not a single-action affair, but that it works in both directions: One of our contributors sent in an article recently, describing a certain new process that he had developed. His idea in so doing was to share with others in the same field of work something that had proved of advantage to him in his own shop. This action, as perhaps is the case with most of the information distributed through the technical press, might be called one-sided service, the writer of the article being the one who serves and the readers who can apply what he has written being the ones served.

The man who does a service of this kind is rewarded, aside from monetarily, by the readers whom he ultimately serves. Perhaps nothing could better illustrate the agreeable "kick-back" coming from such real service than the following extract from a letter received a few days ago from the contributor mentioned:

"My article on . . . has given me widespread attention. I have already received about ninety letters regarding the process, and they are still coming in. I have also received a number of offers of consulting work in getting shops started using the process and have already gotten it established in several in your vicinity."

You could not convince the man who wrote that letter that writing for the *American Machinist* is not highly profitable, any more than you could convince the man who reads it understandingly that he wastes his time in so doing. For reading and writing lead to reputation. Think it over and join the ranks of those who are furthering the cause of American machine shops by sharing their knowledge with 20,000 others.

Machine-Tool Exports During 1916

Government statistics show that the United States exported during the calendar year 1916 metal-working machinery to the total value of $79,698,861. Truly, a stupendous amount compared with the record of former and more nearly normal years! The United Kingdom took the largest portion, $20,499,659 worth. France was next with $18,807,987, and Russia in Europe third with $14,-812,742, thus keeping up the proportionate record of the Allies established during 1915.

Much of this machinery was of American high-production types. Entirely apart from the present, the shop practice of the countries receiving it must be influenced and modified by the great influx of this new type of machinery.

Satisfactory as the export total is, it is not right to infer that the tonnage of machine tools shipped has increased in proportion to the increase in value. On the contrary, to get a sum representative of the number of machines exported, comparable on a basis of individual cost with normal years, the amount given above should be reduced by, say, one-third or some such figure.

Circumventing the Submarine Menace

By F. Huntington Clark

SYNOPSIS—The German submarine is a factor with which the United States must contend, whether we go into the war or keep out of it, if we intend to maintain our established commercial rights. Thus, suggestions of methods for circumventing the attempt to deprive us of these rights are of particular interest at the present moment. Mr. Clark, who suggests the idea outlined in this article, is without personal motives in this matter aside from his interest as a patriotic American citizen. This plan has received the commendation of officials high in government circles, as well as those versed in the handling of commerce on the sea. Whether it is a practical proposition or not depends upon American machine shops, and it is hoped that this article will bring the answer.

The only sure method of neutralizing the effect of the U-boat campaign is to create tonnage as fast as it can be destroyed. If we could build ships of a type calculated to evade the U-boat and build them faster than Germany could sink them, it is probable that Germany would be prepared to retract from the indefensible position she has taken.

Steel Boats Out of the Question

We cannot increase the rate at which we are building steel ships, as our shipyards and rolling mills are doing their utmost now. It is possible, however, for us to build an enormous number of small wooden cargo boats of from 1000 to 2000 tons' capacity, equipped with internal-combustion engines. Boats of this type have been built for the past few years on the Pacific Coast and have demonstrated their usefulness as cheap and efficient cargo carriers. These boats, as built on the Pacific Coast, are equipped with semi-Diesel motors and have a sea speed of about nine knots. The most efficient size for these boats, from a purely commercial point of view, is between 3000 and 4000 tons' capacity; but if we were to build boats for the purpose of carrying cargoes through submarine-infested waters, it is probable that it would be advisable to sacrifice commercial efficiency and economy in operation in order to get both sufficient speed and quick-turning ability to give us the best possible chance to evade the submarines. With this in view it seems probable that a boat of between 1000 and 2000 tons' capacity with a speed of 14 knots would be advisable. It is possible that, to secure a speed of 14 knots, it would be necessary to make a further sacrifice of economy and use a gasoline engine instead of a Diesel or semi-Diesel type.

Low Visibility a Large Factor

A fleet of a thousand such ships equipped with bow and stern guns would have a great many advantages and a maximum chance of getting their cargoes safely to port. Such ships would have very low visibility and would be seen at about one-third the distance of the steamship, thus multiplying the number of submarines necessary to establish a tight blockade. They would be small and specially designed for quick turning. For these reasons the number of misses made by the U-boats would be greatly increased. Furthermore, such boats operate with very small crews, from 12 to 14 men; the value of the cargo on any one ship is small, so that when one of them is sunk the loss in personnel, cargo and shipping is small. For offensive purposes 10 small ships each armed with two guns are much more effective than one large ship with two guns. In case we should become involved in the war, a fleet of such ships would be immensely valuable for patrol boats mine laying, net laying and numerous other purposes.

To build these boats, it would be necessary to utilize the facilities of every wooden shipyard in the country. It is probable that a considerable number could be made in the old yards up and down the Atlantic Coast, but the two points at which the greatest number could be built would be the Pacific Coast, with its inexhaustible supply of lumber and enormous mills, and the coast of Texas, where similar conditions prevail. To build a wooden ship does not require the yard and equipment necessary for the construction of steel boats. About all that is necessary is a crane for handling heavy material and a small amount of woodworking machinery. Such boats should be absolutely standardized, the timbers sent from the mill ready to be bolted into place, and in their construction our utmost skill in scientific management could be utilized.

Everything Ready To Go Ahead

We have in this country the necessary lumber and the facilities for getting it out. We have the labor; we can build the engines. It is physically possible for us to turn out ships of this kind at a rate absolutely to neutralize the U-boat campaign. If we should do this, it would probably end the war very quickly. With these two points established, any ordinary argument of difficulty or cost has very little weight.

The war is at present costing not far from $200,000,000 per day. One-half of the daily cost, or $100,000,000, would put 1,000,000 tons of wooden shipping in the water and do more to bring about the end of the war than any other possible action on our part.

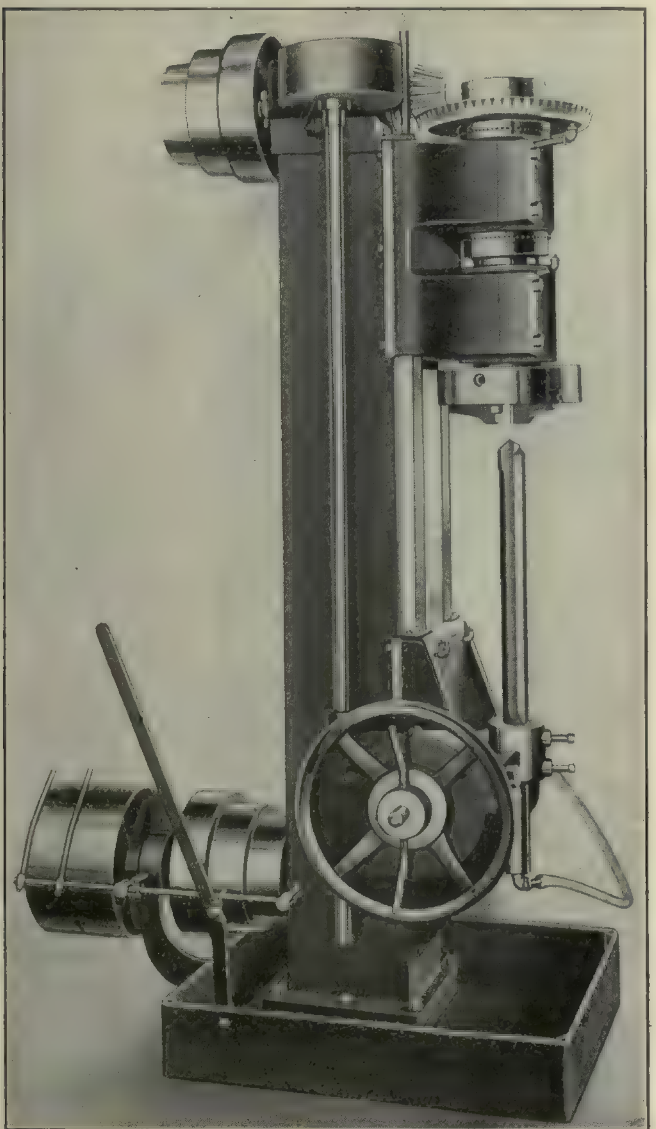
This plan has had careful consideration by leading shipping men in this country, as well as some of our foremost naval authorities, and has been strongly indorsed by them as being the most effective move we could make to end the war.

[The crucial point in the above plan is the possibility of obtaining gasoline engines of the proper size in sufficient quantities and at sufficiently early deliveries to make it practical. It is figured that engines of 1000-hp. capacity will be required for boats of this size. The difficulty which may be anticipated from a lack of sufficient gasoline supply for so many transatlantic power boats is not so serious as it at first seems. After the engines are once wound up, kerosene makes a very satisfactory fuel and there will no doubt be sufficient of this available. What the plan really amounts to is a cargo-carrying mosquito fleet. How many 1000-hp. engines per week can American shops produce?—Editor.]

Shop Equipment News

Spindle-Drilling Machine

The purpose of the machine shown herewith is to drill lathe spindles and work of similar character. In order to prevent the drill from becoming clogged with chips it is placed in a vertical position and fed upward into the work, a force pump being provided for the lubricant. One



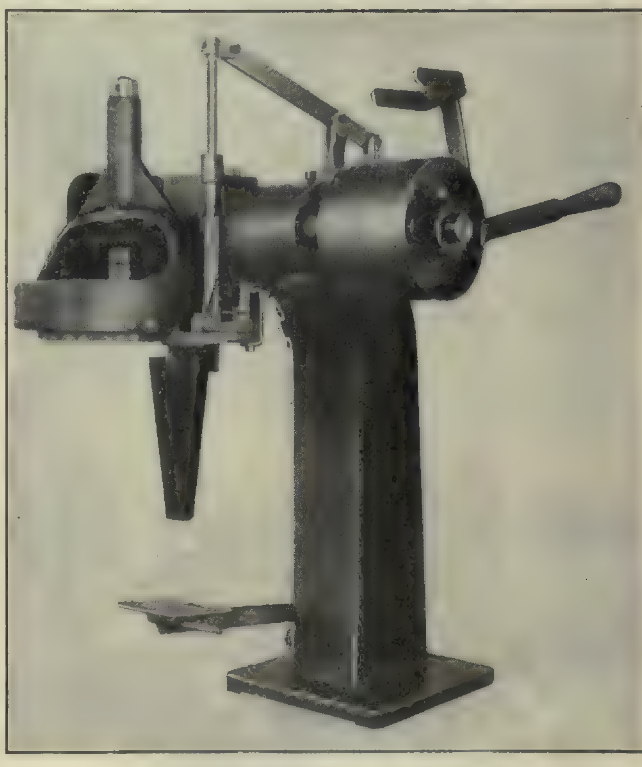
MACHINE FOR DRILLING SPINDLES

Distance between face of chuck and drill holder, $32\frac{1}{2}$ in.; diameter of hole through spindle, $4\frac{1}{4}$ in.; swing over bed, 14 in.; cone pulleys, $9\frac{1}{2}$, $11\frac{1}{2}$ and $13\frac{1}{2}$ in. for 3-in. belt; width of column, 12 in.; floor space, 32 x 48 in.; height, 7 ft. 6 in.; weight, 1800 lb.

chuck is provided at the lower end of the spindle, and this is sufficient for work up to 30 in. in length. Where longer work is handled, it is preferable to use two chucks, one on each end of the spindle. Both horizontal shafts run in ball bearings, and the main spindle is provided with ball-thrust bearings. The feed is altered by changing removable gears, one pair of which is furnished with the machine. Three-step cone pulleys are used for the drive and a belt shifter is furnished as an integral part of the mechanism. The machine is marketed by the Charles Stecher Co., Chicago, Ill.

Screw-Counting Machine

The Reynolds Pattern and Machine Co., of Moline, Ill., has recently placed on the market a machine for counting out a certain number of screws to be packed with other goods for the use of the purchaser in assembling or mounting after the purchase has been made. In operation the depression of the lever below the chute makes



SCREW-COUNTING MACHINE

suitable connections for the operation of an escapement which delivers the proper number of screws. It is intended to develop the machine to enable it to deliver the screws in gross lots, if the demand for such a device is found to exist.

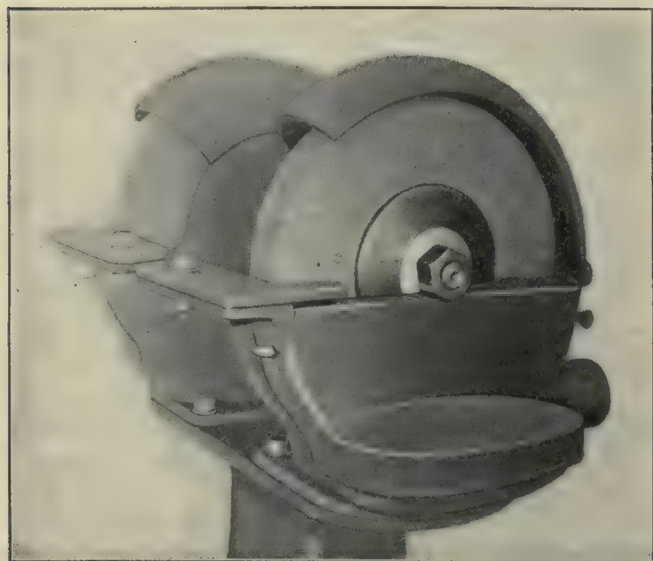
Motor Grinder

The illustration shows the new connections for use with an exhaust system, which have recently been added to the line of motor grinders manufactured by Forbes & Myers, Worcester, Mass.

As will be noticed, the lower halves of the wheels are entirely inclosed, while the upper parts are covered by guards. One of the connections for the exhaust pipes may be seen at the rear. It is claimed that the design is such that the wheels set up a sucking action that carries

most of the dust out through the exhaust openings, even though an exhaust fan is not used. The heavier particles settle in basins directly under the wheels, whence they may be removed by taking off the covers that inclose the lower halves of the wheels.

The motor is fully inclosed to protect it from dirt or injury, and a choice is provided as to voltage, phase and

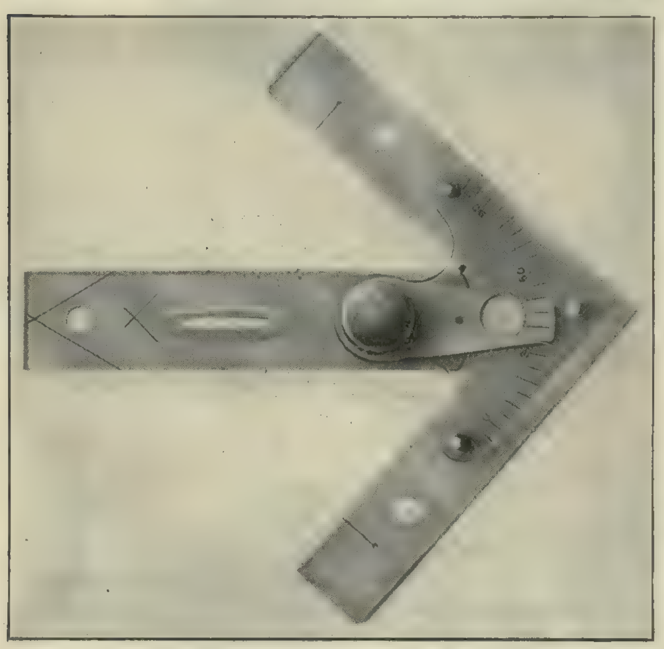


MOTOR GRINDER

cycle. Ball bearings are used on the 1-in. spindle. Wheels are 12x2 in., the machine being especially intended for foundries, blacksmith shops and other places where similar heavy work is done. The rests are adjustable in two directions. The machine is furnished in either bench or floor style.

Draftsman's Square

The universal square shown is one that has recently been placed upon the market for the use of draftsmen. The illustration is about one-half size. The instrument is made of celluloid and consists of a square to which is

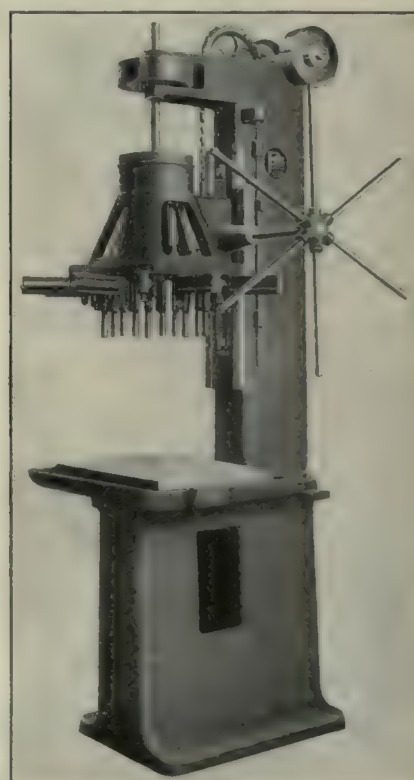


DRAFTSMAN'S UNIVERSAL SQUARE

attached a swinging arm that may be set and held at any angle by means of the thumb-screw. The piece overlying the swinging arm is riveted to the body of the square and is provided with graduations by means of which the arm may be quickly set to the more common angles, such as 30, 45 and 60 deg. D. J. Kelsey, New Haven, Conn., is the manufacturer of the instrument.

Multiple-Spindle Sensitive Drilling Machine

Owing to a demand for a small sensitive multiple-spindle drilling machine for light drilling, countersinking, etc., the Fox Machine Co., Jackson, Mich., has recently placed on the market the machine shown in the illustration. A machine with a base of the box-type construction is shown, but a bench type can be supplied if desired. The table is provided with an oil flange and T-slots, and is cast separate from the base in order that special tables or fixtures may be used. The main vertical shaft runs in bronze-bushed bearings and is equipped with

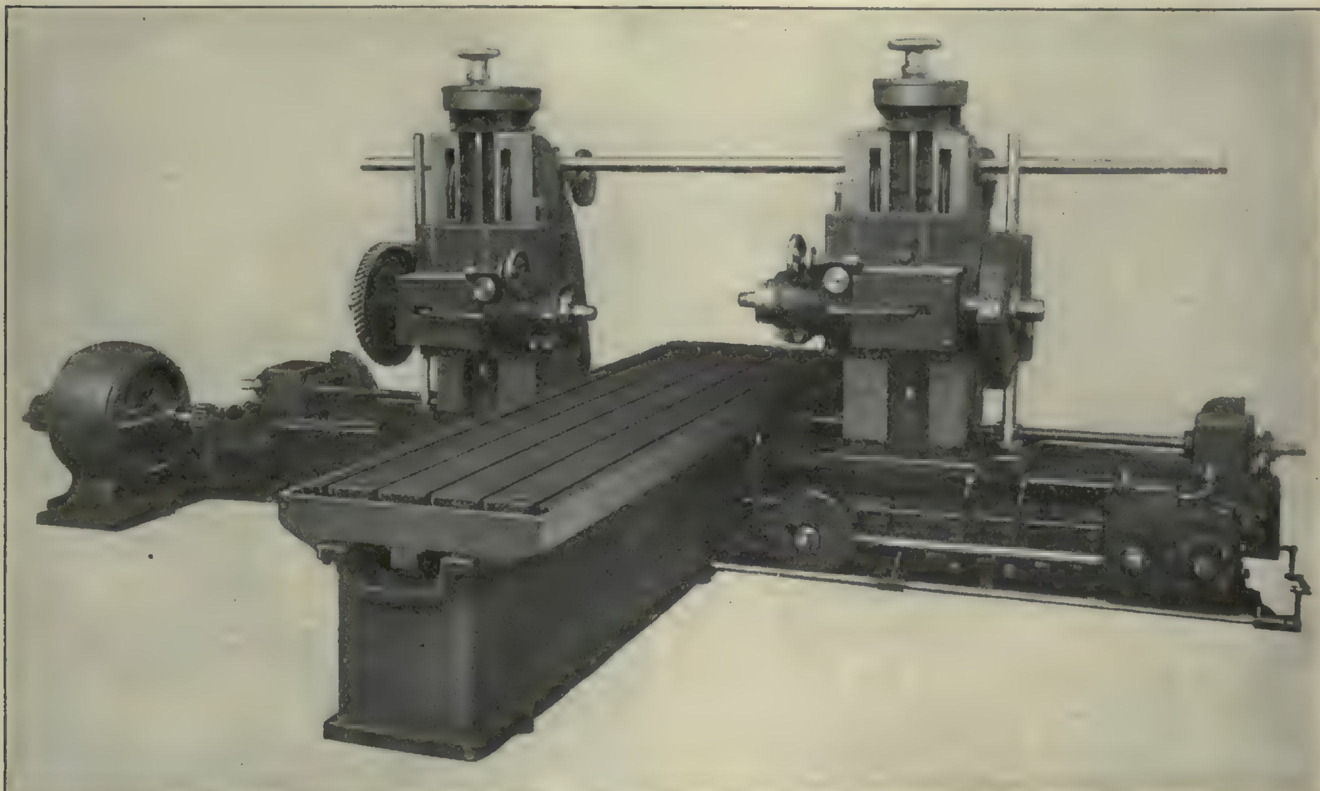


SENSITIVE DRILLING MACHINE

ball-thrust bearings. Hyatt roller bearings are used on the idler pulleys. Either 9- or 12-in. round heads can be supplied, and these may be equipped with from two to ten 1-in. or with from two to sixteen $\frac{3}{4}$-in. spindles. A pilot wheel with pinion and rack provide for easy feeding. The universal joints are of the Fox type without pins, screws or other small parts. The spindles are equipped with ball-thrust bearings. Cluster plates can be furnished where complicated layouts are required, which cannot be secured when the ordinary type of round heads is used. All pinions are of openhearth steel and have a double bearing turned integral. All gears run in an oil bath which insures proper lubrication and quietness. A new type of adjusting arm is used.

Duplex Miller

The Newton Machine Tool Works, Philadelphia, Penn., have recently brought out the miller shown herewith. The machine is equipped almost entirely for power control. The spindles of the machine are driven through worms and wormwheels, which are incased for continual lubrication; the drives are independently clutched at the inside of the driving wormwheel sleeve. The spindles are bored in the nose to accommodate a straight plug 3 in. in diameter and are arranged for cutter keys 1¼ in. wide. If desired, a standard Morse taper will be furnished. The spindle saddles are counterweighted and provided for either simultaneous or independent vertical adjustment either by hand, power, or by fast power traverse. They may be bolted rigidly at any desired height. The uprights are equipped for independent or simultaneous horizontal adjustment by either hand or power, and fast power traverse is provided. Taper shoes are fitted to both the saddles and uprights. The work table is provided with overlapping gibs and is driven by an angular rack and worm pinion. Nine feed changes are provided through an oil-tight gear box. The machine is designed to carry cutters up to 16 in. in diameter operating upon cast iron.



NEWTON SPECIAL DUPLEX MILLER WITH COMPLETE POWER CONTROL

Width of table, 42 in.; width between uprights, 106 in.; length of table over all, 14 ft.; length of table to mill, 12 ft. 6 in.; length of base, 18 ft.; distance face of upright to center of spindles, 6¾ in.; center of spindle to table, maximum 35 in., minimum 2 in.; distance between ends of spindles, maximum 90 in., minimum 12 in.; diameter of spindle driving wormwheel, 27 in.; feeds of work table per spindle revolution, 0.041 to 0.427 in.; feed of spindle saddles, 0.012 to 0.134 in. per revolution; feed of uprights, 0.011 to 0.113 in. per revolution; spindle speeds, 5.4 to 55.2 r.p.m.

Bristol's Automatic Temperature Controllers

Temperature measurement in industrial works and manufacturing plants must logically include the measuring and indicating of the temperature with a reading instrument, automatically recording the temperature with a graphic recording instrument and automatically controlling the temperature, thus eliminating the personal element.

The Bristol Co., of Waterbury, Conn., has developed a new line of automatic temperature controllers for gas- and oil-fired and electrically heated furnaces, the principle being to employ the measuring, the contacting and the operating elements to accomplish this purpose.

The measuring element consists of a number of different types of Bristol electric pyrometers and thermometers, notably the thermo-electric pyrometer with Weston millivoltmeter movement and Bristol separable couples, as well as the Bristol vapor-filled type of thermometer, which is very extensively used for recording temperatures. The controlling element is combined with the measuring element and consists primarily of an elec-

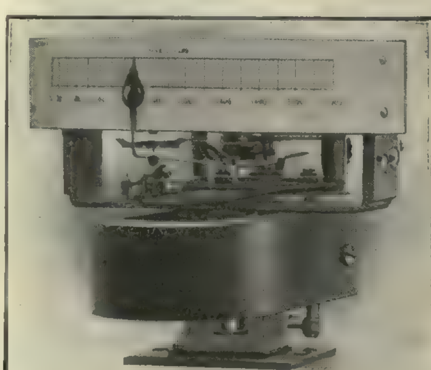


FIG. 1. MEASURING AND CONTROLLING ELEMENTS

trical contact-closing device that operates at predetermined high and low temperatures, electrical circuits being closed or opened by this means and energizing or disconnecting the operating element.

This operating element consists of the device that actually regulates the heat supply in the furnace. In a gas-fired furnace, for example, a pair of electrically operated

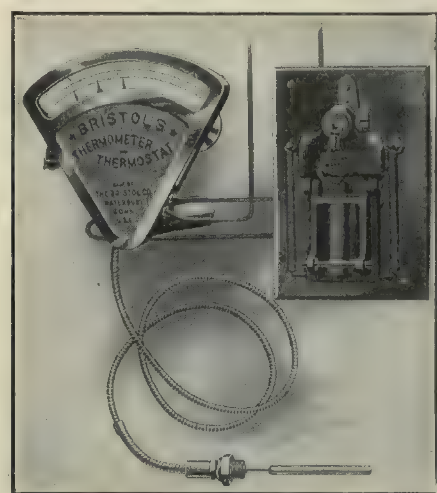


FIG. 2. THERMOMETER-THERMOSTAT, SENSITIVE BULB AND RELAY

gas and air valves are used, while in the case of an electric furnace the operating element consists of a special relay switch opening and closing the circuits of the heating element of the furnace.

Fig. 1 shows an internal view of the measuring and controlling elements of the thermo-electric type, from which it may be seen that the indicating arm is com-

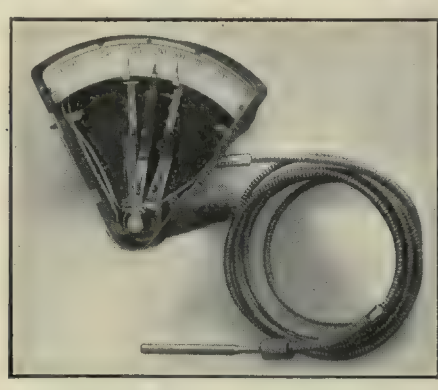


FIG. 3. INTERIOR OF THE THERMOSTAT

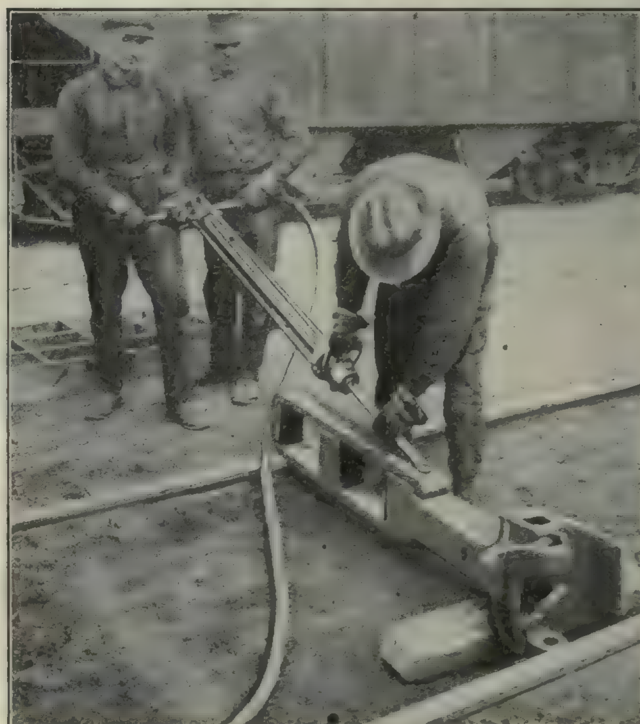
pletely insulated from the operating circuits, the contacting device being absolutely frictionless. These controllers can be furnished for all temperatures up to 3000 deg. F. and with high resistance movements for use with either base- or precious-metal couples.

Then there is a special gas and air valve, two being used in connection with gas furnaces, if air is supplied at a pressure; both gas and air valves are operated simultaneously, so as to insure having the proper mixture at all times.

In Fig. 2 is shown one of the vapor-type Bristol thermometer-thermostats, complete with sensitive bulb and connected to the special relay switch employed for adapting these instruments to the control of temperatures in electric ovens and furnaces. The interior of the thermostat is shown in Fig. 3. This design of contact-closing device has proved very practical and durable in long-continued service. Both the high and the low contacts are shown in this illustration, but with the Bristol automatic electrical controlling valves for both gas and air supply, only one contact is required.

Rivet-Cutting Gun

A pneumatic rivet-cutting gun, closely resembling the type so familiar to railroad men, is now being manufactured by the Rivet-Cutting Gun Co., of Cincinnati, Ohio. Besides cutting off rivets of various sizes, the gun can be utilized for punching holes or riveting. The hammer is in the form of a piston that travels back and forth in the cylinder, the force of the blow delivered to the



PNEUMATIC RIVET-CUTTING GUN

tool being regulated or governed by the amount of air pressure available and the quickness with which the hand valve is operated. As low as 55 lb. air pressure can be used, but 75 to 100 lb. is preferable.

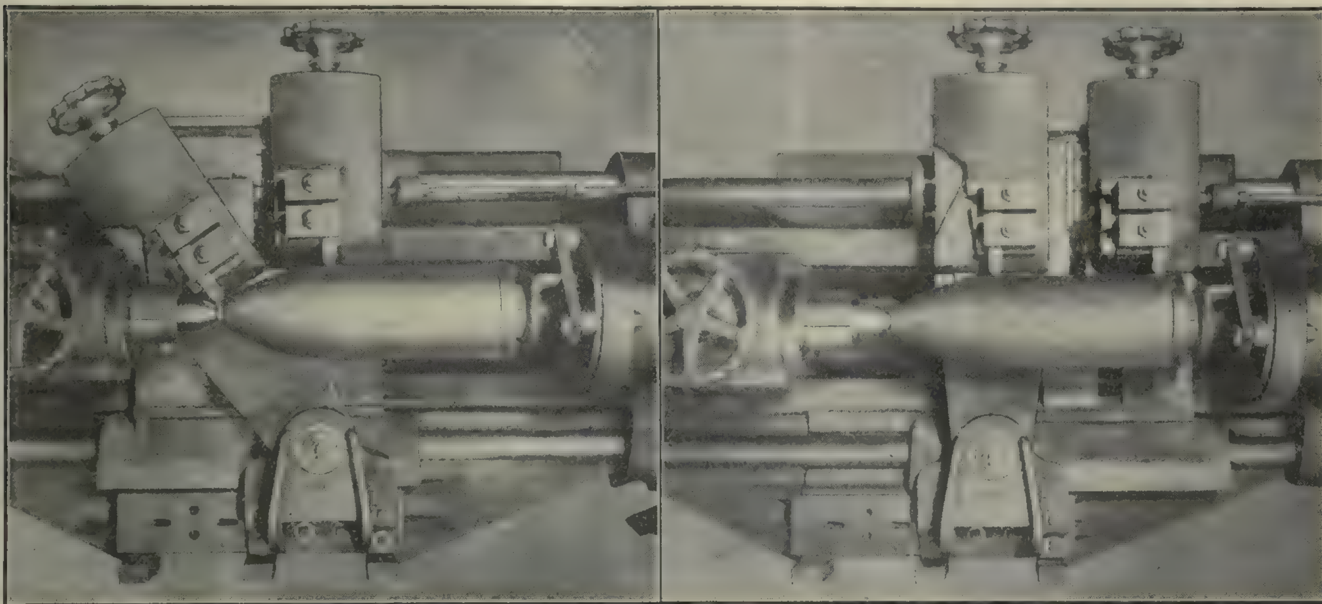
Shell-Turning Lathe Carriage

The "Duplex" turning carriage recently put on the market by the Amalgamated Machinery Corporation, of Chicago, was designed primarily for use on its shell-turning machines, but is adapted to fit any lathe of sufficient strength and size.

The illustrations show the carriage with a 9.2-in. shell in place on the No. 21 machine and give a good idea of the novel features of construction and design. Two tool slides are mounted on a single carriage driven by a single feed screw, and the tool slide for turning the straight part of the shell is of the ordinary construction. The radius-turning tool slide is carried directly on the radius arm, which on its under side is recessed to form the seat for a large swivel bearing that in turn fits over a male swivel seat on a free-traveling lower slide. The advantages of this device are readily apparent. Any desired

form of tool may be used; and it may be set in any way, because it is always carried at the same relative position to the shell radius. Predetermined setting and grinding are not necessary to secure the desired contour.

The distance from the fixed pivot of the link to the point of the tool is obtained by the tool-slide adjustment,

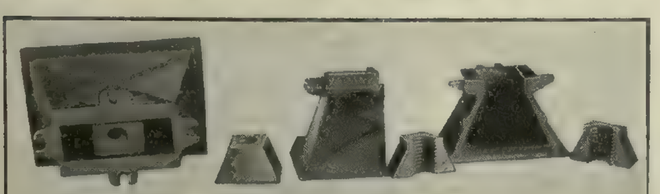


DUPLEX SHELL-TURNING LATHE CARRIAGE

but the distance from the fixed pivot of the link to the center of the swivel on the lower slide is predetermined and established by direct proportion of the length of the straight part of the shell to the axial length of the nose. It is clearly evident that the radius tool, traveling but about a third the whole axial length of the shell in the same time the body tool travels two-thirds the shell length, has its feed automatically reduced to about one-half that of the carriage proper and the body tool. This is particularly desirable in shell making, as the limit of feed possible is always found in the eccentricity and excess stock on the nose. With this device, however, the operator gages his speed by the limits of the cutting tool used for the straight cut and the radius tool automatically feeds accordingly.

Adjustable Insert for Concrete Work

The illustration shows an adjustable insert for concrete work recently placed on the market by the Medina Machine Co., of Medina, Ohio. This insert is intended to ob-



INSERT FOR CONCRETE WORK

viate the necessity of using expansion bolts, channels or other similar devices for holding machinery or other fixtures in place. The four slots shown at the sides are for the purpose of nailing the insert to the forms in order to prevent its being tipped over or knocked out of place when the concrete is poured. In use a nut having the shape of a truncated cone is tipped edgewise and slipped into the insert where it assumes its normal position, in which it is adjustable to some extent in a longitudinal direction. The nut can be removed easily at any time if it becomes necessary to substitute one having a different thread. The illustration shows the insert assembled, as well as broken apart to show the construction. A solid insert which does not include the adjustable feature or the easy means for changing bolt sizes is also made.

Alumni of Stevens Technology Organize for Defense

For the past year the alumni of Stevens Institute of Technology have been actively engaged in measures for military and industrial preparedness. Acting through their Committee on Military and Naval Affairs, the alumni are now compiling a classified list of Stevens men willing and ready to serve in those branches of the army or navy where their specialized education and experience will prove of most value in the Government service. Many Stevens men have already been commissioned in the Officers' Reserve Corps. Some are officers in the regular army, the navy and the national guard, while others are doing special work in ordnance and in naval engineering.

This enrollment is being carried on under the auspices of an advisory committee consisting of Alexander C. Humphreys, president, Stevens Institute of Technology; John W. Lieb, vice-president, New York Edison Co.; Robert M. Dixon, president, Safety Car Heating and Lighting Co.; Anson W. Burchard, vice-president, General Electric Co.; William D. Hoxie, vice-president, Babcock & Wilcox Co.; Newcomb Carlton, president, Western Union Telegraph Co.; William A. Field, general manager, United Alloy Steel Corporation; Charles H. McCullough, Jr., vice-president, Lackawanna Steel Co.

The active committee is at present composed of J. H. Cuntz, L. K. Lydecker, B. F. Hart, Lewis Sanders, W. R. King, Henry Torrance, E. H. Peabody, G. G. Freygang.

A Countershaft Drive Problem

By H. D. Martindale

A condition arose in the shop for which I am unable to formulate an answer, and thought perhaps some of the readers may be able to solve the problem. It was as follows:

A 52-in. by 22-ft. Prentice lathe was set in such a position that it was necessary to erect a countershaft about 2 ft. out of the perpendicular toward the operating side of the lathe, which, according to theory, would be considered all right, although it was rather inconvenient to shift the belt from step to step of the cone by hand. Whenever a heavy cut was put on, this step-cone belt, of its own accord, would climb and in some cases travel on to the next step above the one on which it was required to operate. The countershaft and lathe were leveled and plumbed for line in every direction. And I even went to the extent of throwing the countershaft out of line with the lathe, hoping to make the belt run on the proper step.

I suppose, in six months, $200 were spent for step-cone belts.

The other day one of the men suggested setting the cone either in line perpendicular above, or beyond the perpendicular away from the operating side of the lathe, stating that he thought this would overcome the trouble. Theoretically, I could not see why the belt would not travel in one position as well as another, but, to encourage suggestions, and as a last hope, the belt was moved so that it is about 6 in. out of perpendicular away from the operator; and the trouble is over.

If anybody can tell me why these conditions prevailed, I would like to hear from them.

Since this change was made two other lathes that caused the same trouble have been placed under practically the same conditions, and the change made as above outlined with satisfactory results.

Southwestern Society of Engineers

The Southwestern Society of Engineers held its first convention on Mar. 8, in the Hotel Sheldon, El Paso, Tex. This society was established for the purpose of joining together engineers in the Southwest; to promote social intercourse, the advancement of engineering knowledge, education and practice and the maintenance of a high professional standard among members. Three classes of members are provided for—full, associate and affiliated.

One of the causes leading to the formation of this association was the difficulty experienced by engineers who reside in this portion of the country in attending meetings of the national bodies, while at the same time there are not enough engineers in a given locality in any one branch to make strong sections. The headquarters of this society are at 721 First National Bank Building, El Paso, Tex.

Obituary

Frederick E. Reed, better known as F. E. Reed, the well-known builder of the Reed engine lathe, died at his home in Thompson, Conn., on Feb. 18, in his 70th year. Mr. Reed was born in Croydon, N. H., but removed to Worcester, Mass., at an early age, and began his mechanical career at the age of 17. However, after two years in the shop he decided to take a course at the Worcester Academy and at Howe's Business College. Beginning work with the old Wood & Light Machine Co. and attending drawing school at night at the Worcester County Mechanics Association, he became active in promoting the drawing school, which he felt was needed to help advance the young mechanics of that vicinity.

In 1875 Mr. Reed purchased an interest in the machine-tool business of A. F. Prentice & Co., which had been established three years before by Vernon and Albert Prentice; the latter retained his interest until 1877. Then, Mr. Reed having become the sole proprietor, the firm name was changed to F. E. Reed, which it remained until 1890, when John R. Back, who had been the shop superintendent for many years, became financially interested. The name was changed to F. E. Reed & Co., and then to the F. E. Reed Co. in 1894.

In the meantime the old shop had long been outgrown, the first building on Gold St. having been erected in 1883. This was a two-story building with a floor space of 2262 sq.ft., and about 40 men were employed, the output being 150 lathes per year. In 1888 and again in 1889 and 1890 other buildings were erected, until over 2000 lathes per year were built. Still more buildings soon became necessary, these being of the four-story brick factory type. The eighth of the group was erected in 1904, and it represented an enormous growth from the little shop on Hermon St., with six employees in 1875, to more than 1000 men on the payroll when Mr. Reed finally retired from active business in 1912, when the Reed-Prentice corporation was formed.

Among his other interests were the Reed Foundry Co., the Reed-Curtis Machine Screw Co., the Mathews Manufacturing Co. and the Worcester Lawn Mower Co. Mr. Reed was the second president of the Worcester branch of the National Metal Trades Association and had been a director of the First National Bank.

One of his most striking characteristics was Mr. Reed's optimistic faith in the permanence and stability of the machine-tool industry, as evidenced by his courage in always building machines for stock whenever the demand dropped below normal. And while he probably had more machines in storage at various times than any other machine builder, his faith was always justified by being able to supply lathes promptly when unexpected demands arose, as they did in almost every instance.

Personals

H. L. Harrison has joined the Modern Tool Co., of Erie, Penn., in the capacity of factory manager.

Walter S. Crossley has been made foreman of the tool room and machine repair shop of the Wasson Piston Ring Co., New Brunswick, N. J.

E. Carlson, assistant superintendent of the Stewart Die Casting Co., has resigned to become chief engineer of the Indiana Die Casting Co., Indianapolis, Ind.

F. Lloyd Mark has been appointed Western sales manager of the Stroh Steel Hardening Process Co., Pittsburgh, with offices at 728 Monadnock Building, Chicago.

Dr. W. F. M. Goss, dean of the College of Engineering of the University of Illinois, has resigned to become president of the Railway Car Manufacturers' Association.

F. P. Glosh has resigned as chief designer of the National Acme Co., Cleveland, Ohio, to become director and general superintendent of the Permanent Products Co., of the same city.

S. J. Witt, formerly general foreman of the West Pennsylvania Railways Co., has been appointed master mechanic, succeeding **D. Durie**, who has been made general superintendent of railway operations in territory A.

David Anderson, formerly superintendent of the National Twist Drill and Tool Co., Detroit, Mich., has been made factory manager, and **F. Mansur**, formerly with the Morse Twist Drill Co., will succeed Mr. Anderson as superintendent.

Frank M. Erb, formerly superintendent of production of the R. D. Nuttall Co., has severed his connection with that company and will open an office in the Second National Bank Building, Pittsburgh, to deal in castings and forgings.

Farnham Yardley has recently been elected president of Jenkins Bros., to fill the vacancy caused by the death of Alfred V. Jenkins. **F. T. Swain** has been promoted from general manager to vice-president, and **Samuel Laird**, formerly manager of the Philadelphia plant, has been elected director.

A. H. Ackerman, formerly vice-president and general manager of the United States Light and Heat Corporation, and **C. C. Bradford**, formerly sales manager of the same company, have announced the formation of the Bradford-Ackerman Co., with offices in the 42nd St. Building, New York City. The new concern will represent manufacturers of electrical apparatus, automobile and railway supplies for domestic and export trade. Correspondence with reliable manufacturers is invited.

Trade Catalogs

Filing Machine. Noble & Westbrook Manufacturing Co., Hartford, Conn. Circular No. 300-A. Illustrated.

Dwight-Slate Marking Machines. Noble & Westbrook Manufacturing Co., Hartford, Conn. Catalog No. 10. Pp. 20; 4x7 in.; illustrated.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1735 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

No organization could have been better fitted than the American Machinist for the task of collecting and presenting the manufacturing methods of our arsenals. The average reader does not realize the enormous amount of detail involved in a task of this kind.

The American Machinist has in this work demonstrated its public spirit and patriotism.

Howard E. Coffin

Chairman of Munitions Committee, Council of National Defense

United States Munitions*

The 3-In. Common Steel Shell

United States 3-In. Common Shell

The high-explosive, or common, steel shell, as it is called, is of the solid-point, base-detonating type, which explodes only on impact and cannot be set for time explosion. The explosive carried by the shell is trinitrotoluol, which is forced into the interior of the shell under heavy hydraulic pressure. The base detonator that causes the shell to explode when it strikes is so made that it only becomes active after the shell is fired from the gun. This makes possible the safe handling of loaded shells, which might be dropped point down for some distance without exploding; the explosion, if one should occur from the shell's being dropped, would not be caused by the action of the detonator mechanism in any case unless the shell was fired from a gun, as it is the rotation of the shell in flight that sets the mechanism for active operation.

The specifications for the steel used in these shells are practically the same as given for the 3-in. shrapnel; but since it is impracticable to determine the contour of the front end of the cavity after the forging is closed in at the base, this part is inspected by the inspector at the works after the projectiles are punched and before the closing-in operation. Details of the forging as received at the Government arsenals are given in Fig. 1. The finished projectile is shown in Fig. 2. As with the 3-in. shrapnel, 10 per cent. of these shells are fitted with night

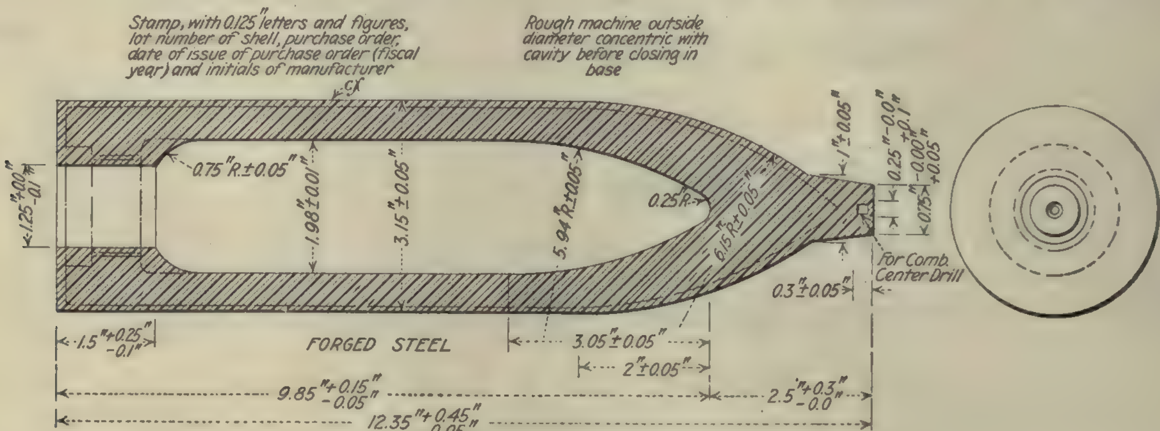
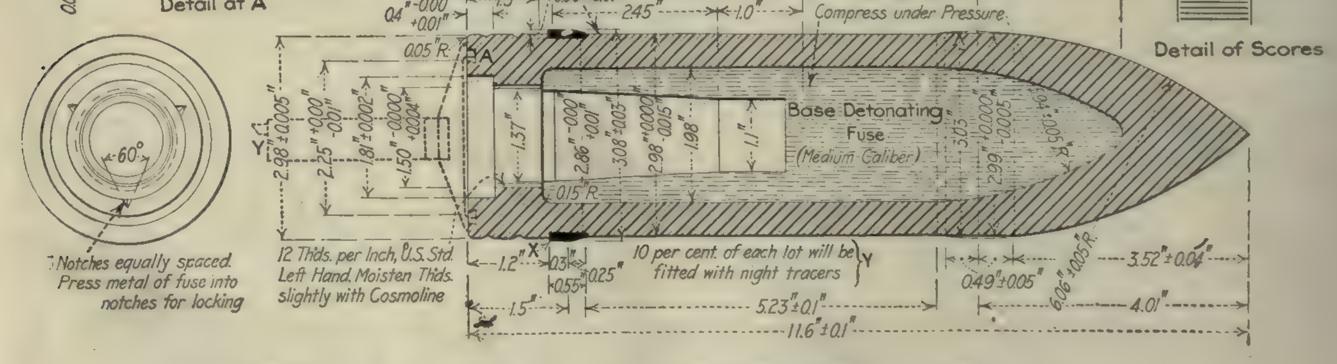


FIG. 1. THREE-INCH COMMON SHELL FORGING



X=Stamp with 0.062" (1/16)" letters & figures, F.A. lot no. & ammunition lot no. The stamping prescribed may be rolled in on band, if also stamped on base within the groove in lieu of stamping in front of band

Finish Outside f ± 0.01", Rough Inside except where marked f; Coat Inside with Non-acid Paint

FIG. 2. DETAILS OF COMPLETE PROJECTILE

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FIG. 3. CENTERING BASE OF FORGING IN A LATHE FITTED WITH CROSS-SLIDE TURRET

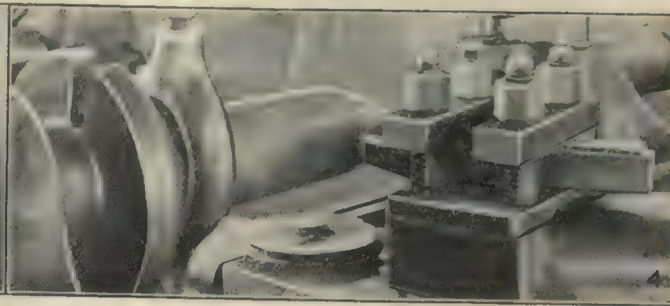


FIG. 4. ROUGH-TURNING THE NOSE OF THE CASE ON A LATHE

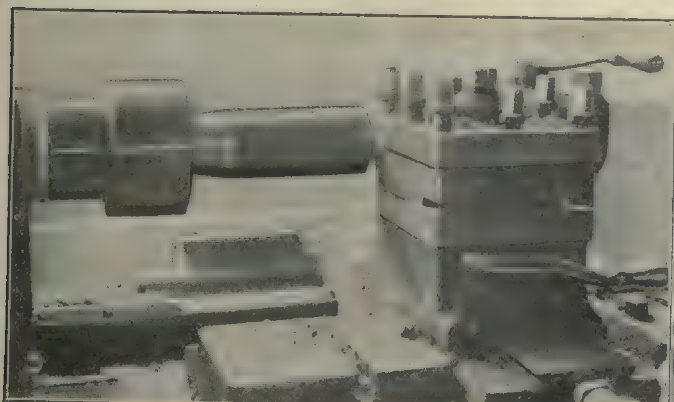


FIG. 5. ROUGH-TURNING BODY, USING A SPECIAL DRIVER AND CENTER

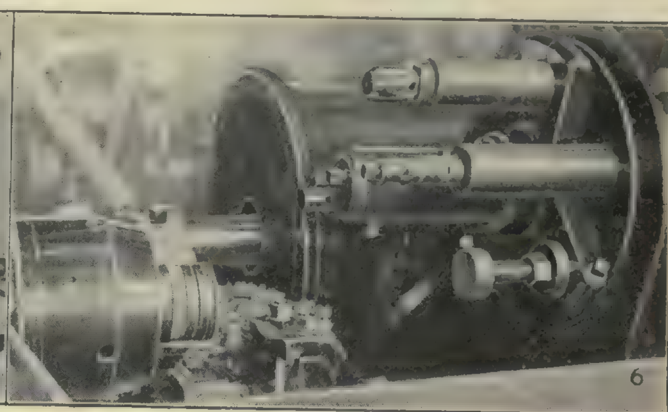


FIG. 6. FINISHING THE BASE ON A CLEVELAND AUTOMATIC SCREW MACHINE

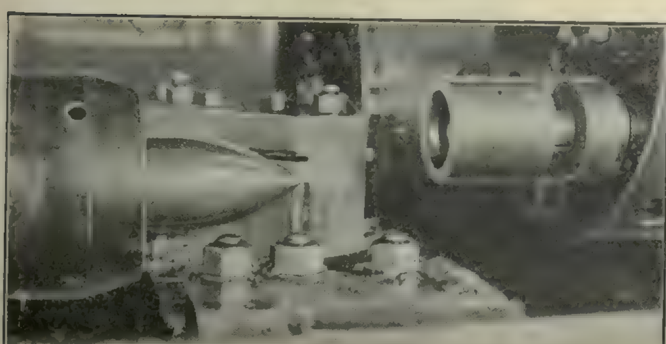


FIG. 7. ROUGH-FORMING AND FINISHING THE POINT AND BOURRELET ON AN AUTOMATIC

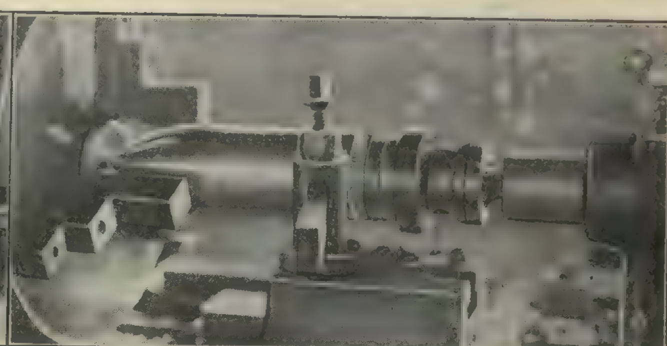


FIG. 8. FINISHING THE BODY, WITH CASE HELD BETWEEN SPECIAL CENTERS

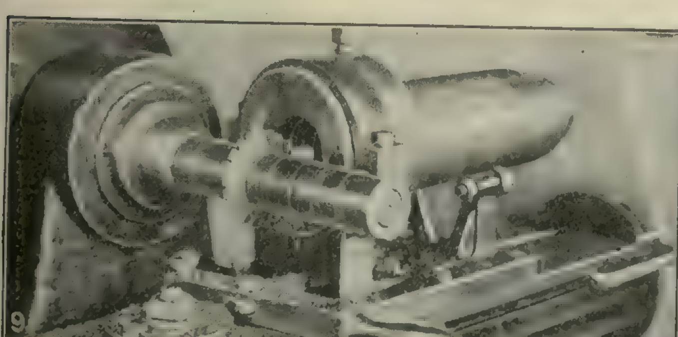


FIG. 9. NOTCHING THE BASE ON A HAND MILLER FITTED WITH SPECIAL FIXTURE

FIG. 10. BORING THE INTERIOR ON A LATHE USING COMMON BORING TOOL

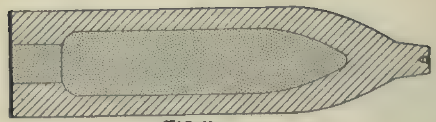
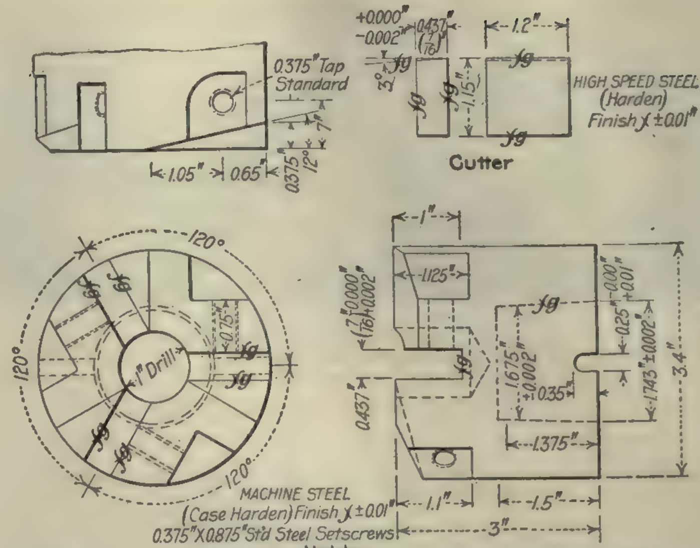


FIG. 11



Holder
FIG. 13

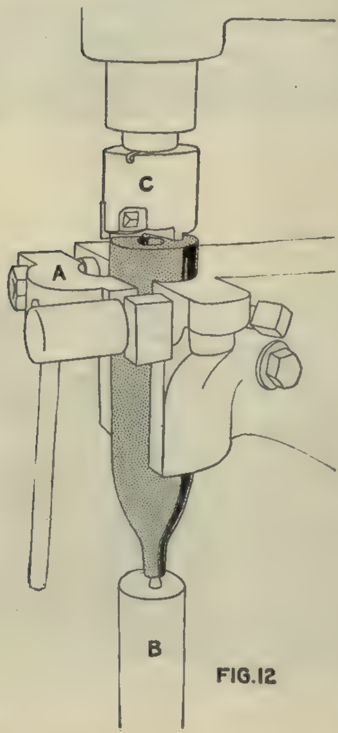
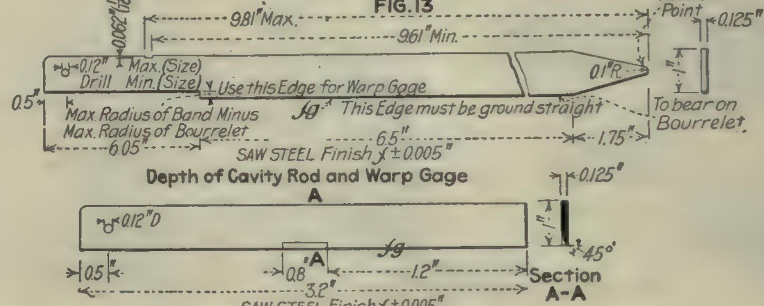


FIG. 12



Depth of Cavity Rod and Warp Gage

Cross Bar (Depth of Cavity Rod)

OPERATION I FIG. 14

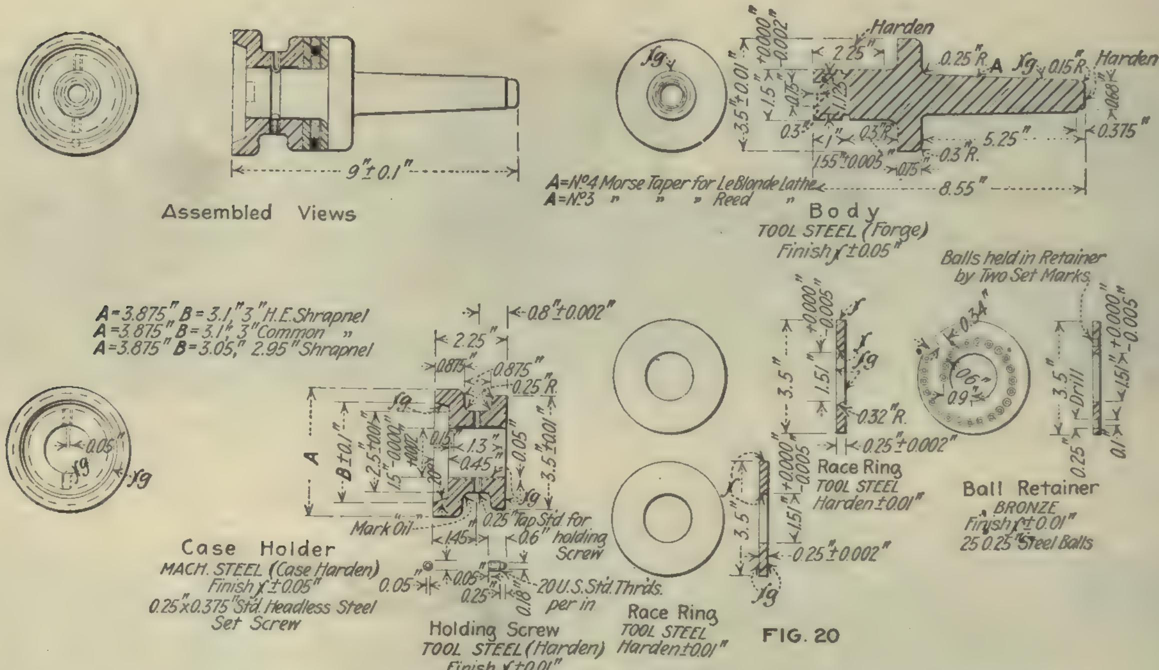


FIG. 20

OPERATION 1. ROUGH-FACE BASE

Transformation—Fig. 11. Machine Used—Prentice upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Table knee clamp, Fig. 12-A; bed-plate center, Fig. 12-B. Cutting Tools—Facing cutter with inserted blades, Figs. 12-C and 13. Cut Data—Spindle runs 65 r.p.m. Coolant—None. Average Life of Tool Between Grindings—About ½ day. Gages—Depth of cavity, Fig. 14. Production—400 per 8 hr. Note—Operator must face base close to the maximum limit to allow for finish.

OPERATION 2. CENTER

Transformation—Fig. 15. Machine Used—Reed 18-in. lathe, Fig. 3. Number of Operators per Machine—One. Work-Holding Devices—Steadyrest; three-jaw universal chuck. Tool-Holding Devices—Turret toolholder; Fig. 16. Cutting Tools—Rough-centering tool, Fig. 16-A; centering reamer, Fig. 16-B. Cut Data—170 r.p.m. Coolant—None. Average Life of Tool Between Grindings—About 2 days. Gages—None. Production—400 per 8 hr.

OPERATION 3. ROUGH-TURN POINTS

Transformation—Fig. 17. Machine Used—Le Blond 17-in. lathe, Fig. 4. Number of Operators per Machine—One. Work-Holding Devices—Drive dog and centers; red lead on tail center. Tool-Holding Devices—Toolpost. Cutting Tools—Lathe turning tool. Number of Cuts—Cuts off scale and cleans up entire point. Cut Data—95 r.p.m. Coolant—None. Gages—None. Production—200 per 8 hr.

tracers. The weight of the complete projectile is divided as follows:

	Lb.
Shell (empty), steel	12.355
Band, copper	0.15
Fuse	1.38
Base cover (complete)	0.215
Trinitrotoluol	0.9
Total weight	15 ±0.15

LIST OF OPERATIONS ON THE CASE

1. Rough-face base
2. Center
3. Rough-turn point
4. Rough-turn body
5. Finish-machine base
6. Finish point
7. Finish-turn body
8. Notch base
9. Bore interior
10. Rough base-cover groove
11. Finish base-cover groove
12. Assemble band
13. Turn band on lathe
13-A. Turn band on special machine
14. Resize threads and counterbore; inspect all over
15. Sandblast
16. Hydraulic test

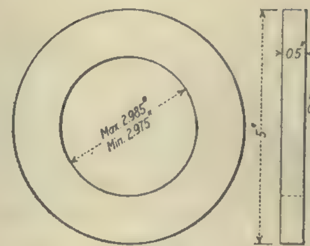


FIG. 39

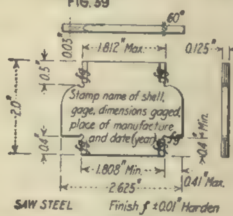


FIG. 40

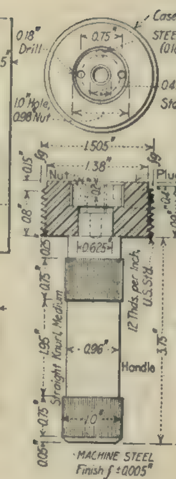


FIG. 41

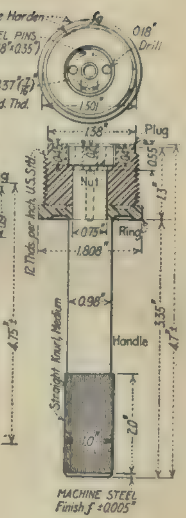


FIG. 42

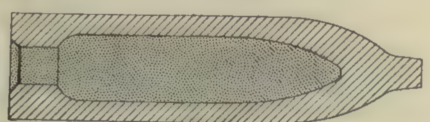
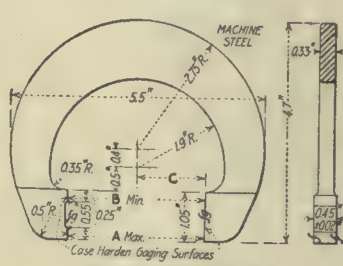


FIG. 15



PART	A	B	C
Band Seat	2.87	2.86	1.43
Body	2.98	2.965	1.5
Bourrelet	2.99	2.985	1.5
Rear of Band	2.985	2.975	1.5

FIG. 43

OPERATION 5

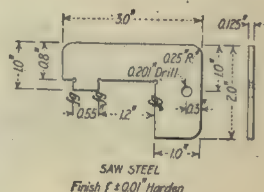


FIG. 44

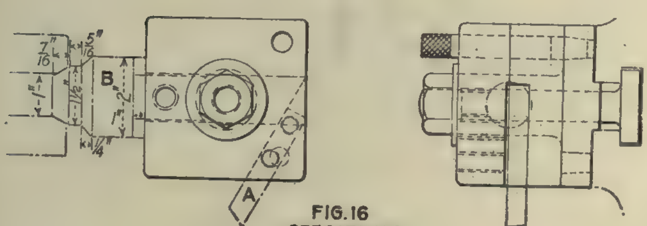


FIG. 16
OPERATION 2

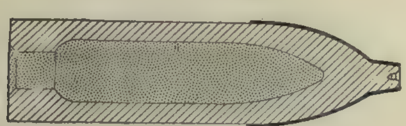


FIG. 17, OP. 3

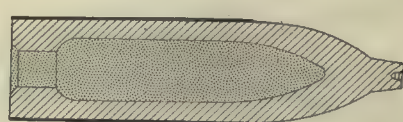
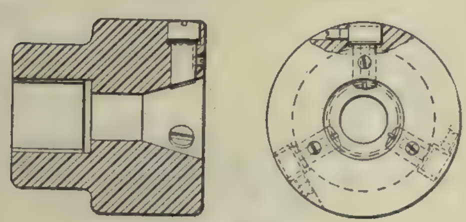
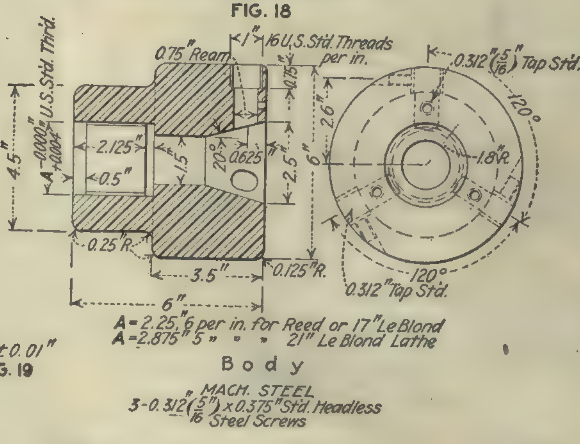


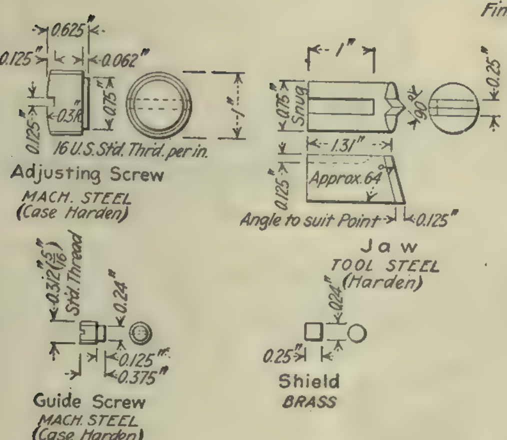
FIG. 18



Assembled Views



Finish f ±0.01"
FIG. 19



OPERATION 4

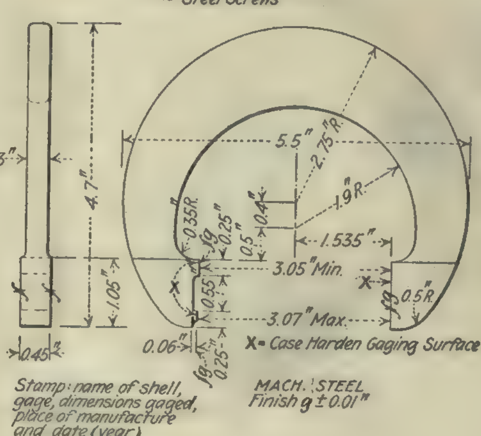


FIG. 21

The rough-facing of the base is done in a drilling machine fitted with a special cutter and holding fixture, as shown in Fig. 12. The point of the case rests on a centering block, and the body is held in a clamping device. The amount faced off the base is determined by the depth of the cavity, a depth gage being used to indicate this. The tool head is fitted with high-speed steel cutters that are easily reground when dull. When centering the base, the inside edge is first trued up with a single roughing tool; and then the centering reamer and counterbore is run in as shown in Figs. 3 and 16.

Roughing the point consists mainly in turning it to approximate shape, care being taken to get under the scale all around. It will be observed that the case here is held on the tail center, yet no mention has been made of the centering of the point. This will be understood when it is explained that the point is centered by the company that makes the forgings, in order to rough down the outside concentric with the cavity. The body is roughed off in a lathe as shown in Fig. 5, the point being held and driven by a special chuck, Fig. 19; and the base is held on a revolving center, Fig. 20. A standard high-speed turning tool is used for the cut.

OPERATION 4. ROUGH-TURN BODY

Transformation—Fig. 18. Machine Used—Le Blond 17-in. lathe, Fig. 5. Number of Machines per Operator—Two. Work-Holding Devices—Special drive chuck, Fig. 19; revolving plug center. Tool-Holding Devices—Tool post. Cutting Tools—Lathe turning tool. Number of Cuts—One. Cut Data—0.040 in. feed, $\frac{1}{16}$ to $\frac{1}{8}$ in. cut, 60 ft. surface speed, 70 r.p.m. Coolant—None. Average Life of Tool Between Grindings—15 pieces. Gages—Combination snap, Fig. 21. Production—200 per 8 hr.

OPERATION 5. FINISH-MACHINE BASE

Transformation—Fig. 22. Machine Used—Cleveland $3\frac{1}{4}$-in. automatic, Fig. 6. Number of Machines per Operator—Three. Work-Holding Devices—Split collet chuck. Tool-Holding Devices—Holder for combination reamer and counterbore, Fig.

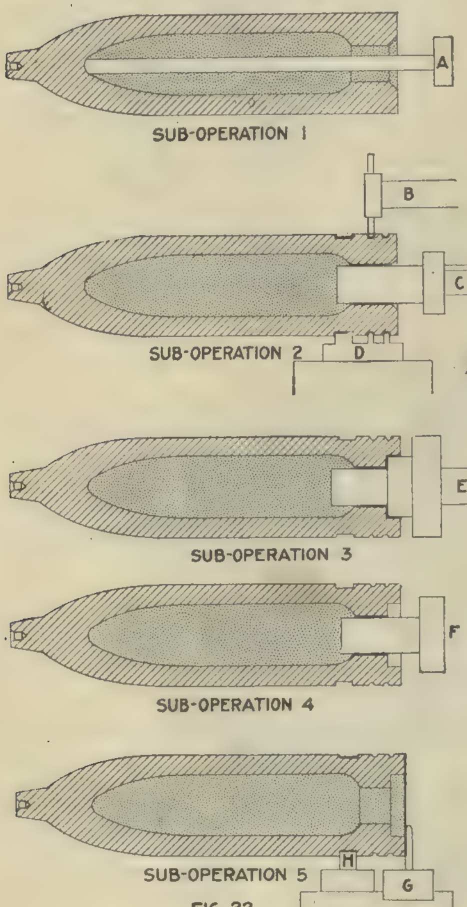


FIG. 22

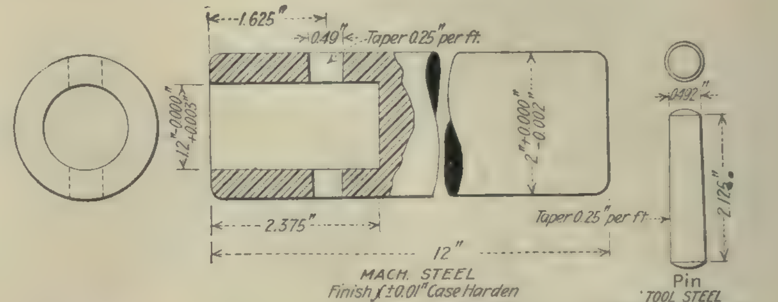


FIG. 23

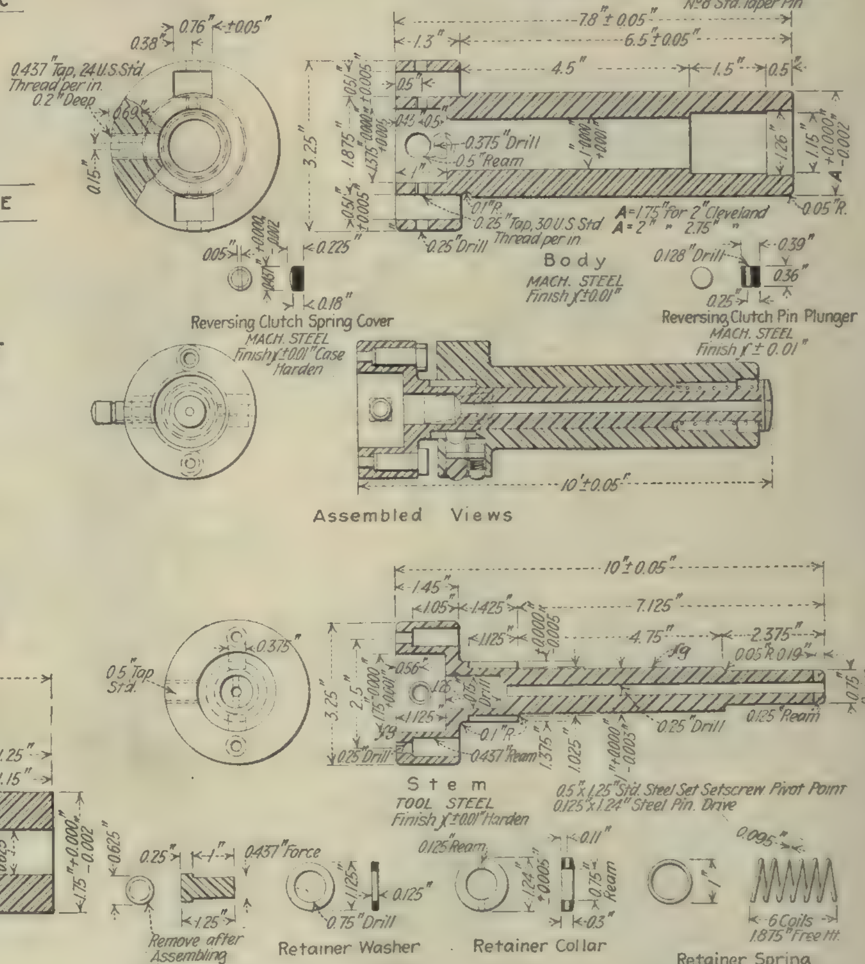


FIG. 24

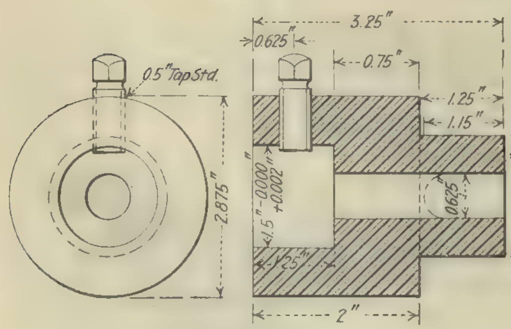


FIG. 25

OPERATION 5

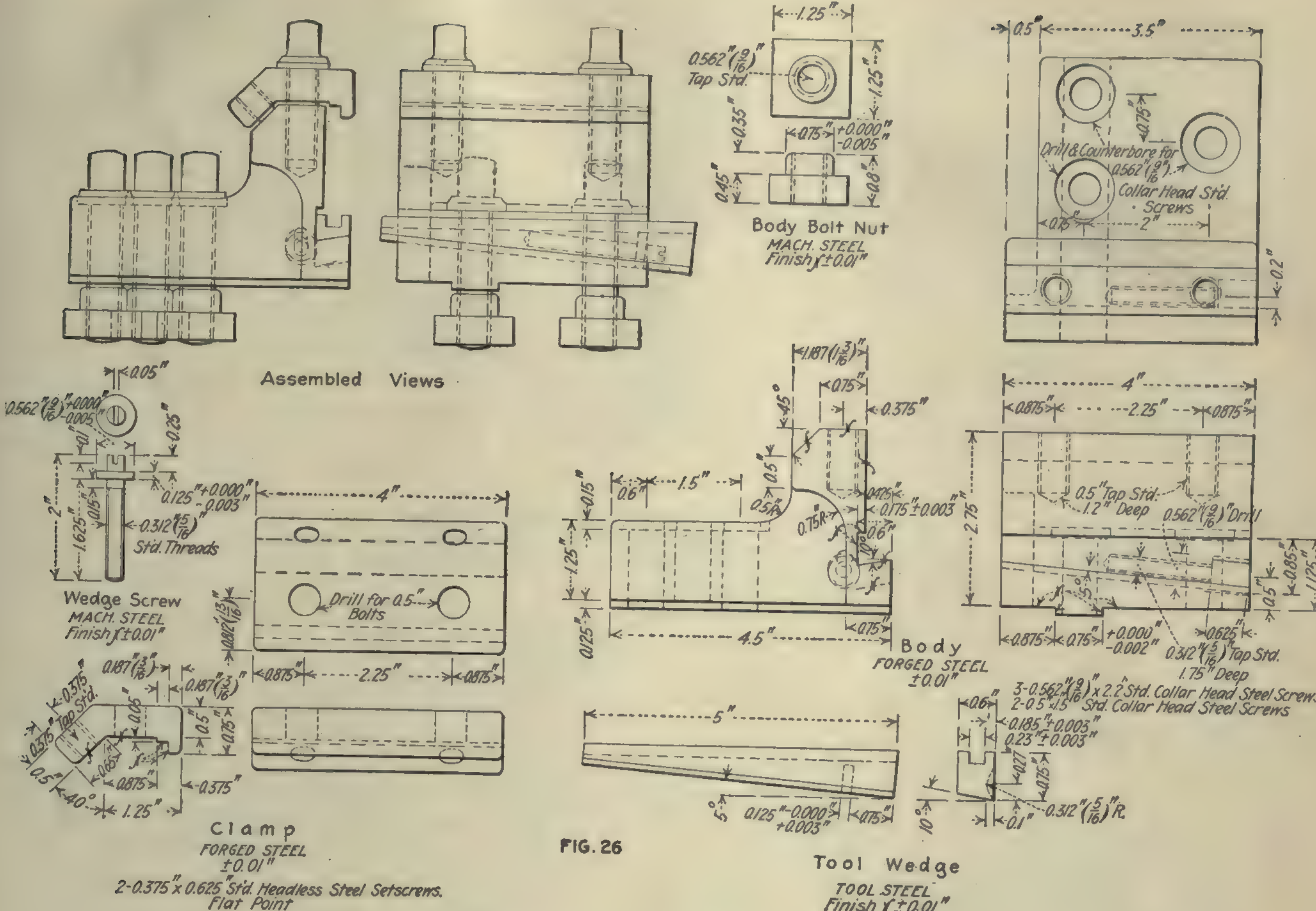


FIG. 26

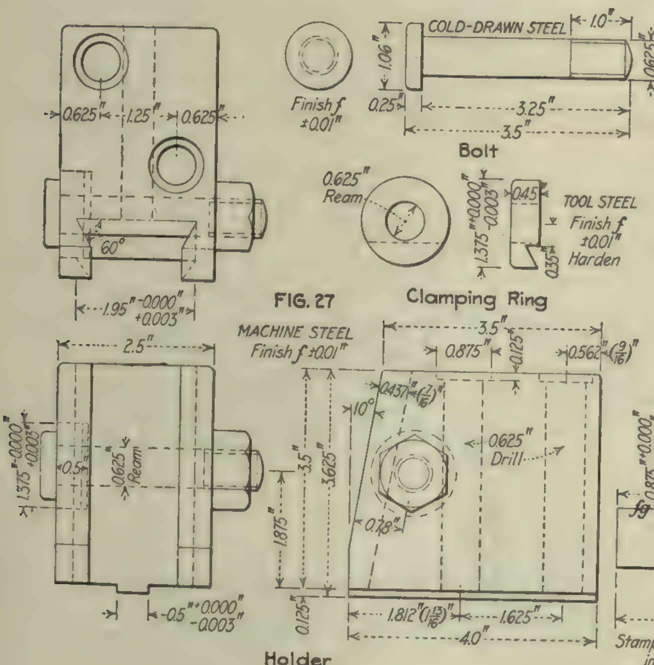


FIG. 27

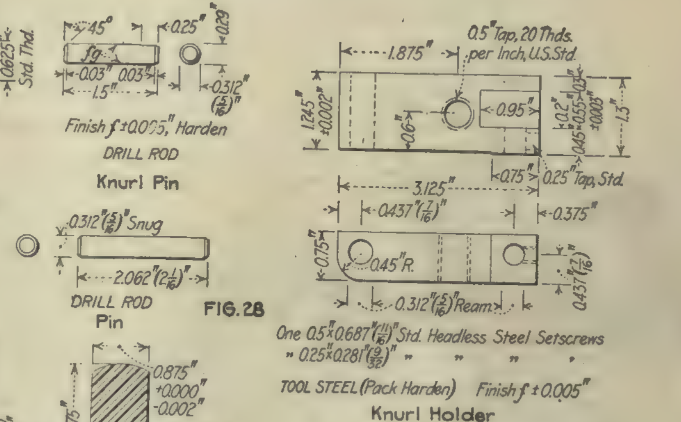


FIG. 28

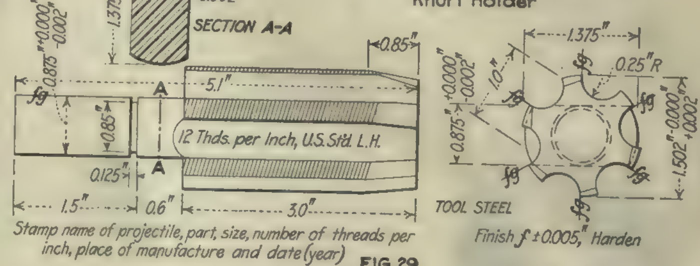


FIG. 29

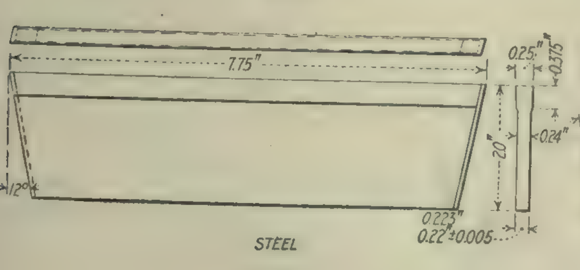


FIG. 30

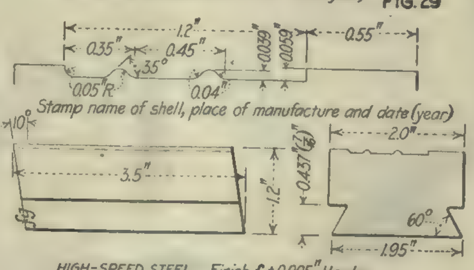


FIG. 31

OPERATION 5

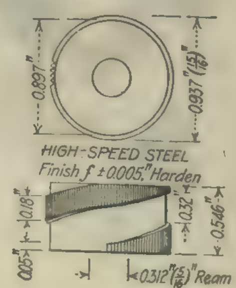


FIG. 32

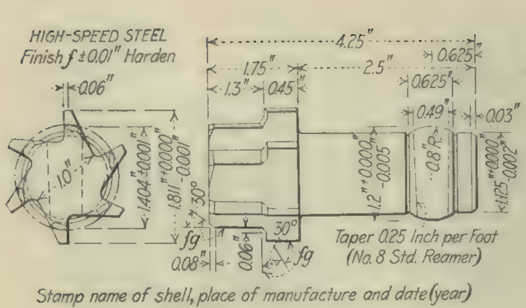


FIG. 33

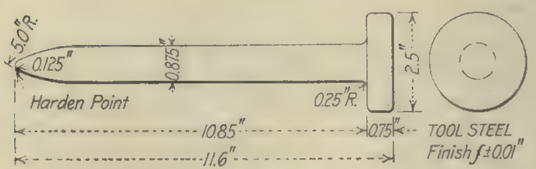
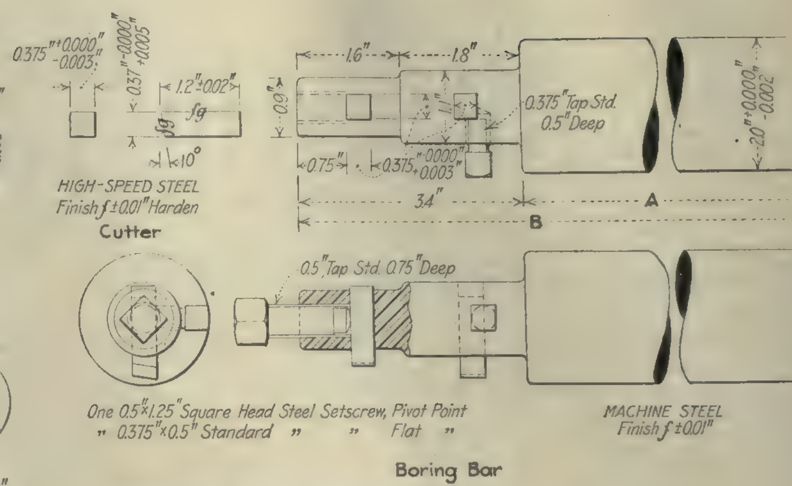


FIG. 36



A	B	NAME OF MACHINE
11.5±0.1	14.9±0.1	FOR 3.25 CLEV. AUTO. MACH.
6.25±0.1	9.65±0.1	FOR POTTER & JOHNSON

FIG. 34

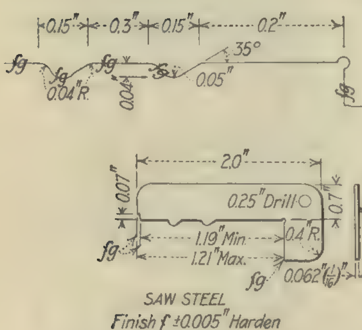


FIG. 37

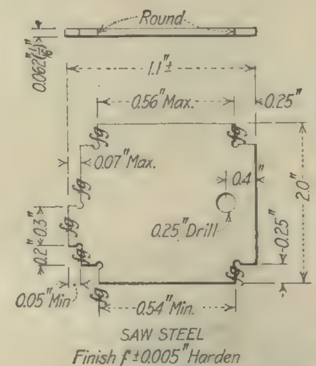
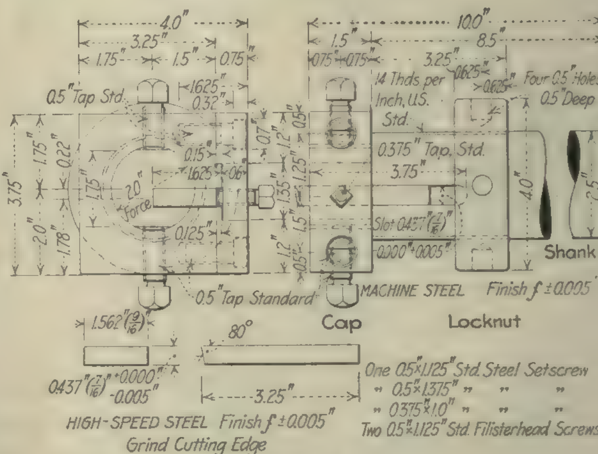


FIG. 38



OPERATION 5

FIG. 35

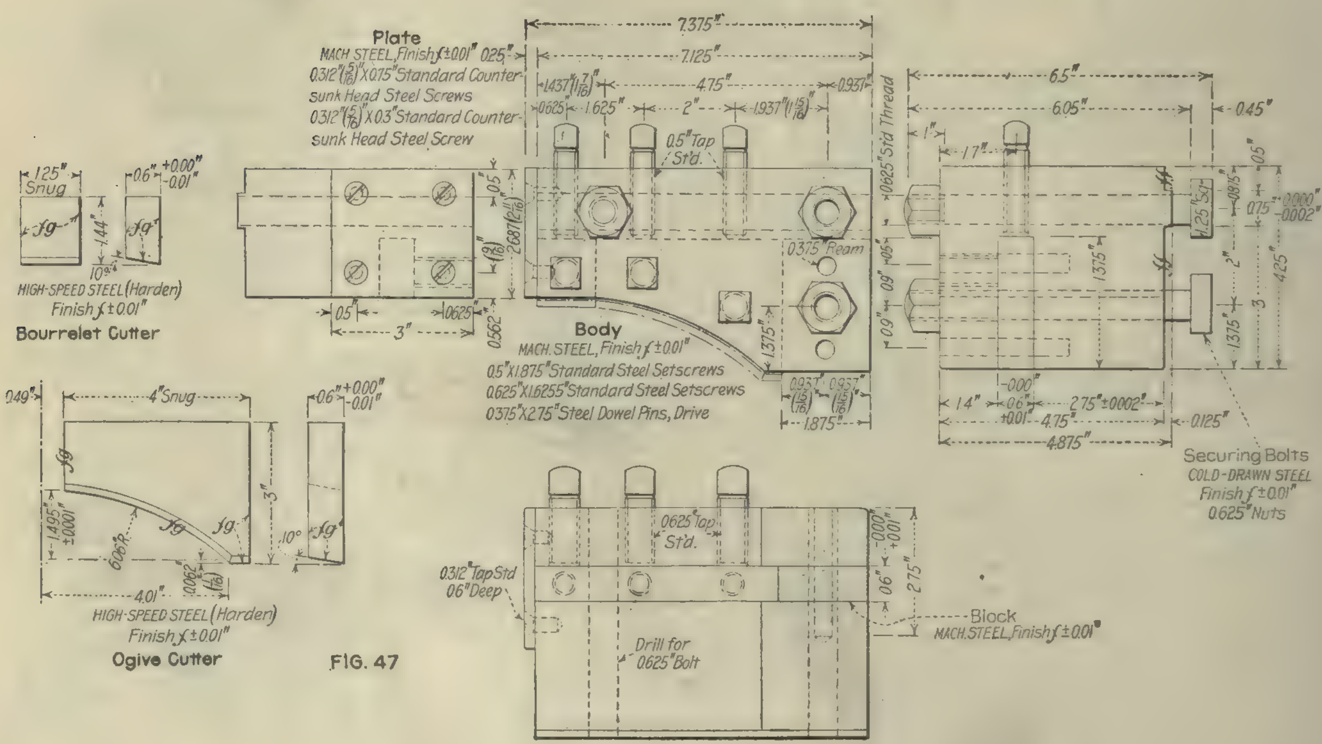


FIG. 47

OPERATION 6

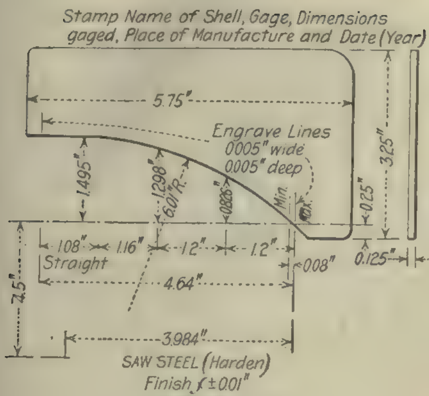


FIG. 48

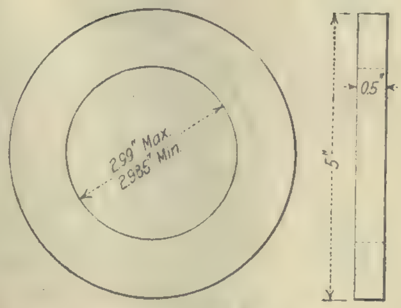


FIG. 49
OPERATION 6

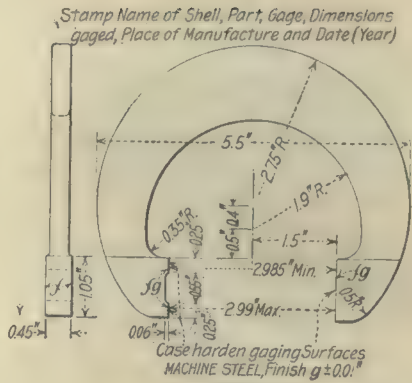


FIG. 50

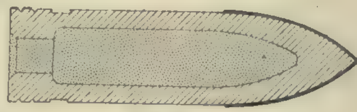


FIG. 45

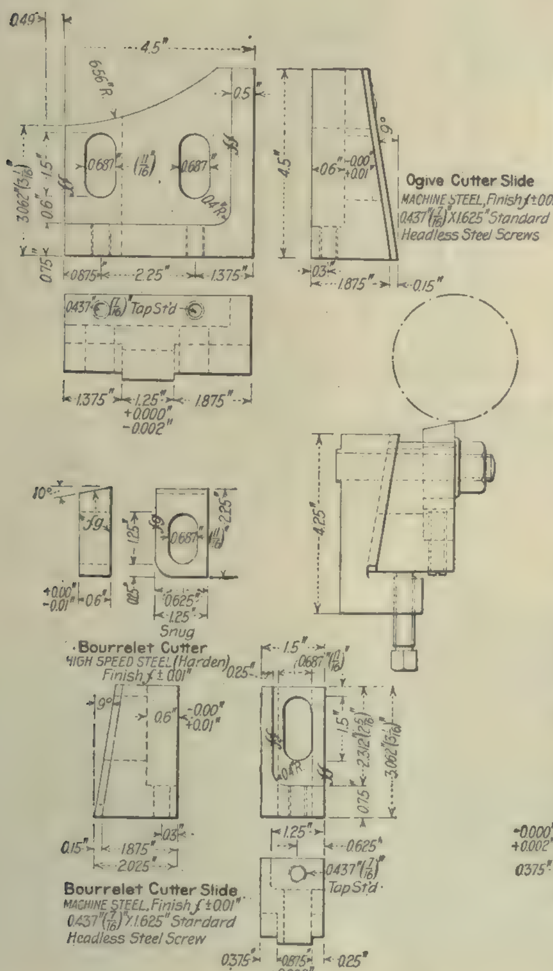
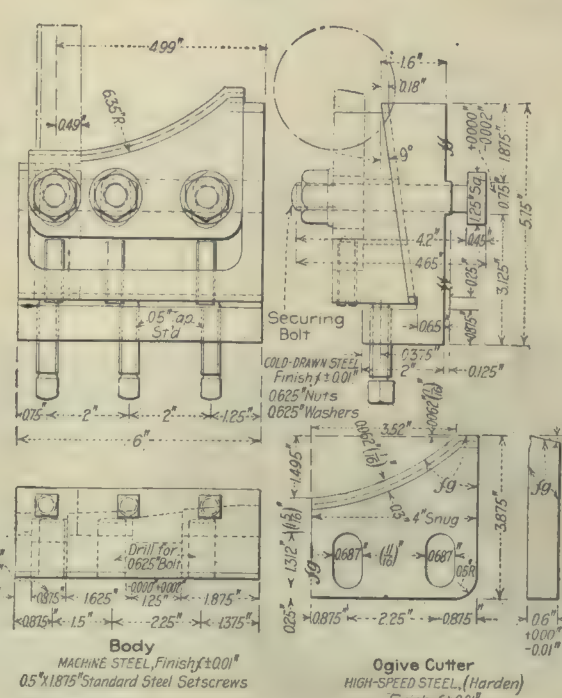



FIG. 46
OPERATION 6

23; tap holder, Fig. 24; tap-holder adapter, Fig. 25; cutoff toolholder, Fig. 26; form tool holder, Fig. 27; knurl holder, Fig. 28. Cutting Tools—Tap, Fig. 29; cutoff tool, Fig. 30; form tool for band seat and groove, Fig. 31; knurl, Fig. 32; counterbore, Fig. 33; boring tool, Fig. 34; facing tool, Fig. 35. Cut Data—80 r.p.m. Coolant—Zurn cutting oil, ¾-in. diameter stream. Average Life of Tool Between Grindings—Tap, 3 or 4 days; forming tool, 1 day; reamer, 3 or 4 days; cutoff, ½ day; other tools, 2 days. Special Fixtures—Stop in pusher tube; pusher stop, Fig. 36. Gages—Depth of cavity, Fig. 14; position of band and grooves, Fig. 37; band-seat width and depth, Fig. 38; maximum ring, rear of band, Fig. 39; minimum ring, rear of band, Fig. 39; diameter and depth of fuse-flange seat, Fig. 40; maximum thread plug, Fig. 41; minimum diameter of thread and eccentric of counterbore, Fig. 42; combination snap-band seat, Fig. 43; position and width of band seat, Fig. 44. Production—32 per 8 hr. per machine.

OPERATION 6. FINISH POINT

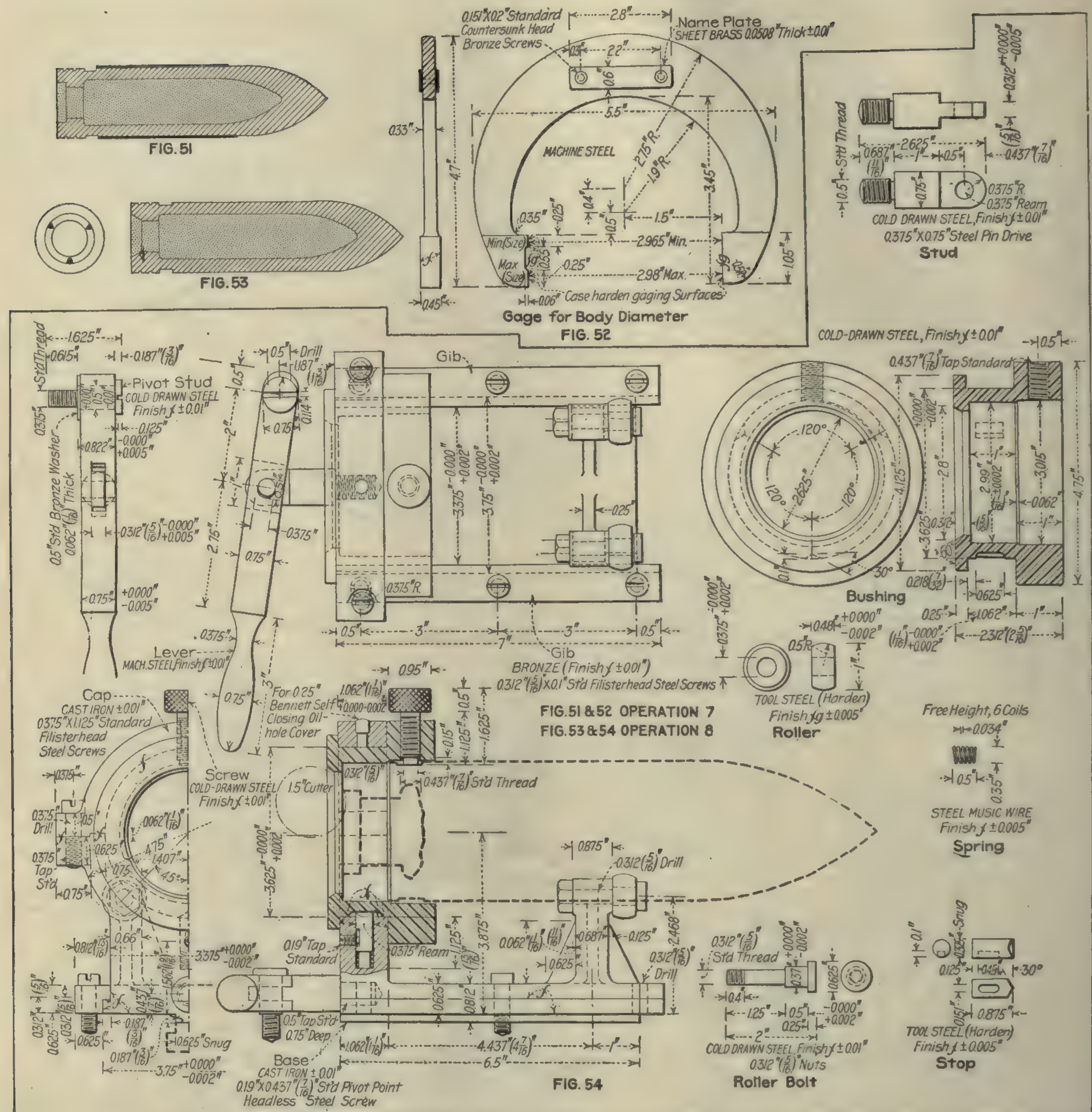
Transformation—Fig. 45. Machine Used—Cleveland 3¼-in. automatic, Fig. 7. Number of Machines per Operator—Two. Work-Holding Devices—Split chuck. Tool-Holding Devices—Roughing toolholder, Fig. 46; finishing toolholder, Fig. 47. Cutting Tools—Tool for roughing ogive, Fig. 46; tool for roughing bourrelet, Fig. 46; tool for finishing ogive, Fig. 47; tool for finishing bourrelet, Fig. 47. Number of Cuts—Two, roughing and finishing. Cut Data—50 ft. surface speed, 57 r.p.m. Coolant—Zurn cutting oil. Average Life of Tool Between Grindings—60 pieces. Special Fixtures—Pusher stop; spring stop. Gages—Profile, Fig. 48; maximum diameter of bourrelet ring, Fig. 49; minimum diameter of bourrelet ring, Fig. 49; combination snap bourrelet diameter, Fig. 50. Production—64 per 8 hr. per machine.

OPERATION 7. FINISH-TURN BODY

Transformation—Fig. 51. Machine Used—Reed 18-in. lathe, Fig. 8. Number of Operators per Machine—One. Work Holding Devices—Universal three-jaw chuck, with extension jaws. Cutting Tools—Lathe turning tool. Number of Cuts—One. Cut Data—125 ft. surface speed; 150 r.p.m.; 0.045 in. depth of cut; 0.024 in. feed; total length of cut, 5½ in. Coolant—None. Average Life of Tool Between Grindings—20 pieces. Special Fixtures—Revolving center; center plug in spindle. Gages—Combination snap-body diameter, Fig. 52. Production—200 per 8 hr.

OPERATION 8. NOTCH BASE

Transformation—Fig. 53. Machine Used—Brown & Sharpe hand miller, Fig. 9. Number of Operators per Machine—One. Work-Holding Devices—Fixture, Fig. 54. Tool-Holding Devices—Arbor. Cutting Tools—Cutter, standard 60 deg., 2.75 in. in diameter, 0.5 in. thick, 22 teeth. Number of Cuts—Three. Cut Data—Cutter runs 370 r.p.m. Coolant—None. Gages—None. Production—600 per 8 hr.



Automatic machines like the one in Fig. 6 are used to finish-machine the base. The interior is rough-bored, counterbored, tapped and the end faced. While these operations are going on, the form tool for the band seat does its work, and the bottom of the groove is knurled with a knurling tool carried in the front tool block.

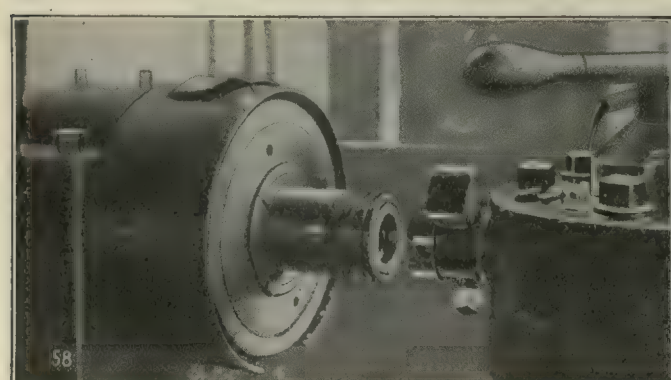
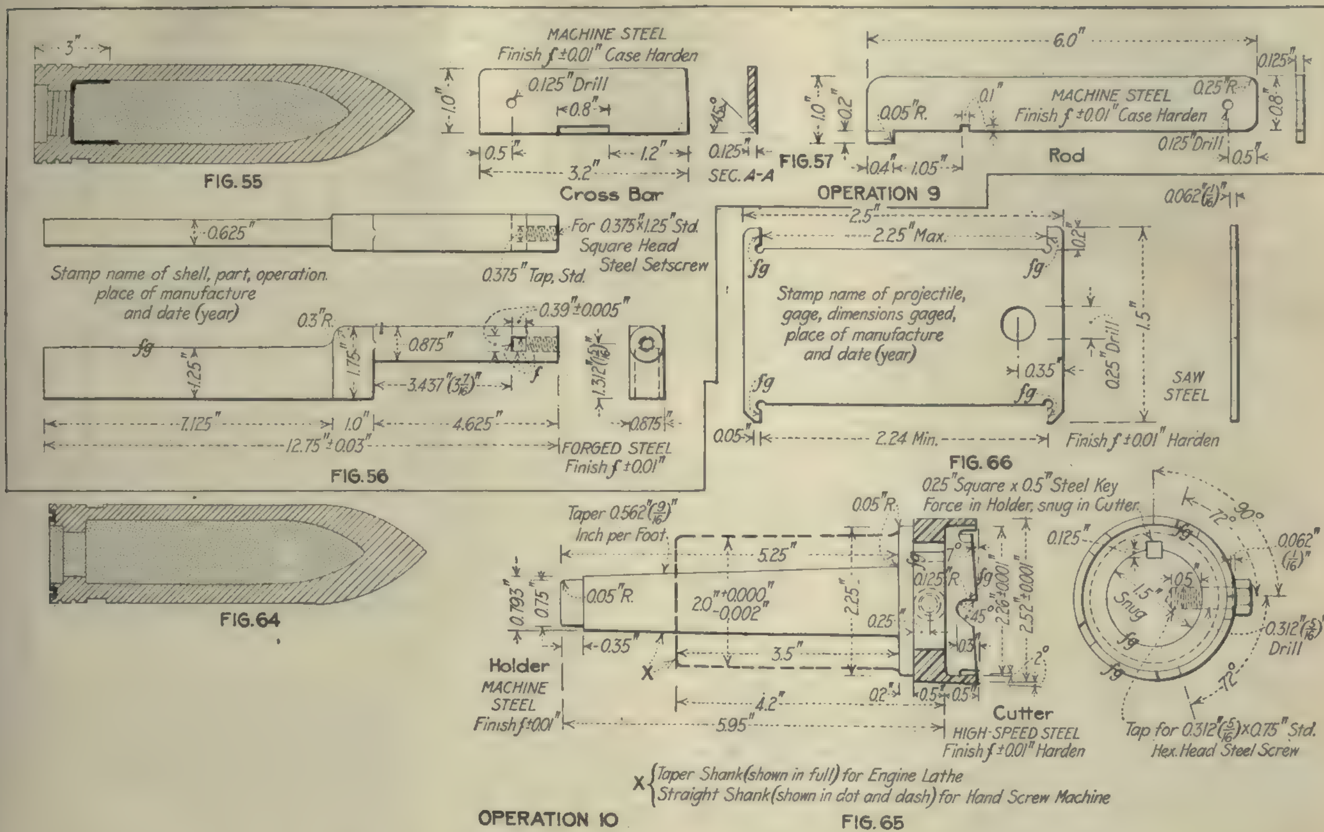


FIG. 58. ROUGHING BASE-COVER GROOVE

FIG. 59. FINISHING BASE-COVER GROOVE



OPERATION 9. BORE INTERIOR

Transformation—Fig. 55. Machine Used—Reed 18-in. lathe, Fig. 10. Number of Operators per Machine—One. Work-Holding Devices—Universal 10-in. three-jaw chuck; steadyrest. Tool-Holding Devices—Toolholder, boring bar, Fig. 56. Cutting Tools—Cutter for boring bar. Cut Data—150 r.p.m. Coolant—None. Average Life of Tool Between Grindings—30 pieces. Gages—Maximum and minimum length of thread, Fig. 57. Production—160 per 8 hr.

OPERATION 10. ROUGH BASE-COVER GROOVE

Transformation—Fig. 64. Machine Used—Bardons & Oliver turret lathe, Fig. 58. Number of Operators per Machine—One. Work-Holding Devices—Set collet pads, 3 in. in diameter. Tool-Holding Devices—Holder for cutter. Cutting Tools—Circular roughing cutter, Fig. 65. Cut Data—115 r.p.m., 50 ft. cutting surface speed. Coolant—None. Average Life of Tool Between Grindings—60 pieces. Gages—Diameter of groove, Fig. 66. Production—240 per 8 hr.

FIG. 60. BAND-ASSEMBLING GROUP

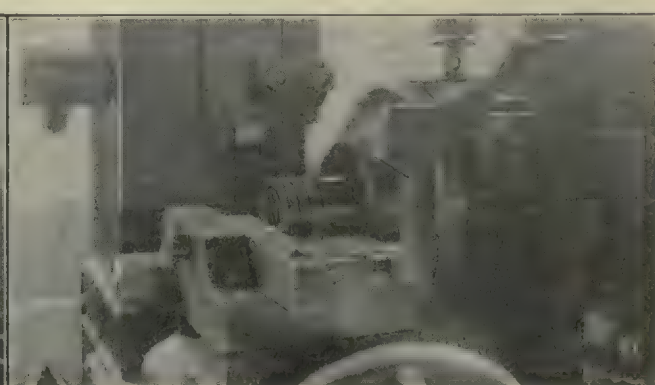


FIG. 61. SPECIAL BAND-TURNING MACHINE

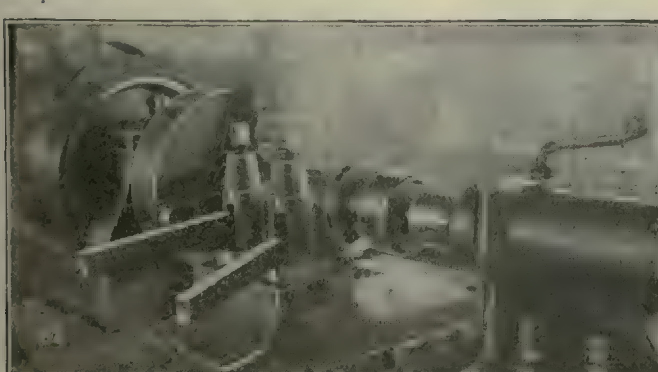


FIG. 62. TURNING BANDS IN A LATHE

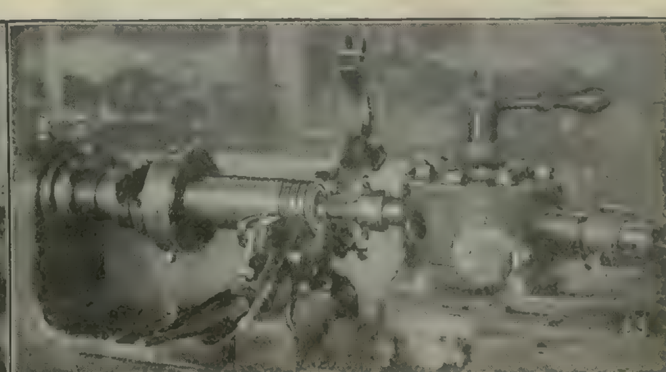


FIG. 63. RESIZING THREADS AND COUNTERBORE

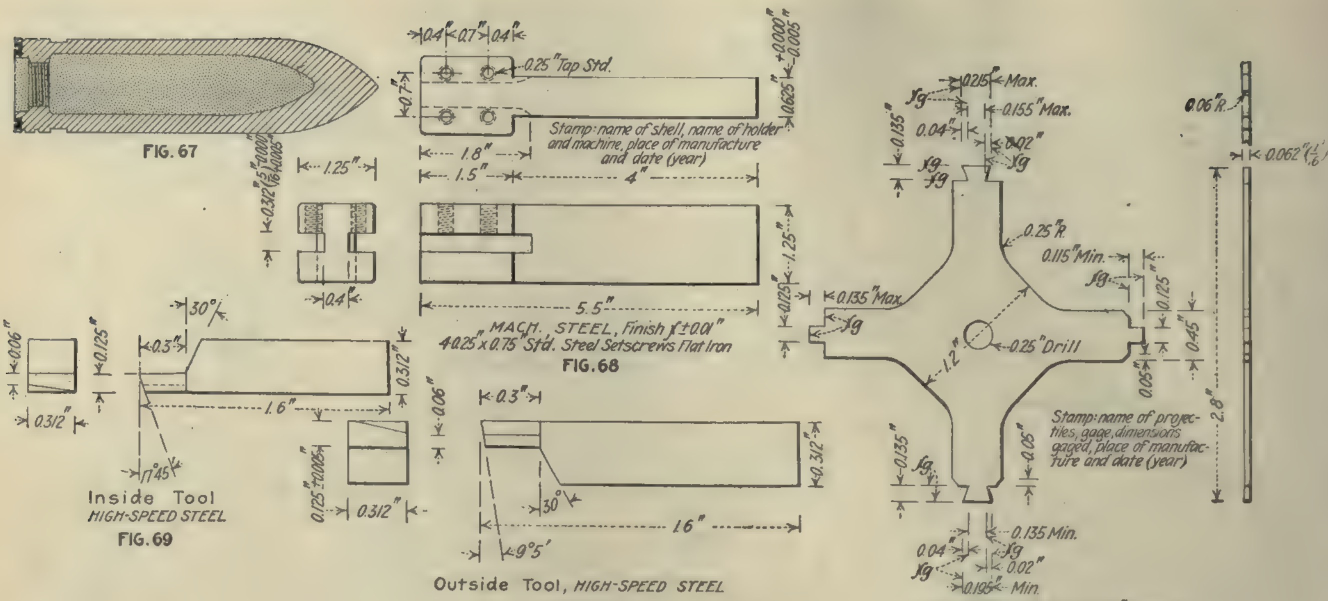


FIG. 67 FIG. 68 FIG. 69 FIG. 70 FIG. 71

OPERATION 11

From this machine the cases go to an automatic, Fig. 7, where the point and the bourrelet are roughed and finished with similar tools carried in tool blocks on opposite ends of the same cross-slide.

In finish-turning the body, it is held in a lathe just the reverse of that in the rough-turning, as shown in Fig. 8. The point rests in a centering plug in the spindle, and the base is held in a special revolving center.

The base-notching fixture is shown in Fig. 9. The shell is held in a collar into which it is locked by means of a setscrew. The outer end is supported by two rollers. As the cutter runs, the operator works the feed lever with one hand and indexes the shell with the other. These notches are cut so that the fuse can be locked in place after it is screwed home.

For the purpose of boring the interior the shell is chucked base out in a universal three-jawed chuck, with the outer end in a steadyrest, as shown in Fig. 10. A strip of tin is wrapped around the shell where the chuck jaws grip, in order to give them a better hold and not mar

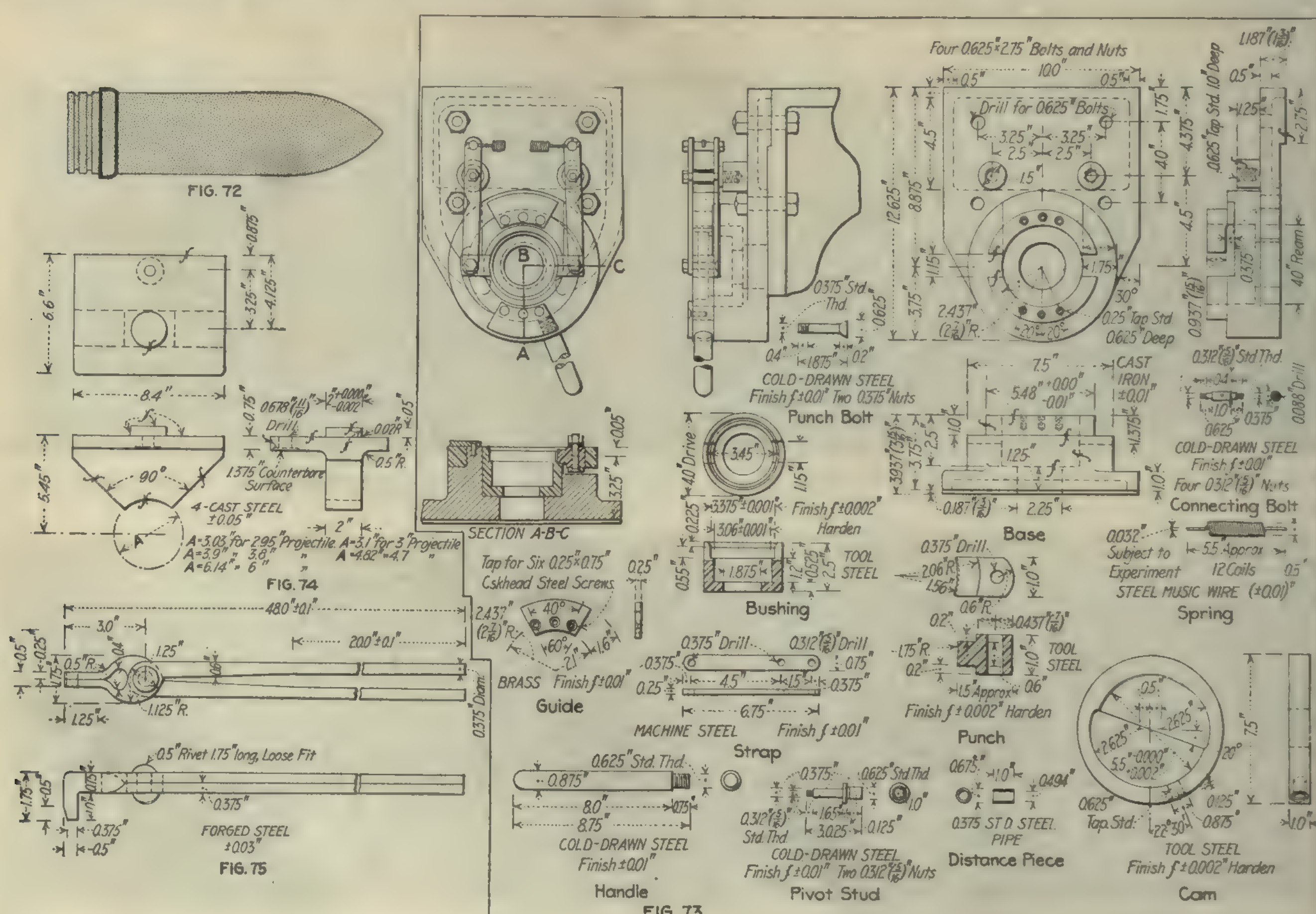


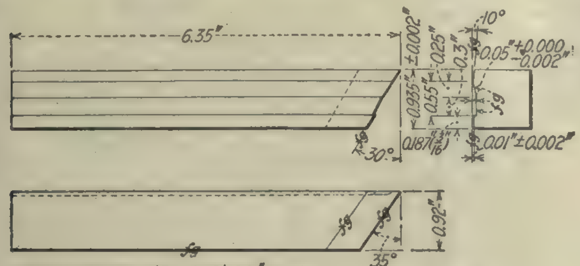
FIG. 72 FIG. 74 FIG. 75 FIG. 73

OPERATION 12

the work. The boring bar is of the ordinary type with a single-point cutter. The inside of the shell is trued up for about 3 in. from the outer end, and the length of thread shoulder is machined back from the inside to the required distance.

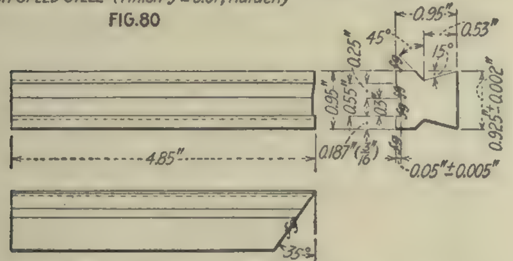
The base-cover groove is first roughed out with a circular cutter, Fig. 58, the shell being held in a collet chuck. From this machine the shell goes to the one shown in Fig. 59, where the groove is dovetailed and finished to correct dimensions.

The work on the copper rotating bands is the same on both the common and the shrapnel shells. The outfit used in assembling the bands to the shell case is shown in Fig. 60. The bands are placed in the furnace at the left by means of a long rod, about a dozen or more being handled at a time. The bands are heated to a low red heat; then one is seized with a pair of tongs and placed in a locating fixture in the arbor press. A shell is then set in and pressed down until the band is on a line with the groove. It is lightly pressed in and passed to the hydraulic banding press, where the band is forced securely into the groove.



HIGH-SPEED STEEL (Finish f ± 0.01", Harden)

FIG. 80



HIGH-SPEED STEEL (Finish f ± 0.01", Harden)

FIG. 81

OPERATION 13a

OPERATION 11. FINISH BASE-COVER GROOVE

Transformation—Fig. 67. Machine Used—Flather 16-in. lathe, Fig. 59. Number of Operators per Machine—One. Work-Holding Devices—Universal lathe chuck, 9 in.; steady-rest. Tool-Holding Devices—Tool holder, Fig. 68; tool post. Cutting tools—Inside tool, Fig. 69; outside tool, Fig. 70. Cut Data—150 r.p.m. Gages—Diameter of groove, Fig. 66; depth and width of groove, Fig. 71. Production—160 per 8 hr.

OPERATION 12. ASSEMBLE BAND

Transformation—Fig. 72. Machine Used—Banding press, furnace arbor press, Fig. 60. Number of Operators per Operation—Two. Pressure Required—1300 lb. Special Fixtures—Fixture to locate band in groove, Fig. 73; set of banding dies, Fig. 74; tongs, Fig. 75; bar for bands. Gages—None. Production—150 per hr. Note—First operator puts about 40 bands on a bar and inserts in furnace; when the bands are at red heat, the operator takes one out with tongs and drops into arbor-press fixture, then drops in shell butt first, slightly compresses band and passes shell to man at banding machine, who finishes the operation.

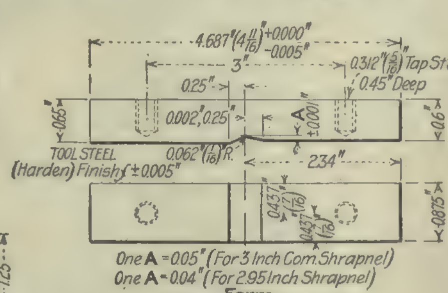
OPERATION 13. TURN BAND ON LATHE

Transformation—Fig. 76. Machine Used—Reed 18-in. lathe, Fig. 62. Number of Operators per Machine—One. Work-Holding Devices—Universal 9-in. three-jaw chuck. Tool-Holding Devices—Two tool posts. Cutting Tools—Standard band-turning tool; standard band-facing tool; 10-in. mill file. Number of Cuts—Two, forming and facing. Cut Data—330 r.p.m., 320 ft. surface speed. Average Life of Tool Between Grindings—About ½ day. Special Fixtures—Revolving center; form, Fig. 77; form holder, Fig. 77; form follower, Fig. 77. Gages—Band profile, Fig. 78; maximum diameter of band ring, Fig. 79; minimum diameter of band ring, Fig. 79. Production—400 per 8 hr. Note—Band is profile turned, faced, and then smoothed with file.

OPERATION 13-A. TURN BAND ON SPECIAL MACHINE

Transformation—Fig. 76. Machine Used—Fig. 61. Number of Machines per Operator—One. Cutting Tools—Roughing tool, Fig. 81; finishing tool, Fig. 80; end scraper for hand use on rest. Number of Cuts—Two. Cut Data—Spindle runs 145 r.p.m.; 120 ft. per min. surface speed. Special Fixtures—Outside swing bracket is a stop; front swing bracket is hand-scraper support. Gages—Same as operation 13. Production—750 per 8 hr.

FIG. 76



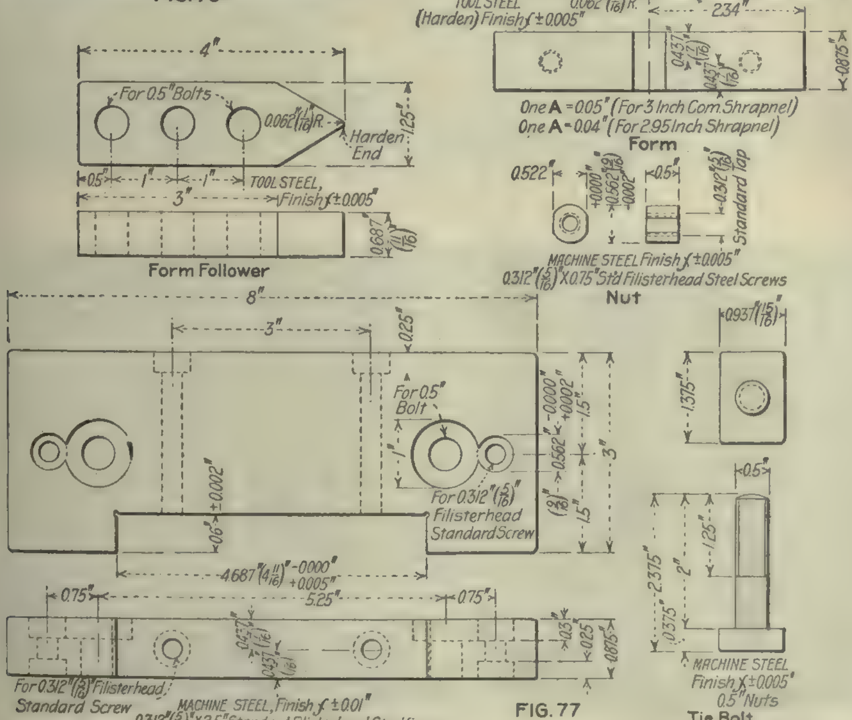


FIG. 77

OPERATION 13

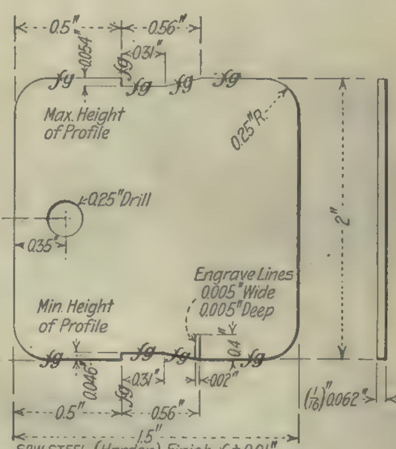


FIG. 78

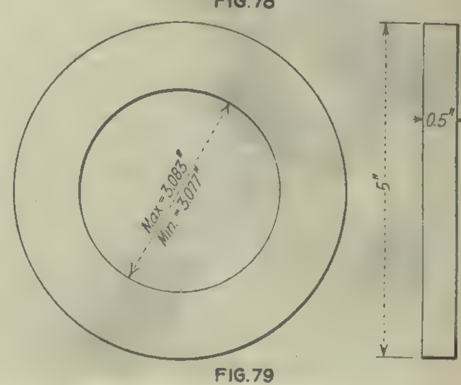


FIG. 79

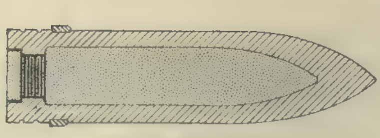


FIG. 82, OP. 14

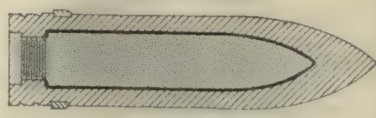


FIG. 89, OP. 15

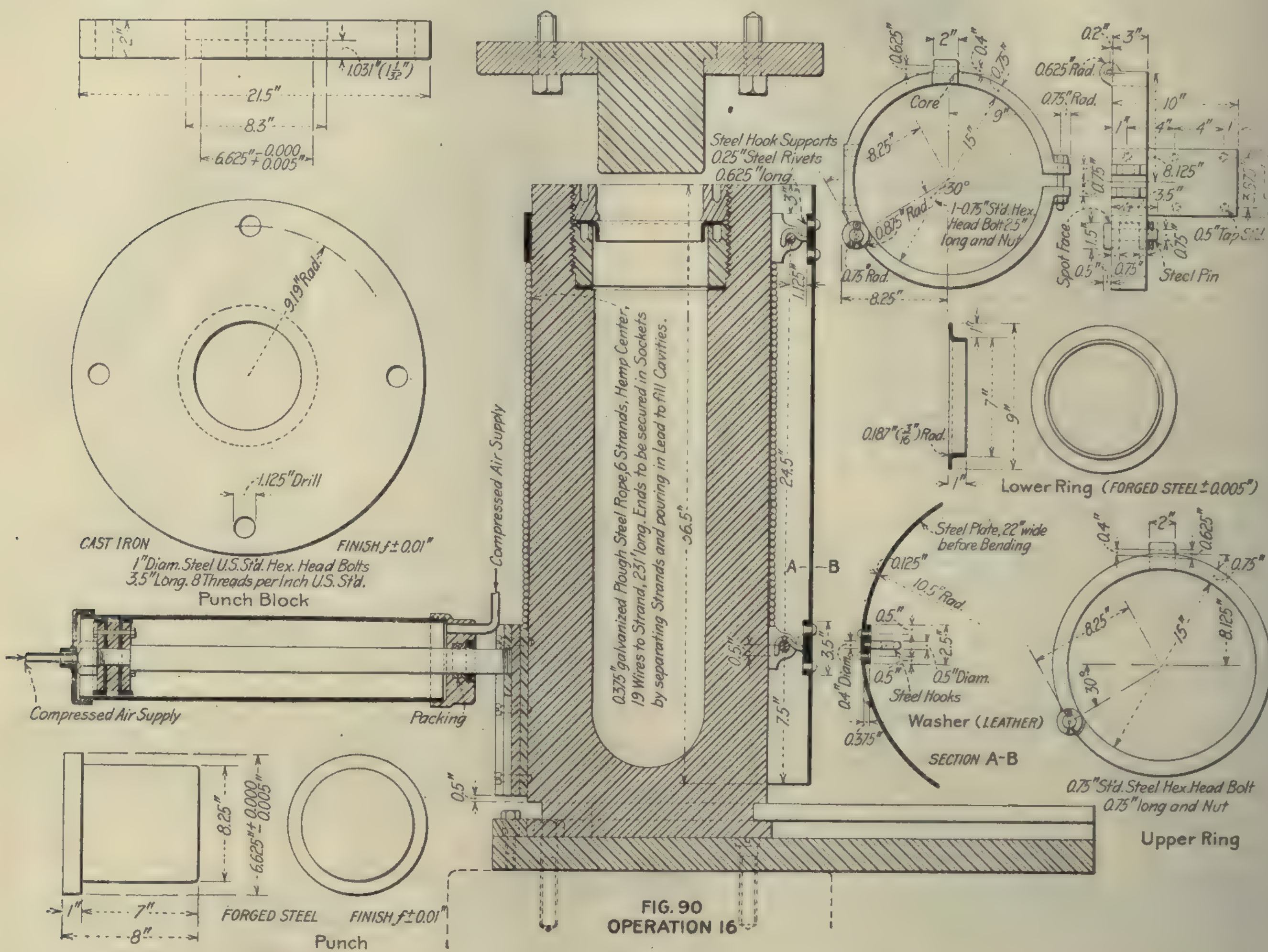


FIG. 90
OPERATION 16

OPERATION 14. RESIZE THREADS AND COUNTERBORE

Transformation — Fig. 82. Machine Used — Warner & Swasey turret lathe, Fig. 63. Number of Operators per Machine—One. Work-Holding Devices—Pot chuck; steady-rest. Cutting Tools—Boring tool; counterbore; tap. Cut Data—80 r.p.m. Coolant—Lubricated with lard oil put on with small brush. Gages—Thread gage and counterbore. Production—280 per 8 hr. Note—The shells are now inspected all over and divided into three weight classes: 12 lb. 1 oz. to 12 lb. 4 oz., 12 lb. 4 oz. to 12 lb. 8 oz., and 12 lb. 8 oz. to 12 lb. 12 oz.; these weights are then averaged in the loading process.

OPERATION 15. SANDBLAST

Transformation—Fig. 89. Number of Operators—One. Description of Operation—The operator lays a row of shells on the special bench, Fig. 83, with open ends out, pulls the hinged cover nearly down and thrusts the end of sandblast nozzle into hole in shell, sandblasting the interior to remove scale. Apparatus and Equipment Used—Paxson-Warren sandblast equipment, using No. 5½ chilled-steel shot, made by Globe Steel Co., Mansfield, Ohio; 80 lb. air pressure, with ⅜-in. diameter nozzle outlet. Gages—None. Production—3000 per 8 hr.

FIG. 83. SANDBLASTING APPARATUS

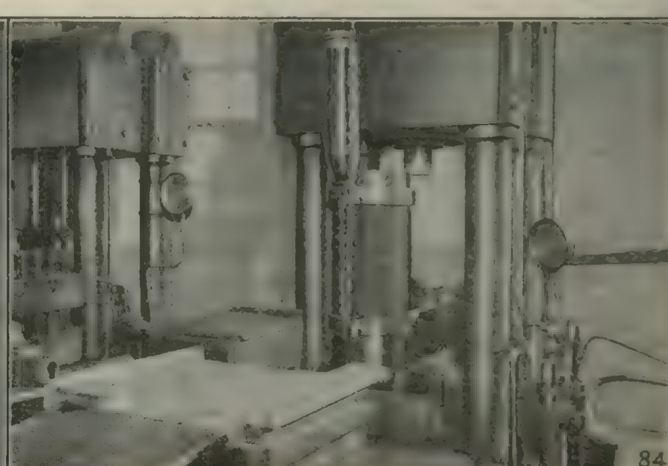


FIG. 84. PRESS FITTED FOR HYDRAULIC TESTING

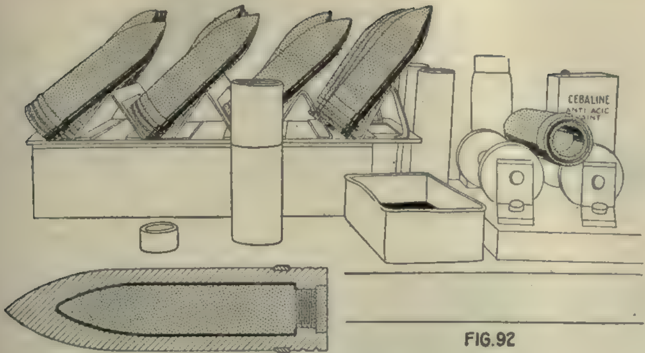


FIG. 92

FIG. 91

OPERATION 1

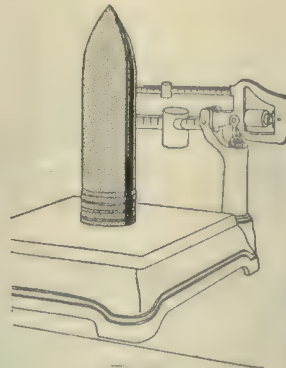


FIG. 93
OPERATION 2

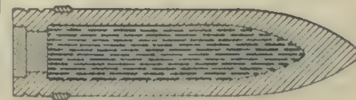


FIG. 94
OPERATION 3A

FIG. 95

OPERATION 3B

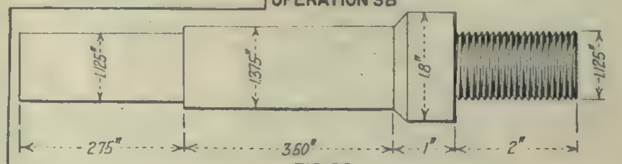


FIG. 96

OPERATION 16. HYDRAULIC TEST

Description of Operation—Case is placed in a vise, and a plug is screwed into the end to make it water-tight; the case is then placed in a special fixture, Figs. 84 and 90, in a 1500-ton heading press; the pressure applied is 350 tons, or 20,000 lb., per sq.in. Apparatus and Equipment Used—1500-ton heading press; pressure pump; testing fixture, Fig. 90; triplex chain drop; common vise. Gages—None.

OPERATION 1. PAINTING INTERIOR BY HAND

Transformation—Fig. 91. Number of Operators—Two. Description of Operation—Operator pours case full of Cebaline anti-acid paint up to threads, then pours it out and sets case in rack, base down, to drain a minute or so; second operator takes a drained case from rack and wipes end and threads with waste, and places it in truck box to dry; paint dries rapidly in about 1 hr. Apparatus and Equipment Used—Cans of paint, pans, draining rack, waste, Fig. 92. Production—1200 per 8 hr.

OPERATION 1-A. PAINTING INTERIOR WITH A SPRAY

Transformation—Fig. 91. Number of Operators—One. Description of Operation—Using the spraying apparatus, Fig. 85, the operator thrusts the nozzle inside a shell, presses the valve lever and sprays the inside to the threads; he then shuts the valve and withdraws nozzle. Apparatus and Equipment Used—Eureka spray and Cebaline anti-acid paint. Production—10 per min.

OPERATION 2. WEIGHING

Number of Operators—One. Description of Operation—Operator places case on scale platform, weighs it and chalks weight on side, Fig. 93, then places piece in tote box, ready for elevating truck. Apparatus and Equipment Used—Small platform scale. Production—1600 per day.

OPERATION 3-A. FILLING WITH TRINITROTOLUOL

Transformation—Fig. 94. Number of Operators—Three in gang for filling and compressing. Description of Operation—A complete fuse and base cover are kept on platform of scale; first operator weighs out enough trinitrotoluol in a tin container to bring total weight of case, fuse and base cover to 15 lb.; he then pours the trinitrotoluol into case on holding

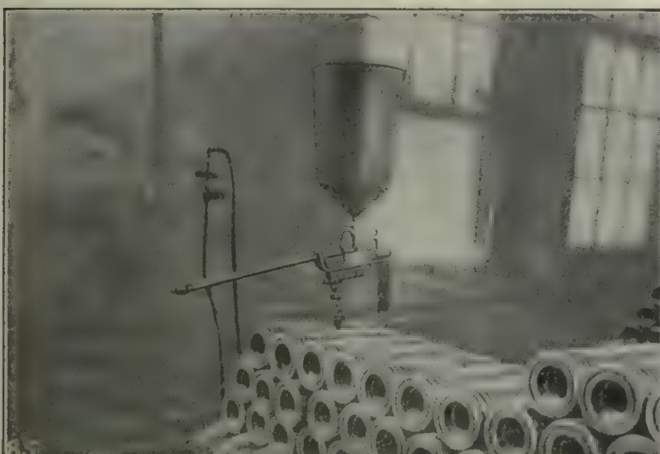
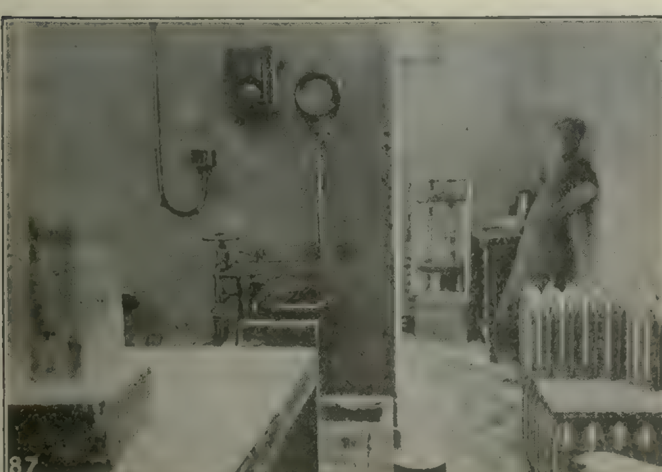


FIG. 85. INTERIOR PAINT-SPRAYING OUTFIT

FIG. 86. FILLING WITH TRINITROTOLUOL



IG. 87. COMPRESSING THE TRINITROTOLUOL

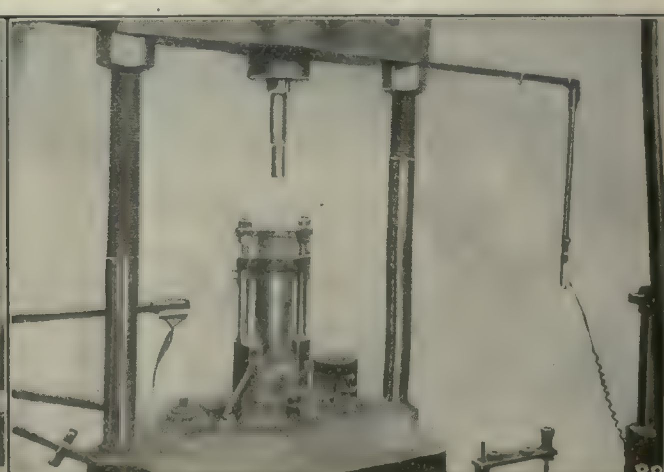


FIG. 88. HOLDING FIXTURE AND RAMMER

block and rams down powder with brass rammer and heavy rawhide hammer; load is then compressed in hydraulic press; in case of a light-weight shell, more powder is added and again compressed, in some cases several compressions being necessary to get enough powder in to bring weight high enough. Apparatus and Equipment Used—Small platform scale, rawhide hammers, brass rammer, holding blocks, Fig. 86. Production—320 per day.

OPERATION 3-B. COMPRESSING THE TRINITROTOLUOL

Transformation—Fig. 95. Machine Used—Riehle 40,000-lb. hydraulic press. Number of Operators in Gang—Three. Punches and Punch Holders—Bronze ramming punch, Fig. 96. Description of Operation—Second operator takes filled case and puts in hydraulic press; third operator then operates valve levers from outside of "bombproof," as soon as second operator is outside, and watches operation of press ram from a mirror placed as shown in Fig. 87; about 30 sec. is required for ram stroke each way; the punch is forced in 4⅞ in. from end of case, which is 4¾ in. + ⅛-in. allowance for end of detonator fuse. Pressure Required—Pressure varies according to amount of trinitrotoluol needed to bring weight of case to 15 lb. ± 2½ oz.; on cases weighing 12 lb. 2 oz., about 24,000 lb. pressure is required; from 12 lb. 4 oz. to 12 lb. 6 oz., 14,000 lb.; 12 lb. 14 oz., 8000 lb.; as a rule, 12-lb. 2-oz. cases are considered too light, as the pressure required to force in enough trinitrotoluol makes the work too dangerous. Special Fixtures—Case-holding fixture, Fig. 88. Production—320 per day. Note—The bombproofs in which the presses are placed are of concrete about 7 ft. wide, 9 ft. long, 10 ft. high, with walls 1 ft. thick.

OPERATION 4. REAMING FOR FUSE CASE

Transformations—Figs. 103 and 104. Machine Used—Small lathe, Fig. 97. Number of Machines per Operator—One. Cutting Tools—Reamer, Fig. 105. Gages—Stop collar on reamer. Production—1200 per 8 hr.

OPERATION 5. CLEANING THREADS AND COUNTERBORE

Number of Operators—One. Description of Operation—Operator places case on revolving fixture, Fig. 98; cleans threads and counterbore with hook tool and scraper; then wipes with waste soaked in benzol and finally wipes with dry waste. Apparatus and Equipment Used—Fixture, Fig. 107. Production—350 per 8-hr. day.

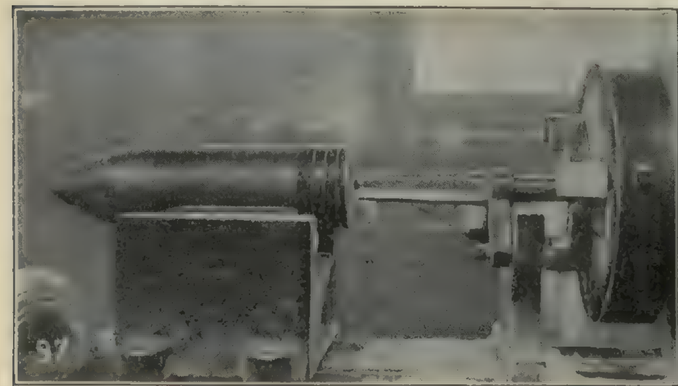


FIG. 97. REAMING FOR FUSE CASE

FIG. 98. CLEANING THE THREADS

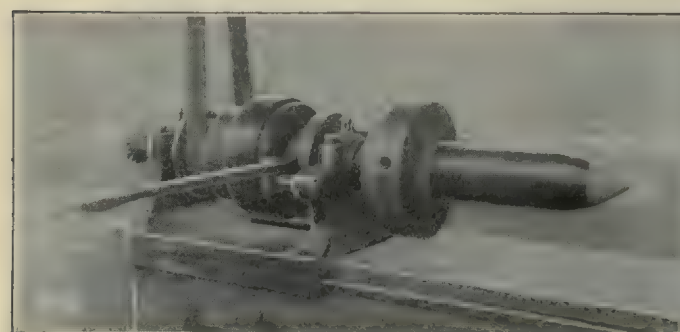


FIG. 99. PAINTING THE OUTSIDE

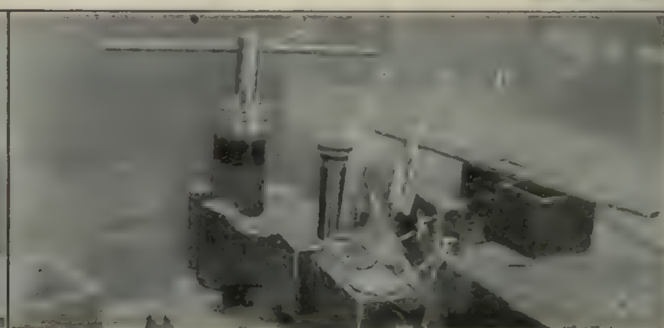


FIG. 100. PUTTING IN FUSE AND BASE COVER

FIG. 101. PRESSING ON BASE COVER WITH TRACER

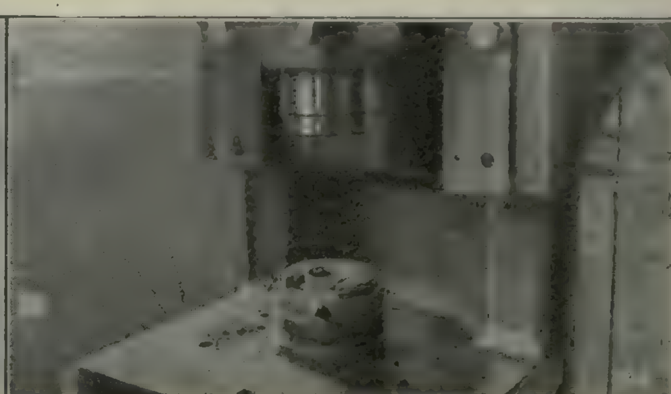


FIG. 102. PLANISHING THE BANDS

OPERATION 6. PAINTING OUTSIDE

Transformation—Fig. 108. Number of Operators—One. Description of Operation—Operator chucks case in small lathe, Fig. 99, fitted with split centering chuck, pushing butt end in as far as the rotating band will allow; he then starts lathe, which runs 240 r.p.m., and applies paint with wide brushes. Apparatus and Equipment Used—Black, red and gray paint; three brushes to suit. Production—350 per day.

OPERATION 7-A. PUTTING IN FUSE (WITHOUT NIGHT TRACER)

Transformation—Fig. 109. Number of Operators—One. Description of Operation—Operator puts case in vise and sees that reamed cavity is clean and deep enough; if not, he puts in a reamer and pounds and rotates it until of the desired size; if the threads are tight, he retaps them; the threads of the detonating fuse are greased with cosmoline, and it is

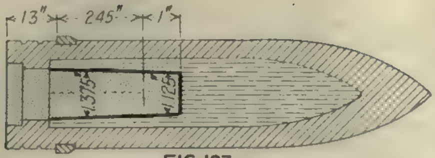


FIG. 103

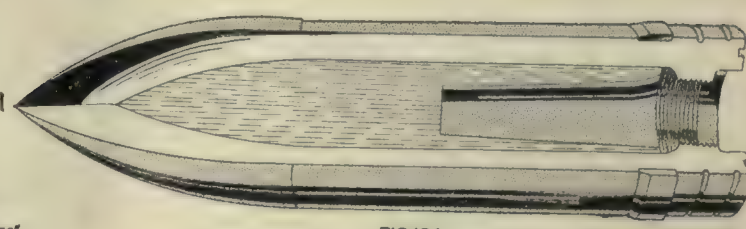
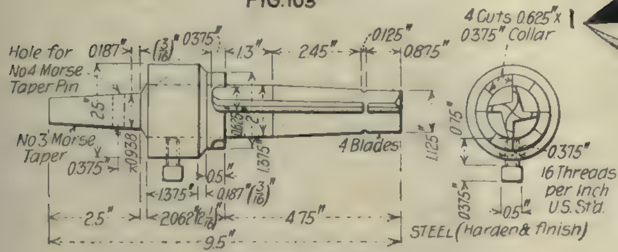


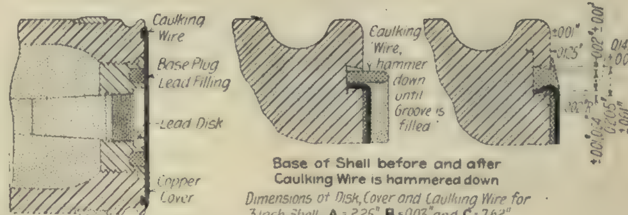
FIG. 104

OPERATION 4



Reamer with Stop
(For Medium Caliber Base-detonating Fuse)
FIG. 105

screwed home with a long spanner wrench, then locked in place by means of a punch used at the three milled notches in the case; the spanner holes are filled by pounding in lead slugs, Fig. 110; lead disk and base cover are put on; lead calking washer is put in base-cover groove and pounded down all around, securely holding base cover in place, Fig. 111. Apparatus and Equipment Used—Common vise, reamer, bronze hammer, tap, spanner wrench, cosmoline, complete detonator fuse, base cover, lead ring, boxes of lead slugs, Fig. 100. Production—160 per day.



Base Cover

Base of Shell before and after Caulking Wire is hammered down

Dimensions of Disk, Cover and Caulking Wire for 3 inch Shell - A = 2.25", B = 0.03" and C = 7.62"

FIG. 109

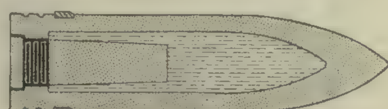
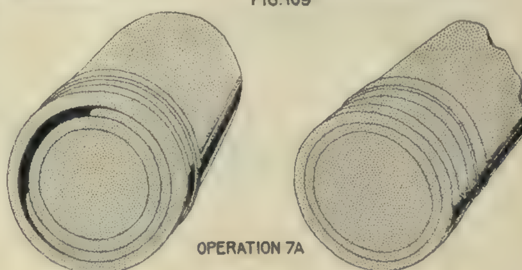
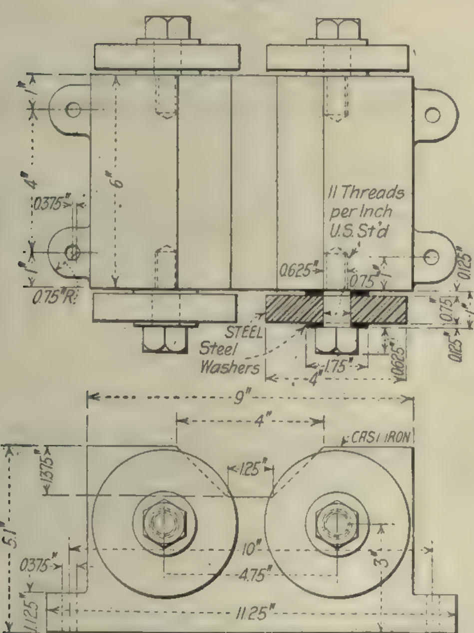


FIG. 106



OPERATION 7A

FIG. 110 FIG. 111



V-Block with Rollers
(For cleaning Fuse-seat Thread)
FIG. 107
OPERATION 5

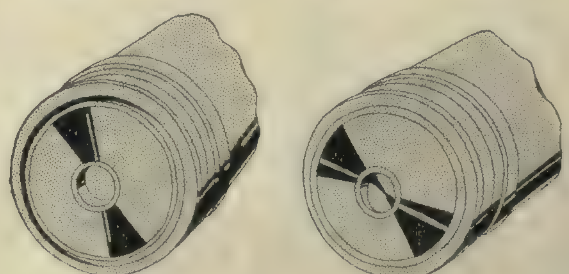
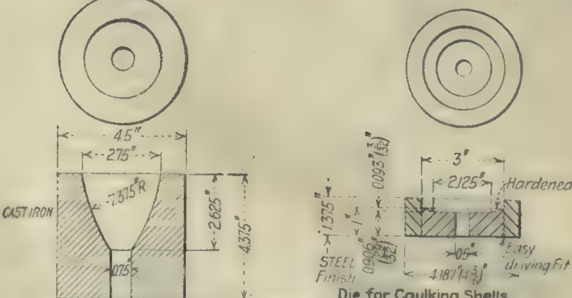


FIG. 112 A FIG. 112 B



Solid Punch for Caulking Shells FIG. 113 Die for Caulking Shells
OPERATION 7B

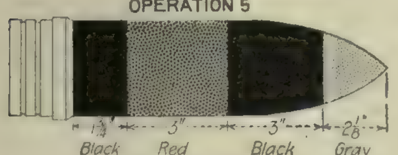


FIG. 108
OPERATION 6

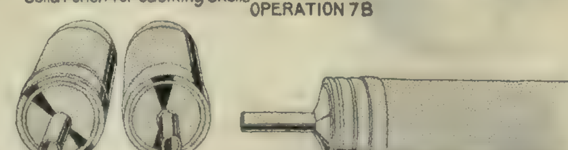


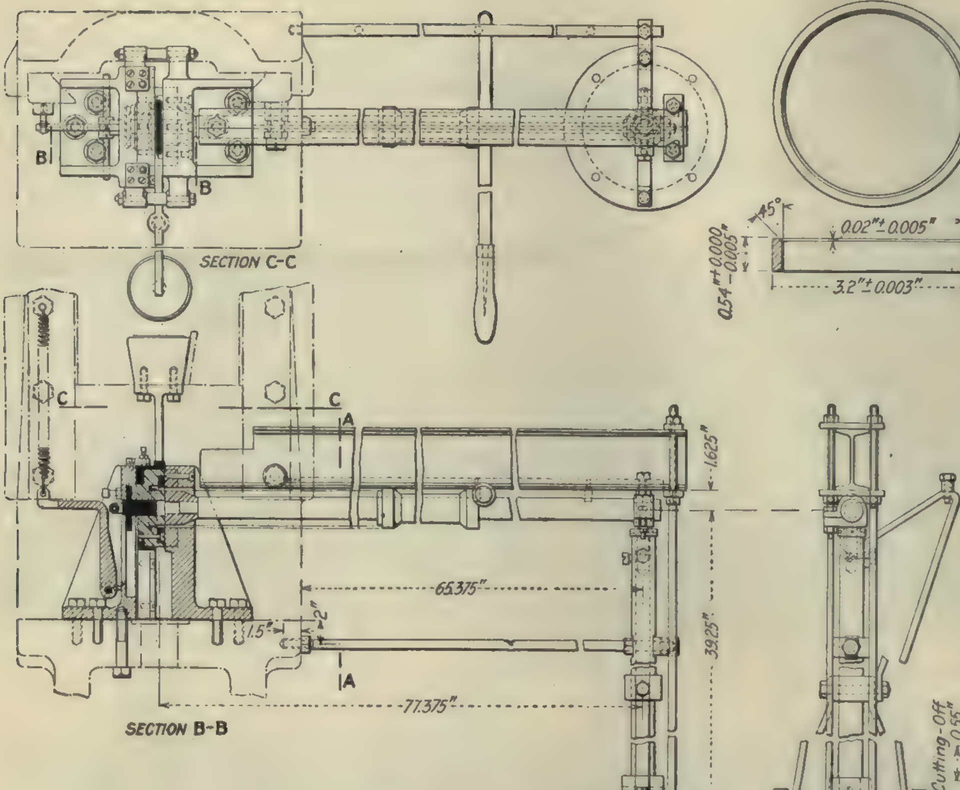
FIG. 114
OPERATION 7C

OPERATION 7-B. PRESSING ON BASE COVER WITH NIGHT TRACER

Transformation—Figs. 112-A and 112-B. Machine Used—Watson-Stillman hydraulic press, Fig. 101. Number of Operators—Two. Description of Operation—The base detonating fuse is put in as in operation 7-A, then piece is taken by this gang; the helper puts on lead disk and night-tracer base cover and presses in the calking ring; press operator then takes it and presses down the ring, as shown. Pressure Required—About 2000 lb. Special Fixtures—Point-holding block; cover-ring pressing block, Fig. 113. Production—300 per 8-hr. day.

OPERATION 7-C. SCREWING IN NIGHT TRACER

Transformation—Fig. 114. Number of Operators—One. Description of Operation—Operator clamps a night tracer in a vise and, holding the case in his hands, screws it on the tracer. Apparatus and Equipment Used—Common vise.



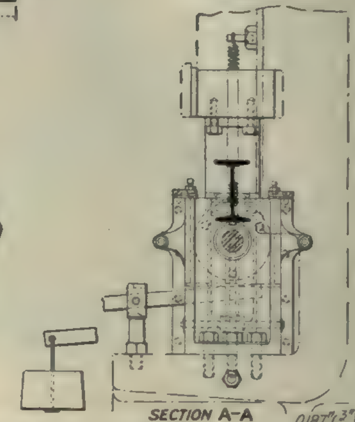
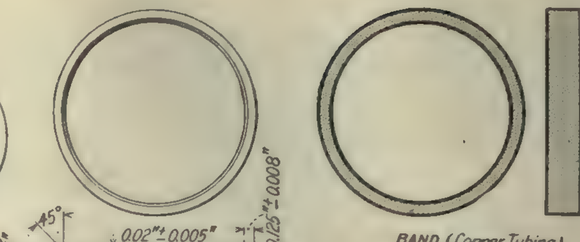
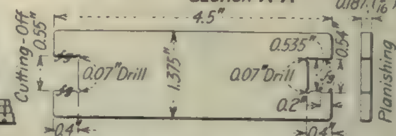


FIG. 116
OPERATION 1



BAND (Copper Tubing)
FIG. 115



MACHINE STEEL (Finish f ± 0.01", Case Harden)
FIG. 117

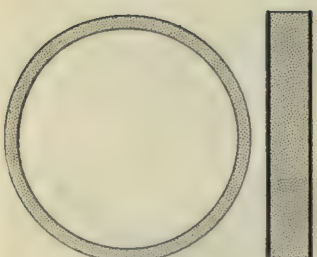
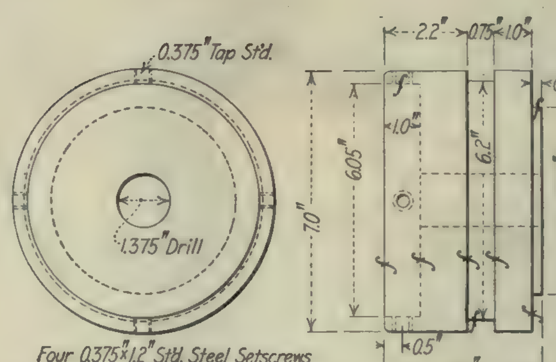
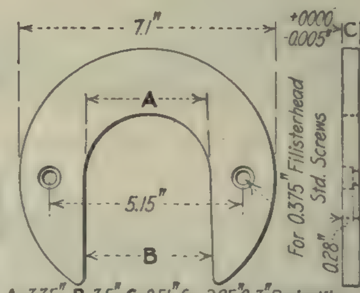


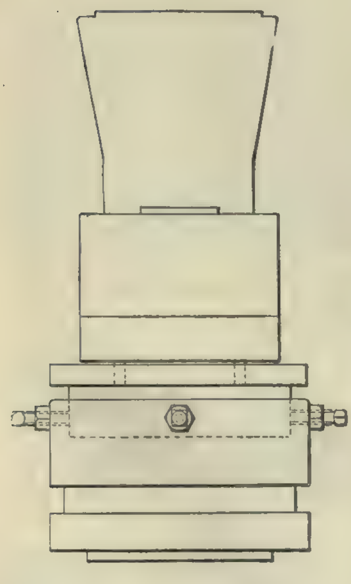
FIG. 118

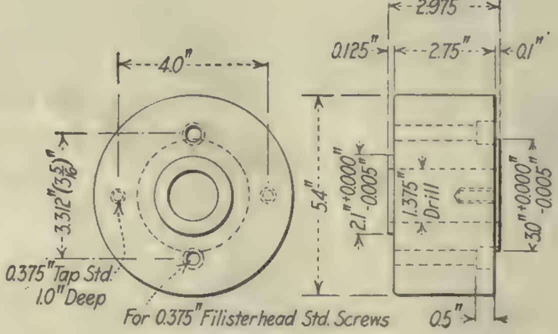


MACHINE STEEL ± 0.01"
Lower Punch Holder

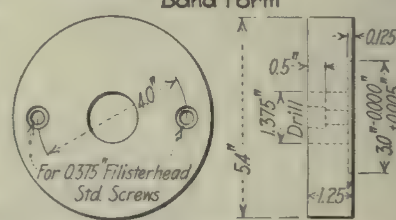


A=3.35" B=3.5" C=0.51" for 2.95" & 3" Projectiles
A=4.25" B=4.4" C=0.66" for 3.8" Projectiles
COLD-DRAWN STEEL Finish f ± 0.01"
Band Form

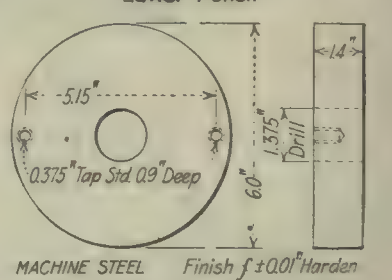




MACHINE STEEL
Finish f ± 0.01"
Upper Punch Holder



MACHINE STEEL Finish f ± 0.01" Harden
Lower Punch



MACHINE STEEL Finish f ± 0.01" Harden
Upper Punch

FIG. 119
OPERATION 5

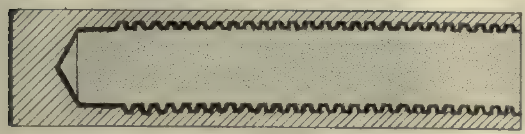


FIG. 120

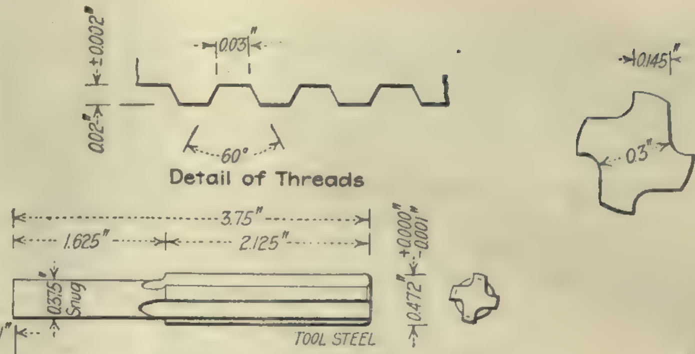


FIG. 122

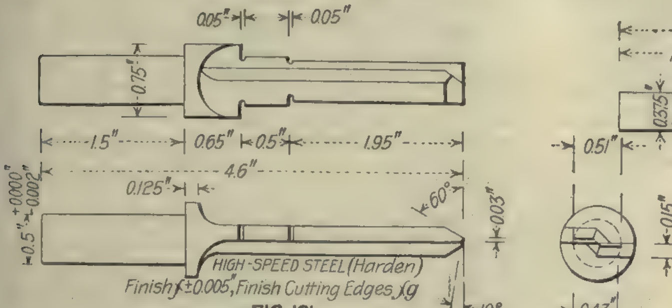


FIG. 121

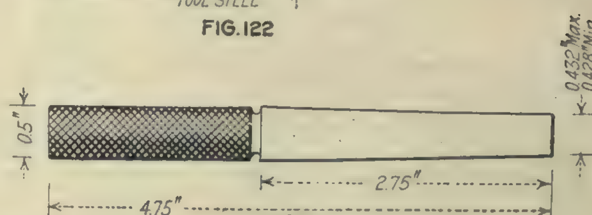


FIG. 124

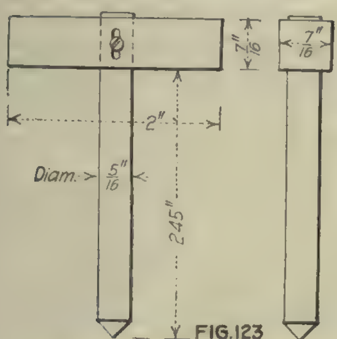


FIG. 123

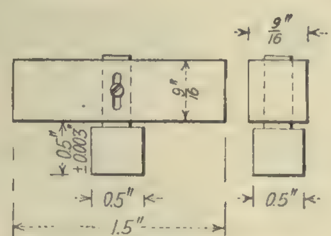


FIG. 125

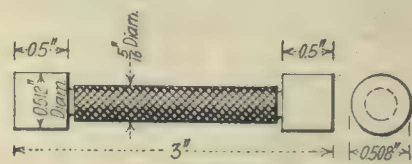


FIG. 126

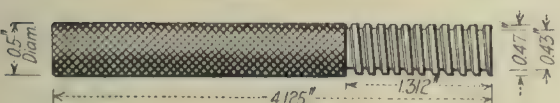


FIG. 127

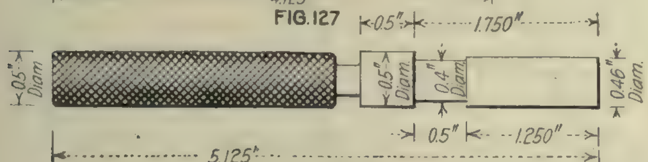


FIG. 128

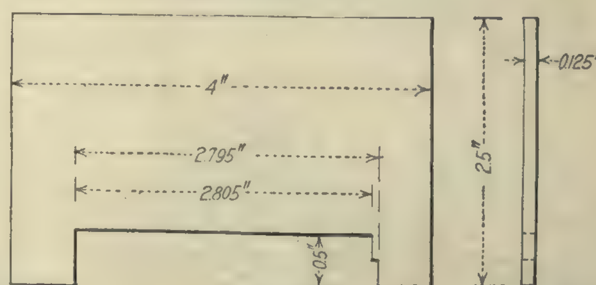


FIG. 129

OPERATION 1

OPERATION 1. CUT FROM TUBING (COPPER)

Transformation—Fig. 115. Machine Used—15,000-lb. adjustable-stroke crank press. Number of Operators per Machine—One. Special Fixtures—Shearing attachment, Fig. 116. Gages—Maximum and minimum width, Fig. 117. Production—3000 in 8-hr. day.

OPERATION 2. ANNEAL

Number of Operators—Three. Description of Operation—Bands are placed 1000 at a time in a large pan; four of these pans are put into furnace and heated for ¾ hr. to about 1200 deg. F.; they are then placed on trucks and run out into the air to cool. Apparatus and Equipment Used—Annealing pans, truck, furnace. Production—40,000 per 8-hr. day.

OPERATION 3. PICKLE

Number of Operators—Two. Description of Operation—Bands are put in baskets and pickled in 1 part vitriol and 6 parts water until scale is removed and pieces are brightened. Production—8000 per 8 hr.

OPERATION 4. WASH

Number of Operators—Two. Description of Operation—Washed well in cold water to remove pickle solution. Apparatus and Equipment Used—Basket and tank. Production—8000 per day. Note—Pickling and washing tanks are side by side, and a basket of pickled bands is simply hoisted out of one tank into the other and, after washing, suspended a short time to drain.

OPERATION 5. PLANISHING

Transformation—Fig. 118. Machine Used—15,000 lb. adjustable-stroke crank press, Fig. 102. Number of Operators per Machine—One. Special Fixtures—Fig. 119. Gages—Maximum and minimum, Fig. 117. Production—3000 per 8 hr.

OPERATION 1. DRILLING, COUNTERBORING, TAPPING

Transformation — Fig. 120. Machine Used — Brown & Sharpe automatic. Number of Machines per Operator—Three. Cutting Tools—½-in. twist drill (drills in $\frac{15}{32}$ in. for counterbore); $\frac{13}{32}$-in. twist drill; combination reamer and counterbore, Fig. 121; tap, Fig. 122; circle chamfering tool, 3 in. in diameter; circle cutoff tool, 3 in. in diameter by 0.10 in. thick. Cut Data—1200 r.p.m. for all but tapping; 530 r.p.m. for tapping. Coolant—Zurn cutting oil. Gages—Depth of drilled hole, Fig. 123; maximum and minimum reamed diameter plugs, Fig. 124; depth of counterbore feeler, Fig. 125; maximum and minimum diameter counterbore, Fig. 126; diameter of thread, Fig. 127; depth of thread, Fig. 128; maximum and minimum length, Fig. 129. Production—800 per 8-hr. day. Note—Made from hard-rolled brass rod, ⅝-in. diameter ±0.005; tools are used in order given.

Turning of the bands is done on either a special machine or a lathe, as shown in Figs. 61 and 62. On the lathe two tools are used in the same slide. One roughs off and edges the band, and the other finishes it, being guided by means of a profile block and follower at the back. A final dressing is given with a mill file.

On the special machine, the band is roughed off with one tool and then finished with a form tool. A tool rest is then dropped in place and the band smoothed up with an end scraper. Following this the threads and counterbore are carefully sized, as shown in Fig. 63. This operation, however, is not always necessary and is only done when needed.

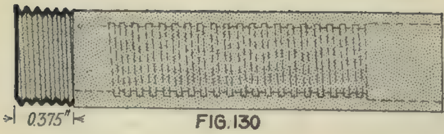


FIG. 130

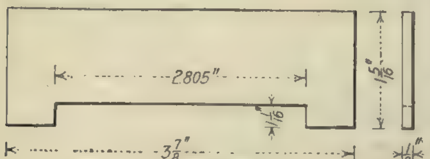


FIG. 133

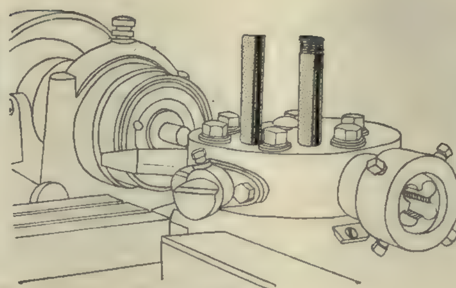
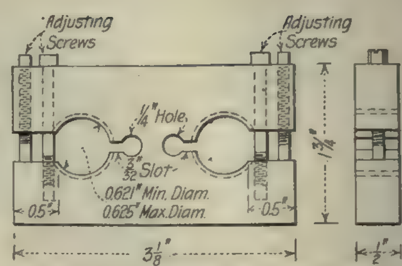


FIG. 131
OPERATION 2



18 Threads per Inch, Left Hand, U.S. Standard

FIG. 132

OPERATION 2. FACING END AND THREADING

Transformation—Fig. 130. Machine Used—Turret lathe, Fig. 131. Number of Operators per Machine—One. Work-Holding Devices—Collet chuck. Cutting Tools—Facing tool; die to cut 0.625 (+0.000, —0.004) diameter, 18 left-hand U. S. Standard thread. Cut Data—Speed, 850 r.p.m. Coolant—Lard oil. Gages—Maximum and minimum thread gage, Fig. 132; length gage, Fig. 133. Production—1200 per 8-hr. day.

OPERATION 1. PUNCHING INNER DISK

Transformation—Fig. 134. Machine Used—Small punch press. Number of Operators per Machine—One. Punches and Punch Holders—Fig. 135. Dies and Die Holders—Fig. 136. Lubricant—Mineral oil. Production—About 75,000 per 8 hr. Note—Press flywheel runs 70 r.p.m.

OPERATION 2. PUNCHING OUTER DISK

Transformation—Fig. 137. Machine Used—Small punch press. Number of Operators per Machine—One. Punches and Punch Holders—Fig. 138. Dies and Die Holders—Fig. 139. Lubricant—Mineral oil. Production—About 75,000 per 8 hr. Note—Press flywheel runs 70 r.p.m.

OPERATION 3. TURNING IGNITION TUBES

Transformation—Fig. 140. Machine Used—Brown & Sharpe automatic. Number of Machines per Operator—Three. Cutting Tools—Drill; countersink; formed tool; cutoff tool. Cut Data—Spindle runs 2400 r.p.m. Coolant—Zurn Cutting oil. Gages—Combination, Fig. 141. Production—3500 per 8 hr. Note—Made from ¼-in. diameter brass rod.

OPERATION 4. MILLING IGNITION TUBES

Transformation—Fig. 142. Machine Used—Hand miller. Number of Operators per Machine—One. Work-Holding Devices—Miller vise and formed jaws, Fig. 143. Cutting Tools—Milling cutter, 1¾ in. in diameter, 20 teeth. Cut Data—Cutter runs 600 r.p.m. Production—4000 per day.

OPERATION 5. ASSEMBLING IGNITION TUBE TO OUTER DISK

Transformation—Fig. 144. Number of Operators—One. Apparatus and Equipment Used—Bench riveter, Fig. 145. Production—1600 per 8 hr.

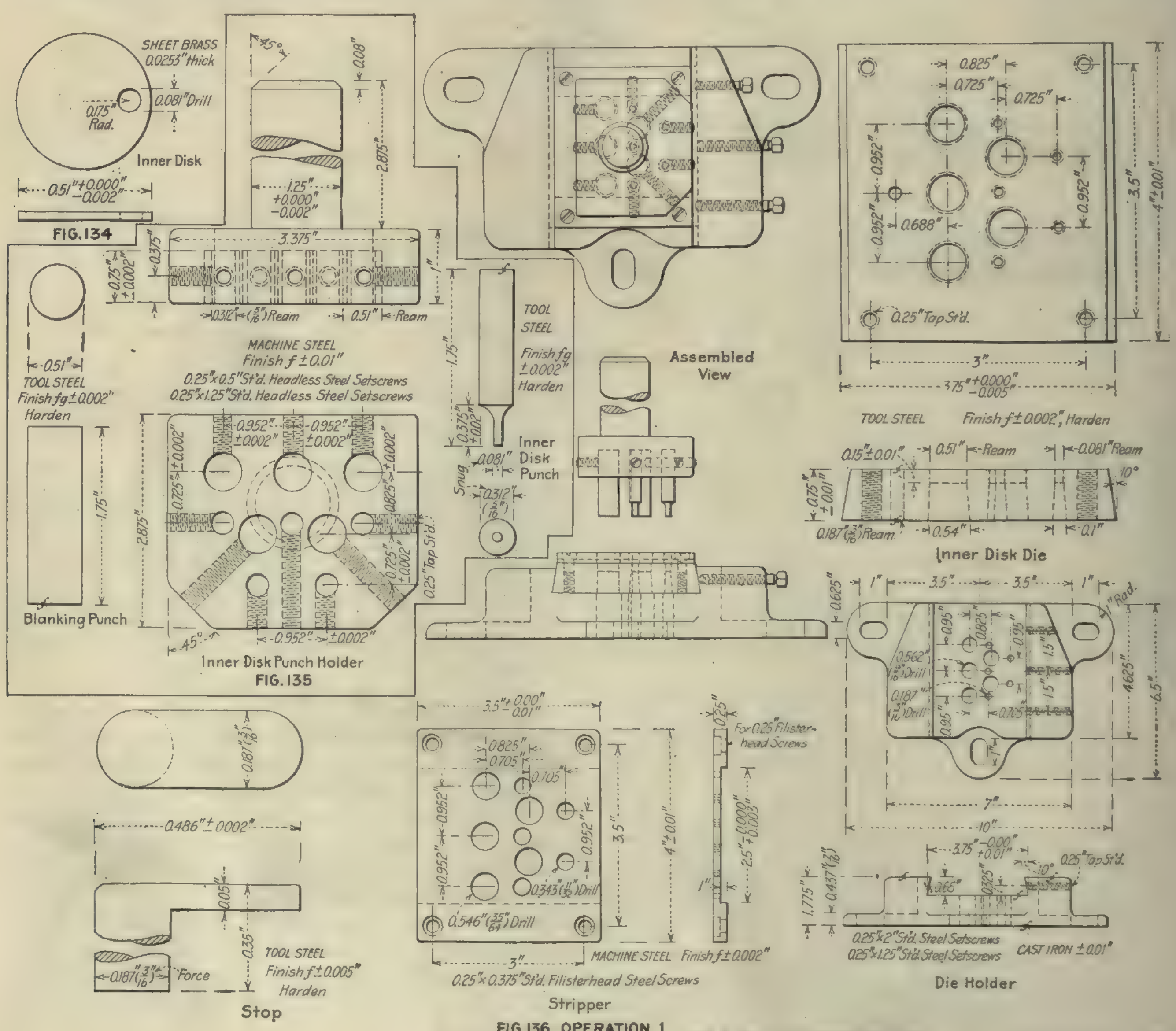


FIG. 134

FIG. 135

FIG. 136 OPERATION 1

The next in order is a thorough inspection of the entire case by a group of regular inspectors who also divide the shells according to weight, after which the inside back of the threads is sandblasted, as shown in Fig. 83. The shells are laid in a row on a wooden grating, open ends out, and the operator thrusts the sandblast nozzle into each in turn. This thoroughly cleans out the part of the cavity that has not been machined.

The hydraulic testing is done in the apparatus shown in Fig. 84 and in detail in Fig. 90. The test is an external one, a plug being screwed into the base to make it water-tight; then the shell is hoisted into the testing cylinder by means of a chain block hooked to a screw-eye in the base plug. The testing cylinder slides on ways, so as to be moved from loading to testing positions under the press ram. The moving of this testing cylinder is accomplished by the operation of a small hydraulic cylinder at the back of the press, the connecting-rod of which is coupled to the cylinder, as can be seen in Fig. 84. After the cylinder, full of water and with the shell inside, is in place under the press ram, the ram is lowered and pressure applied until it is equal to 350 tons, or about 20,000 lb. per sq.in. on the surface of the shell. This test shows whether there are any flaws, weak spots or blow-holes leading into the interior.

The first operation directly connected with the loading of the explosive charge is painting of the interior with acid-proof paint, the various loading operations being in the following order:

1. Painting interior by hand
1-A. Painting interior with a spray
2. Weighing
3-A. Filling with trinitrotoluol
3-B. Compressing the trinitrotoluol
4. Reaming for fuse case
5. Cleaning threads and counterbore
6. Painting outside
7-A. Putting in fuse (without night tracer)
7-B. Pressing on base cover (with night tracer)
7-C. Screwing in night tracer

Painting of the interior may be done in either one of two ways: By hand, using the outfit shown in Fig. 92, or with a spray, using the apparatus shown in Fig. 85. The hand method is slower, but may be used where a spray is not available or when it is out of order. The operator fills the cavity to the threads with paint and pours it out,

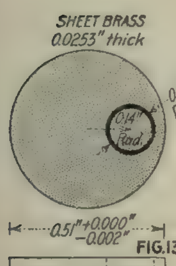
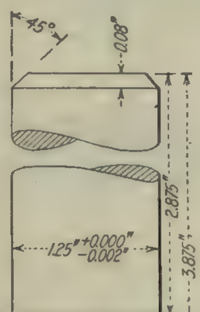
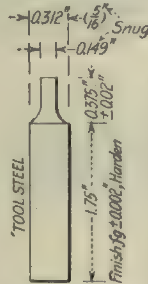
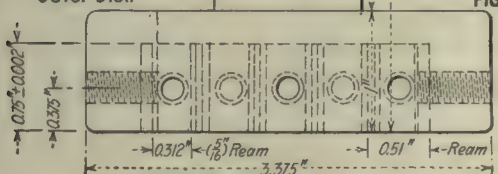


FIG.137
Outer Disk

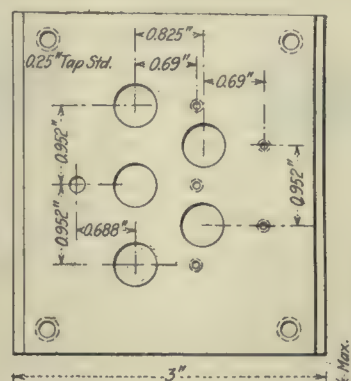


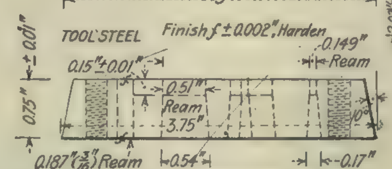


Outer Disk Punch
FIG.138



MACHINE STEEL Finish f ±0.01"
0.25"x1.25" Std. Headless Steel Setscrews
0.25"x0.5" Std. Headless Steel Setscrews





Outer Disk Die
FIG.139

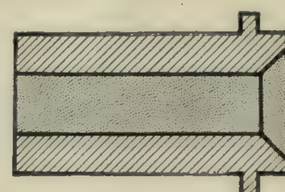
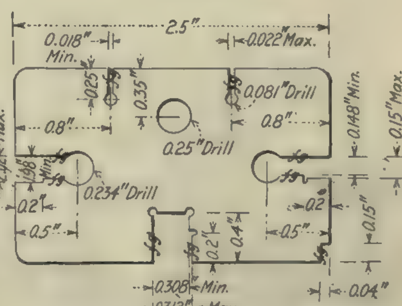
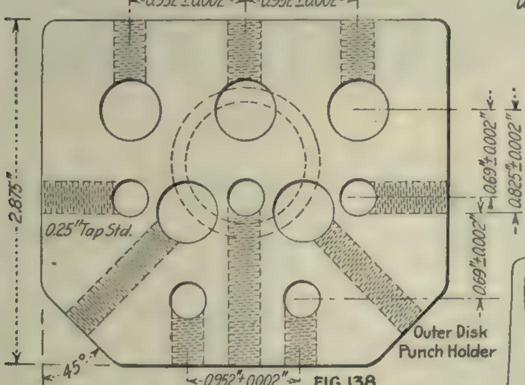


FIG.140



MACHINE STEEL Finish f ±0.01", Case Harden
FIG.141



Outer Disk Punch Holder
FIG.138

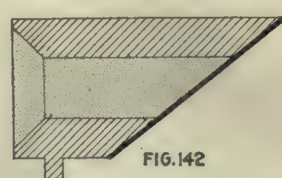


FIG.142

FIG. 137, 138 & 139 OPERATION 2
" 140 & 141 OPERATION 3
" 142 & 143 " 4
" 144 & 145 " 5

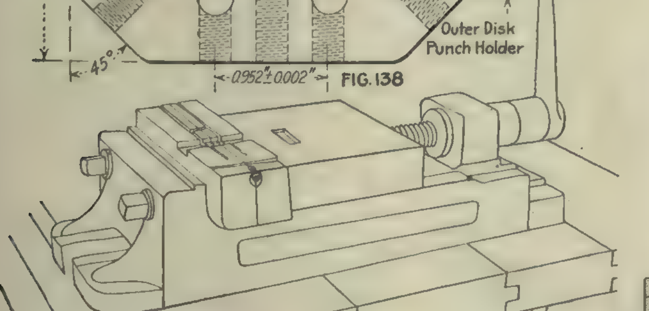


FIG.143

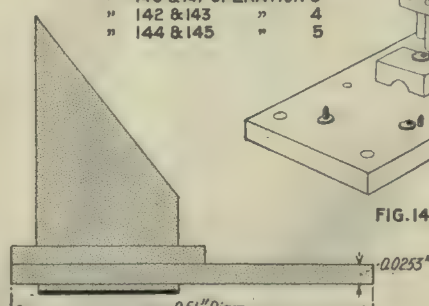


FIG.144

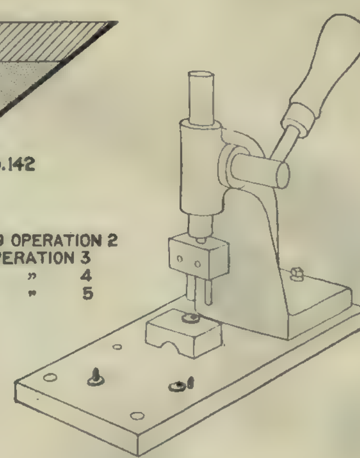


FIG.145

OPERATION 1. LOADING ILLUMINATING POWDER

Transformation—Fig. 146. Number of Operators—Three. Description of Operation—Tracers are filled and mixture compressed in a bombproof with the same type of Riehle press used for trinitrotoluol loading; tubes are first filled with illuminant powder and placed 10 at a time in the fixture shown in Fig. 147 and given 40,000 lb. total pressure, equal to 4000 each; this is repeated three times. Apparatus and Equipment Used—Riehle hydraulic press; holding fixture and pressing punches for 10 tubes; small-handled powder measures or dippers. Production—1000 per 8-hr. day.

OPERATION 2. COUNTERBORING

Transformation—Fig. 148. Machine Used—Small turret lathe. Number of Operators per Machine—One. Work-Holding Devices—Collet chuck. Cutting Tools—Counterbore, Fig. 149. Cut Data—Spindle runs 350 r.p.m. Production—2000 per 8-hr. day.

OPERATION 3. LOADING IGNITION MIXTURE

Transformation—Fig. 150. Number of Operators—Three. Description of Operation—4 gr. igniting mixture is poured into drilled and counterbored hole and shaken down; 24 gr. black powder is then poured on top of this and a brass inner disk placed on top of the powder; each tube is given 4000 lb. pressure, using the same fixture as for illuminant; in loading, two holders are used with one set of punches in the press, and they are employed alternately, as the illuminating and igniting powder are loaded in turn. Apparatus and Equipment Used—Same as for operation 1. Production—1000 per 8-hr. day.

OPERATION 4. LOADING RETARDING MIXTURE

Transformation—Fig. 151. Description of Operation—On top of the inner disk is poured 12 gr. delay mixture; the outer disk is put on, the holes in the two disks being placed on opposite sides; two tubes are compressed at once at 14,000 lb. total pressure, or 7000 each, using the holders and punches shown in Fig. 152. Apparatus and Equipment Used—Riehle hydraulic press in bombproof. Production—1800 per 8-hr. day.

OPERATION 5. TRIMMING END

Transformation—Fig. 153. Machine Used—Small turret lathe. Number of Operators per Machine—One. Work-Holding Devices—Collet chuck. Cutting Tools—Fig. 154. Cut Data—Spindle runs 350 r.p.m. Production—2000 per day. Note—Tracer is chucked and end of tube faced off until about 0.002 in. from outer disk; inside of mouth and disk is then coated heavily with nonacid paint, except opening in ignition tube; complete night tracer is shown in Fig. 155.

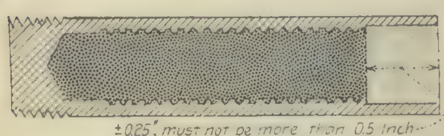


FIG. 146

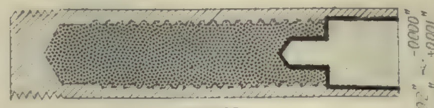


FIG. 148

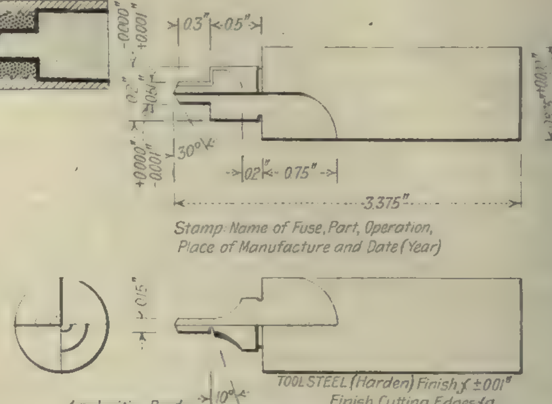


FIG. 149

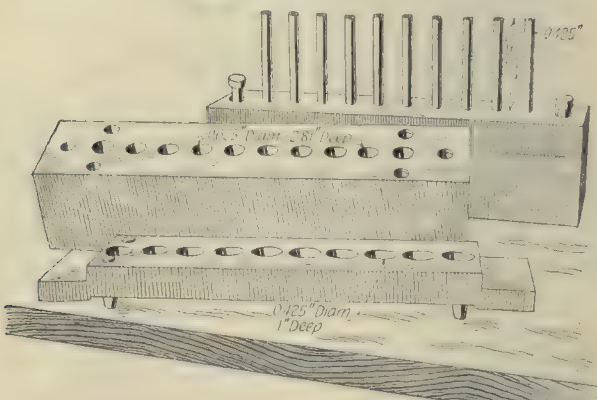


FIG. 147

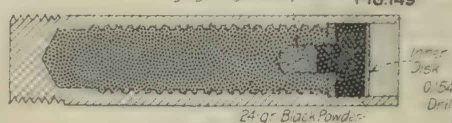


FIG. 150

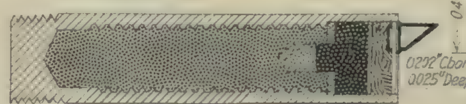
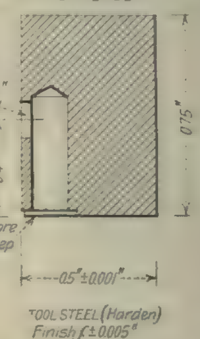


FIG. 151



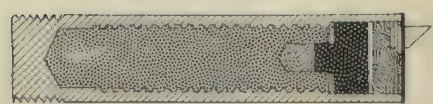


FIG. 153

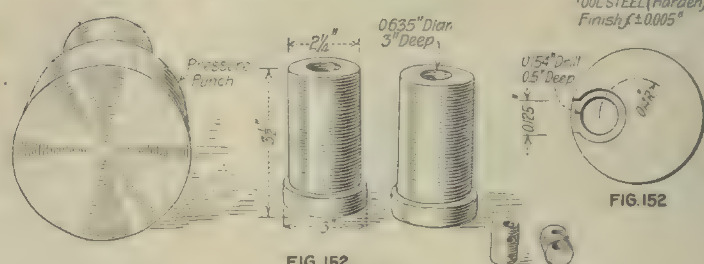


FIG. 152

FIG. 152

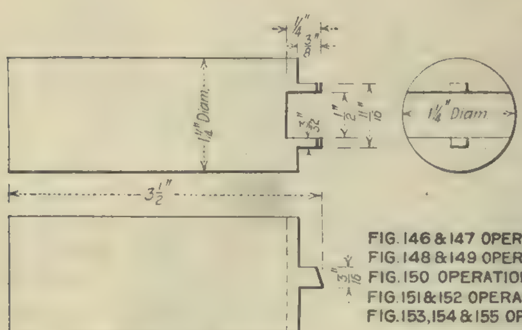


FIG. 154

FIG. 146 & 147 OPERATION 1
FIG. 148 & 149 OPERATION 2
FIG. 150 OPERATION 3
FIG. 151 & 152 OPERATION 4
FIG. 153, 154 & 155 OPERATION 5

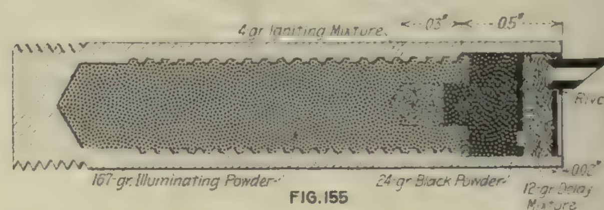


FIG. 155

then passes the shell to another, who wipes the threads with waste. The spray method is far quicker and does not smear the threads so much, as the operator turns on the spray after the nozzle is inside the shell and turns it off before removal.

The weighing of the case is for the guidance of the fillers, the weight being chalked on each shell, as shown in Fig. 93. The fillers work in gangs of three, one filling, one carrying and refilling, and one operating the press. These operators shift positions or help on the different operations, as occasion demands in order to balance the work.

The high explosive, or trinitrotoluol, is a yellowish-white powder not dangerous in the ordinary sense, until compressed; but when compressed and fired by means of a detonator, it is one of the most powerful explosives known.

Compressing the trinitrotoluol is done with a hydraulic press placed in a concrete bombproof room, the operator watching the actual work by means of a mirror, as shown in Fig. 87. A shell in the holding fixture with the punch or rammer ready to descend is shown in Fig. 88. The rammer presses the explosive solidly into the shell and leaves a cavity for the insertion of the detonator. This cavity afterward has to be reamed out to size, which is done as shown in Fig. 97. The reamer is held in a chuck and passes over two jaws of a steadyrest, which not only steadies the reamer, but acts as a stop for the depth of the cut. Fig. 105 shows a stop collar on the reamer, but in the actual shop practice this is no longer used. The operator places a shell on the guiding block and presses it forward onto the revolving reamer until the end of the shell contacts with the steadyrest jaws.

After being reamed out, the threads and counterbore have to be cleaned. This is done by placing the shell on the fixture shown in Fig. 98 and using the hook tool there shown to clean the threads as the operator rotates the shell by hand. The counterbore is scraped out with a scraper made from an old file. Following these operations the shell is painted from point to band, while held as shown in Fig. 99, the operator applying the paint with wide brushes.

The detonator fuse is next screwed in, with the shell held in a bench vise, Fig. 100. A detonator is shown at *A*. If the threads are a little tight, a tap *B* is run in. If the hole is not quite deep enough or has not clearance enough, it is made larger by pounding and rotating the reamer *C* in the hole. With everything clear, the fuse is screwed home with the spanner *D* and locked to the notches in the shell with a punch and hammer. In case no night tracer is to be used on the shell, lead plugs are pounded into the spanner holes, and a sheet-metal cover *E* is put over the end with the edges in the cover groove. A calking lead ring *F* is then pounded into the groove as indicated in Fig. 109.

Where a night tracer is used, the fuse is put in in the same way, the lead slugs are pounded in, the special cover put on and a lead ring put in place. This ring, however, is not pounded in as previously described, but is pressed in as shown in Fig. 101, the process being graphically shown in Figs. 112-A and 112-B. Screwing in of the night tracer consists in placing the tracer in a vise and screwing the shell onto it by hand.

Making the Band

Operations on making the copper band are as follows:

1. Cut from tubing
2. Anneal
3. Pickle
4. Wash
5. Planish

The list of operations is almost self-explanatory; the details, however, are given under the proper headings. The last operation, planishing, is really a sizing for width, as the band is pressed between two flat dies, as shown in Fig. 102.

Making Night Tracer

1. Drilling, counterboring, tapping
2. Facing end and threading

Night tracers are made from brass rod in automatic screw machines; the order of procedure is as given above and is the usual standard screw-machine practice in every way.

Facing and threading of the closed end is done in a hand screw machine.

Making Night-Tracer Disks

1. Punching inner disk
2. Punching outer disk
3. Turning ignition tubes
4. Milling ignition tubes
5. Assembling ignition tube to outer disk

The making of the disks is a punch-press job, as shown by the punches and dies, Figs. 135, 136, 138 and 139. The ignition tubes are made on automatic screw machines from brass rod and are milled off at a sharp angle on the outer end in a hand miller. The assembling of the ignition tube to the outer disk is done by hand, and then the tube is riveted fast in the disk in the bench riveter, Fig. 145.

Loading Night Tracer

1. Loading illuminating powder
2. Counterboring
3. Loading ignition mixture
4. Loading retarding mixture
5. Trimming end

The loading of the night tracer with the illuminating powder is done in a hydraulic press, using the holders and punches shown in Fig. 147. Several fillings and pressings are needed to complete the work. After the illuminating powder has been pressed in, it is machined out at the open end of the tracer in a small turret lathe, using the combination drill and counterbore, Fig. 149. The object of drilling into the illuminating powder is to give the ignition mixture a better chance of surely doing its work. The ignition mixture is next put in and the inner disk pressed in. On top of this a slow-burning powder is placed, and then the outer disk is pressed in. Finally, the end of the tracer is faced off with the tool shown in Fig. 154. The tracer is now ready to be screwed into the base of the shell. It may be noted that the thread on the base of the tracer is left-hand, so that there is no tendency to unscrew as the shell is fired from the gun.

Turning Wheel Fits and Journals—Pennsylvania R.R. Practice

By Joseph K. Long

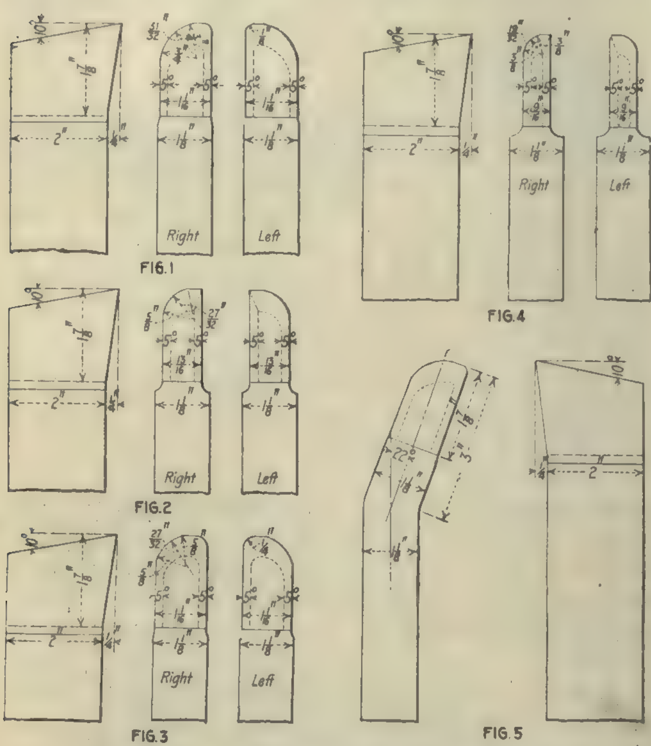
The use of burnishers for finishing bearing surfaces and wheel fits has long been standard practice in many railway shops, and might be of advantage where heavy-duty bearings and press fits are concerned. The illustrations show the cutting tools, the burnishing rollers and their holders, and the gages used.

The tools are shown in Figs. 1 to 5. Fig. 1 illustrates the right- and left-hand tools for journals from 5x9 to 6x11 in.; Fig. 2 for 4¼x8-in. journals; Fig. 3 for 4⅛x 8-in. and for special "foreign" journals 4½x8 in. In Fig. 4 is shown the size tool for the 3¾x7-in. journal. while Fig. 5 shows an offset tool. The cutting end of this tool is made the same as the right-hand tools shown in the preceding illustrations.

The straight tools are made in pairs—right and left—for use in double-end axle lathes, while the offset tools are for use in large gap axle lathes. In the latter the axle is put on with both wheels in place, to have the journal trued, and it is generally necessary to have an offset tool for that purpose.

The cutting speed may be from 70 to 90 ft. per min., and rolling can be done at the same speed. The feed for

both is from $\frac{1}{32}$ to $\frac{1}{16}$ in. per revolution. The depth of cut varies with the wear on journal. If it is $\frac{3}{32}$ in. or over, two cuts should be taken, one heavy and one



FIGS. 1 TO 5. VARIOUS CUTTING TOOLS

light. The rollers should be well oiled on the rolling surface while being used.

The amount of metal to be left for burnishing depends on the finish of the last cut. When this is fairly smooth,

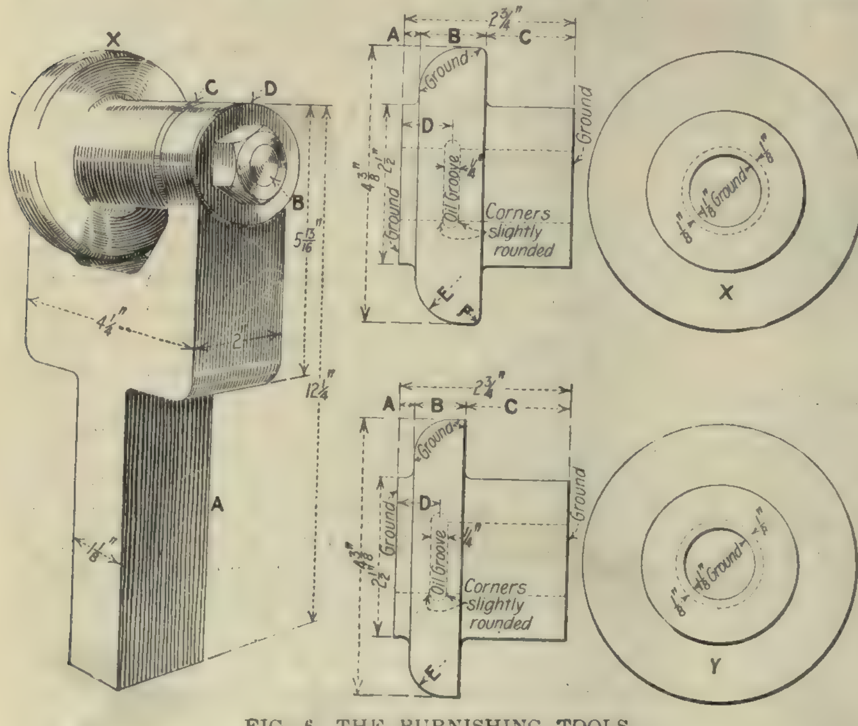


FIG. 6. THE BURNISHING TOOLS

$\frac{1}{32}$ in. is usually sufficient. Rolling surfaces should be set perfectly square with the axle. The proper fillets should also be given each side of the roller hub to avoid cracks developing either in hardening or in use. Both the cutting tools and rollers should be made of a high-grade tool steel.

The rolling, or burnishing, tools are shown in Fig. 6. Both of these tools fit into the same holder, which is

TABLE OF ROLLER SIZES

	No.	A, In.	B, In.	C, In.	D, In.	E, In.	F, In.
X........	1	$\frac{1}{4}$	$1\frac{1}{16}$	$1\frac{7}{16}$	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{1}{8}$
X........	2	$\frac{1}{4}$	$1\frac{1}{16}$	$1\frac{7}{16}$	$\frac{13}{16}$	[illegible]	$\frac{1}{4}$
Y........	3	$\frac{1}{4}$	$\frac{13}{16}$	$1\frac{11}{16}$	$\frac{11}{16}$	[illegible]	
Y........	4	$\frac{1}{4}$	$\frac{9}{16}$	$1\frac{15}{16}$	$\frac{11}{16}$	[illegible]	
X........	5	$\frac{5}{8}$	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{3}{16}$	[illegible]	$\frac{1}{8}$
X........	6	$\frac{5}{8}$	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{3}{16}$	[illegible]	$\frac{1}{4}$
Y........	7	$\frac{13}{16}$	$\frac{13}{16}$	$1\frac{1}{8}$	$1\frac{1}{4}$	[illegible]	
Y........	8	$1\frac{1}{16}$	$\frac{9}{16}$	$1\frac{1}{8}$	$1\frac{5}{16}$	[illegible]	

Numbers 1 and 5 for 5x9 in, $5\frac{1}{4}$x9 in, $5\frac{1}{2}$x10 in, $5\frac{1}{2}$x11 in and 6x11-in journals. Numbers 2 and 6 for $4\frac{1}{4}$x8 in, and special foreign $4\frac{1}{2}$x8-in journals. Numbers 4 and 8 for $3\frac{3}{4}$x7-in journals

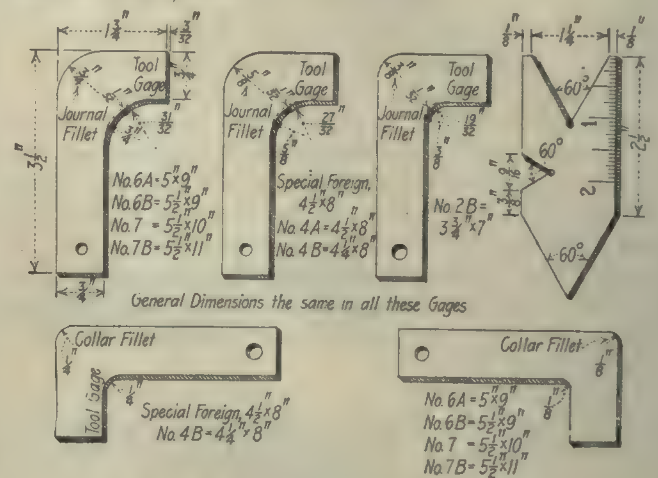


FIG. 7. VARIOUS SPECIAL GAGES

shown at *A*; the spindle is illustrated at *B* and the washers at *C* and *D*. The spindle is of tool steel, hardened and ground. The washers *C* are also of tool steel, hardened and ground, one being placed at each end of the burnishing roller, while the outside washer *D* is made of axle steel, as it merely forms a seat for the nut. The rollers *X* and *Y* are made of tool steel, hardened, and ground out for the spindle bearing and also on the outer curved face, as shown. The oil grooves in both the roller and the spindle are clearly shown. The table of sizes gives the dimensions of the rollers for different axles and also for both single- and double-ended lathes. The gages form an important part of the whole method and are shown in Fig. 7. They are made of $\frac{3}{32}$-in. tool steel and are hardened and ground. The outside corner gages the fillets on the different sizes of axles stamped on each gage. The inside corner, or curve, shows the shape to which the tool to be used is ground. This is not a duplicate of the radius of the journal, as can be seen by the difference between the solid and dotted lines. The space between these lines shows the amount of metal to be left by the tool for final rolling by the burnishing tool, already shown. The center gage is for testing the lathe centers and the centers in the axles. It is of the usual type, but is made longer and heavier for convenience in handling.

Heat-Treating Plant of the New Process Gear Corporation—II

By E. A. Suverkrop

SYNOPSIS—The furnace room where the case-hardening operation is performed is well lighted by means of a glass roof. The floors of the furnaces and that of the cooling dock are on the same level so that once the pots are raised to the level of the furnace platform no further lifting is necessary.

In Fig. 7 is shown a view down the center of the furnace room. This department is 50 ft. wide by 140 ft. long and is one story high. At the extreme back is the coke storage, into which the coke is shot from the spur track two stories above. Overhead trolleys run to each furnace and carry the lifting tools *A,* which take hold of the pots by the ears, as shown.

FIG. 7. FURNACE ROOM, SHOWING THE OVERHEAD TROLLEYS AND THE LIFTING TOOLS

The temperature of the furnaces is around 1650 deg. F. There is of course a fixed temperature for each analysis of steel and sectional area of work. A rule covering this has been evolved by Mr. Dodge, superintendent of the department. Its basis is the depth of the keyway and thickness of the tooth of the gear.

The furnaces are equipped for the reception of both base- and rare-metal thermocouples. Two protection tubes are provided in the top of each furnace. One of these is permanently occupied by a pyrometer; the other is used, without disturbing anything, for checking the permanent pyrometer. The cold-end junctions are carried to a central station, at which the temperature is maintained constant by an electric thermostat. This device controls the temperature within 3 deg. F. above or below normal. Each furnace is provided with an indicator. These are out of the way, but can be seen by the operator at all times.

Mention has been made of the cooling dock. If the reader will refer to Fig. 8, he will see how its floor level is arranged with relation to the floor level of the furnace room. In this illustration *A* represents the floor level of the furnace room, *B* the inclined runway to the cooling

dock and C the level of the floor of the cooling dock. One of the furnaces will be noticed at D, and at E may be seen the charging platform in front of it. The floor C of the cooling dock is at the same level as the charging platforms E of the furnaces in the furnace room.

By this arrangement of levels the men have no lifting to do when the pots are withdrawn from the furnaces. The overhead trolleys run right out to the cooling dock and connect there by means of switches to two overhead tracks running the full length of the dock. Simple hand-operated switches permit the workmen to transport the pots to any point desired. One of the lifting tools will be observed in this illustration at F and the overhead tracks at G. In Fig. 9 is shown a part of the cooling dock with the pots on the floor. The dock is raised about 4 ft. above the ground A outside. The sill B is of heavy steel and concrete construction, with an opening underneath to the outside air. Crosswise at C are heavy I-beams for the support of the standard grate bars D that form the floor. Thus indirectly the cooling floor is open to the outside atmosphere; and when the heated pots are laid on it, the hot air rising from them causes a draft that draws the cool air from the outside and accelerates the cooling. This dock is approximately 130 ft. long by 12 ft. wide. Vertically sliding steel shutters E can be raised or lowered as the treatment demands. Here, too, at F can be seen the overhead tracks and switches. To handle the pots on the dock, self-sustaining rope blocks G are used. When the pots are cool, they are raised with the block G and literally thrown along the dock by the workman. The track overhead is so level that the men with a vigorous swing can propel a pot the entire length of the dock, the block automatically sustaining the loaded pot during transit.

The pots are dumped at the other end of the dock—that is, at the packing-room end—over a hopper into which the fireclay luting, dust and hardening compound fall through the openings between the grate bars. This mixed material is then taken by an exhaust system to a separator that automatically removes the spent material, clay and dirt. The remainder, which is suitable for mixing with new compound, is sucked up to the mixing room on the top, or fourth, floor of the packing house, where it is mixed with new material in the proper proportions and shot down to the packing room again.

The work from the pots is placed in tote boxes and carried up on an elevator to the sorting room on the fourth floor of the hardening building, which adjoins the packing building.

The hardening building is four stories in height and covers a ground area 122x43 ft. It is of heavy concrete steel construction, as the loads of machines and material supported by the floors are very great. One sees gear rings stacked several feet high; at a rough guess these would run about 100 lb. per foot of height, so one can readily estimate that the floors must be extremely strong to support such loads without involving danger of collapse.

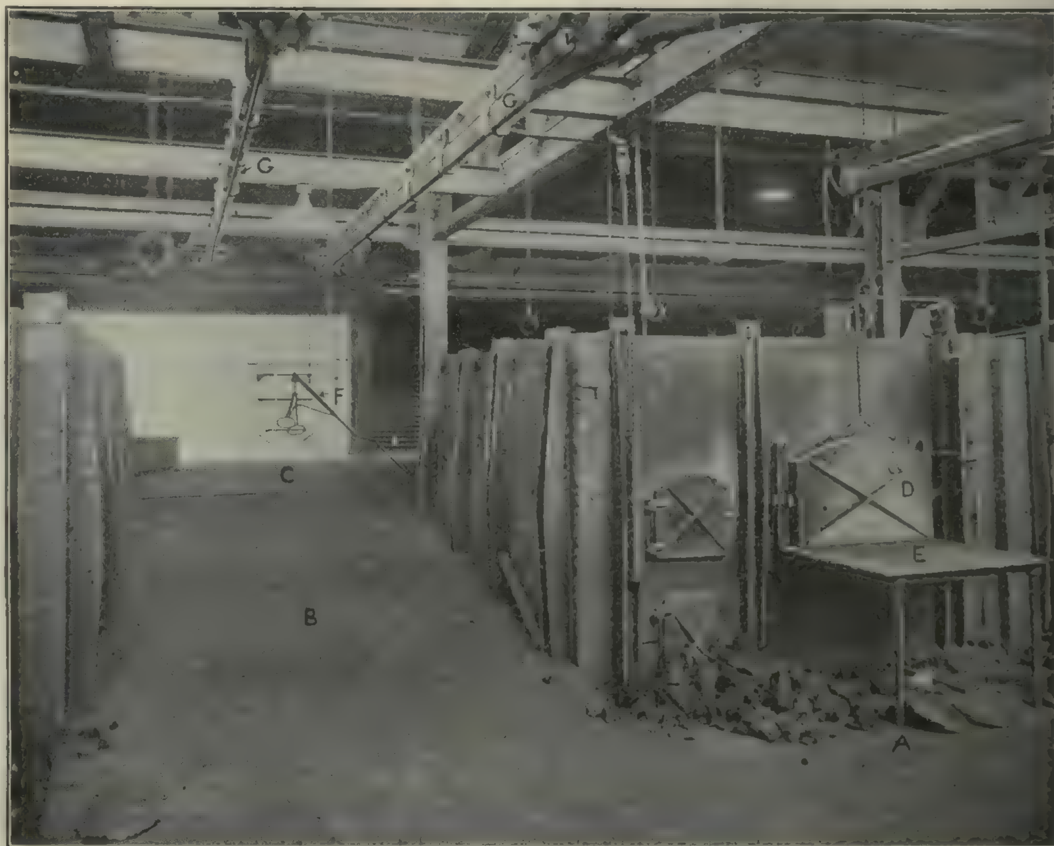


FIG. 8. RUNWAY FROM THE FURNACE ROOM TO THE COOLING DOCK

All gears and parts from the carbonizing operation go to the sorting room on the fourth floor of the hardening building. Here they are inspected for possible defects made visible by the carbonizing process and are also sorted out into lots according to their analysis, so as to facilitate their handling in the processes which follow; as obviously parts made from steel of similar analysis and for similar duty should receive similar treatment.

Large pieces, such as ring gears, are inspected and stacked singly on trucks. The smaller parts after inspection are wired together in bunches containing varying numbers of pieces. This is done for two reasons—to facilitate handling them into and out of the furnaces and quenching tanks and also to expedite counting them later on.

In Fig. 10 are shown a number of stacks of gear rings and a truck load of smaller pinions. The condition of all these is just as it was when they came from the carbonizing department; that is to say, they are a clean steel-gray in color, without scale. This is due to the protection offered by the reducing atmosphere liberated from the carbonizing compound in the luted pots in which

they were packed. Here and there they are slightly discolored, but this is only superficial and not caused by scale. The smaller gears shown in Fig. 10 are wired in bunches of five for the reasons previously stated. Part of the work in this department consists in wire brushing the gears, etc., to remove any of the carbonizing material that lodges in the tooth spaces or other depressions or holes. This cleaning facilitates inspection and assists in eliminating dirt from the quenching oil in the hardening tanks and system.

From the sorting room the gears are trucked through a communicating doorway to the hardening department, which is housed in two adjoining rooms on the fourth floor of the hardening building. In Fig. 11 is shown a part of the hardening room adjacent to the sorting room. It has been in use for some time and, owing to discoloration of the windows and the smoke from the furnaces and vapor from the oil quenching tanks, a satisfactory photograph was not obtainable. At *A* will be observed one of the oil-fired semi-muffle furnaces. They use ordinary fuel oil at 10 lb. pressure and air at 1 lb. A row of these furnaces runs along both sides of each hardening room.

It may be mentioned in passing that not only does all steel bought by the company undergo a rigid chemical analysis, but all coal, oil and other materials used in the factory are analyzed in the company's own laboratory.

In this room there are 12 such furnaces, six along each side, two cyanide pots and two General Electric oil drawing furnaces. The air for the furnaces is supplied by General Electric turbine blowers and is preheated, but this will be described later in connection with Fig. 12, which shows the other hardening room.

At *B* are two of the oil quenching tanks, which are supplied with clean cool oil from the bottom and are kept constantly overflowing. Each tank is provided with a screen bottom *C*, which catches the work and is raised and lowered by an air hoist *D*.

In Fig. 12 is shown the other hardening room and, more clearly than in Fig. 11, the arrangement of the furnaces and pipes. The air for the burners is preheated to a temperature of about 200 deg. F. in the following manner: The waste heat from the furnaces *A*, Fig. 12, is led up through the drum *B* on top of each furnace, passes up through the two ducts *C* into the waste-heat pipe *D* and out into the open air through the vertical pipe *H*. The air for the burners is, as previously stated, supplied by General Electric turbine blowers. It passes through the T-shaped pipe *E*, which serves two furnaces. The air on entering the drum *B* passes into a helical heating coil, which is exposed to the action of the waste heat from the furnace. It passes at the other end of the drum *B* into the L-shaped pipe *F* and is carried by it down to the burners *G*, of which there are two for each furnace. Heating the blast in this manner is economically attained and has the desirable feature of driving out the moisture, making it more efficient in the operation of the burner. Each furnace is provided with a pyrometer of the same make as those used in the carbonizing department. The same method of control for the cold junction is also employed, and the indicators for each furnace are also similar.

FIG. 9. COOLING DOCK, SHOWING THE FLOOR MADE OF GRATE BARS

The carbonizing process leaves the gear rings with the core—that part inside the "case"—more or less coarsely crystalline. This condition must be corrected before the condition of the case is ameliorated. In order to correct it the procedure is similar to the original heat-treatment that was given to the rough forging when it first arrived at the factory. The rings are carefully charged a number at a time into the furnace and brought, in the case of nickel steel of the analysis chiefly used in this plant, to a temperature of about 1540 deg. F.

When this heat has been reached, the rings are removed one at a time on a steel hook and quenched in oil. It must be remembered that this treatment is merely to correct the core and does not result in a gear that is ready for use. The rings are dipped edgewise quickly in the oil, and the operator moves them gently back and forth in it. The handling in this operation is carried out as carefully as possible, so as to avoid distortion. Slight distortion that may occur is corrected in the second, or low, heat.

Referring again to Fig. 11, at E is shown a Gleason hardening machine, which is used for hardening the ring gears. These machines are so well known that a short description should suffice to make their operation clear. When hardening such objects as ring gears, where the sectional area of the work is small as compared to the size of the piece, there is great difficulty (when hardening in the ordinary way by heating the piece and, while suspended from a hook, quenching it in oil) in keeping the work straight—that is, keeping it from warping. Hanging from the hook, one edge of the work strikes the cold oil first; and no matter how quickly it may be submerged in the quenching medium, there is unbalanced contraction, with consequent greater or less distortion. This is just what these Gleason hardening machines were designed to overcome, and this is the way in which they overcome it.

It was argued by the designer of the machine that, if the gear or other piece to be hardened were rigidly held while being quenched, there would be less chance of distortion; and this is the principle upon which the design of the machine is based.

The machine consists of a quenching tank and two vertically moving plungers. The base of the machine forms the tank, which is supplied from the bottom with a constant stream of cool fresh oil, the heated oil con-

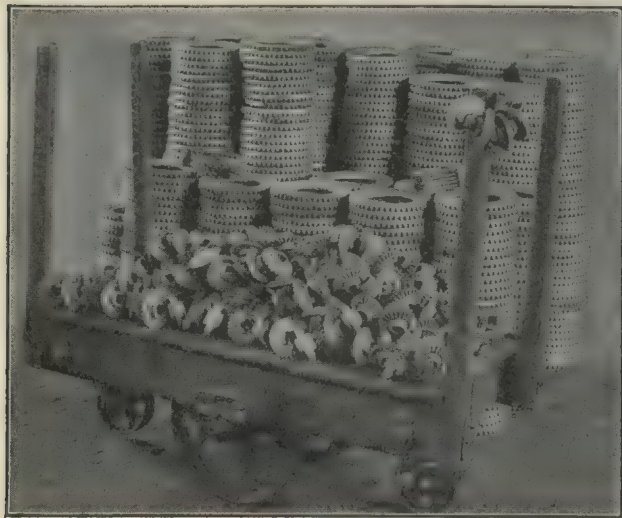


FIG. 10. GEARS IN THE SORTING ROOM

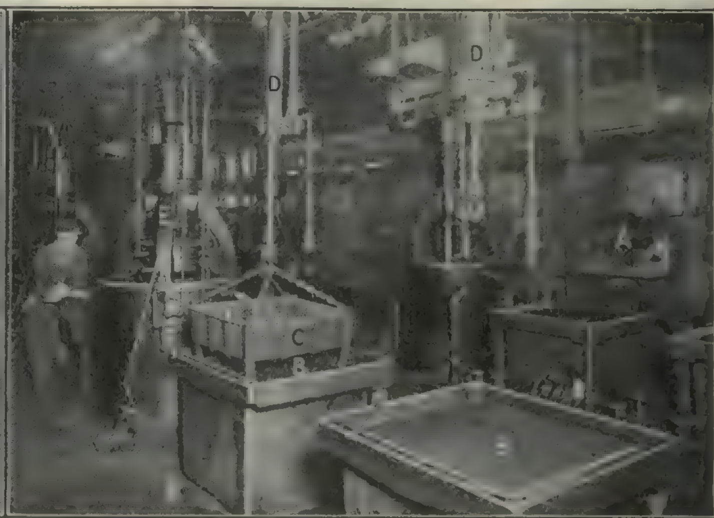


FIG. 11. PART OF HARDENING ROOM

FIG. 12. LATEST HARDENING ROOM, SHOWING ARRANGEMENT OF PIPING

stantly overflowing at the top and passing to the waste pipe leading to the storage tanks. In the center of the tank is a plunger, the vertical movement of which is from a position about 6 in. above the surface of the oil to about 1 ft. below its surface. Above the tank is another plunger the movement of which, in a vertical direction, is from about 2 ft. above the surface of the oil in the tank to a position about 1 ft. below it.

Heavy steel dies are made to fit the gear to be hardened. Each shape of gear requires two dies, an upper and a lower. These dies are bolted to the faces of the upper and the lower plunger respectively. The operation of the hardening machine is as follows: A heated gear ring is inserted by the operator in the bottom die when it is at its normal position—that is, when it is above the surface of the oil and at rest. The machine is then tripped, and the upper plunger descends till it brings up against the ring gear, which is now clamped firmly between the two dies affixed to the plungers. Both plungers proceed to descend, carrying the gear ring between them down into the oil to a depth of about a foot. Liberal passages for the circulation of the oil are provided in the dies, and through these it rushes, cooling the exposed parts.

On reaching the bottom of the stroke the plungers pause for whatever space of time necessary to bring the rings to the desired temperature. They then reverse, traveling upward together till the bottom plunger has reached the limit of its upward travel, when it stops. The upper plunger proceeds on upward till it comes to a stop at the limit of its travel. The danger of warping is now past; the operator removes the gear from the bottom die in the machine and finishes the quenching in the tanks shown at *B*.

The Gleason hardening machines are used for the second, or low, heat only and on work that is likely to warp. This heat is to correct the case—that is, to give it the durability necessary to resist wear. With the steel under discussion the temperature is around 1360, and the quenching medium is oil. After coming from the machines the gears are drawn slightly to render the case less brittle. Then the gears go to a bath of hot soda to remove the oil.

Selective Assembling and Interchangeability

By F. H. Bogart

It is apparent from casual conversation with various classes of men employed in manufacturing plants that there are widely varying ideas as to what is meant by the expression "selective assembling" and as to the relation it bears to interchangeable manufacture.

Not long since I was surprised to hear the superintendent of a large plant manufacturing an interchangeable product refer, in conversation with his chief inspector, to selective assembling as if it were a process of promiscuous picking and matching together from a stock of the various components of an assembly such parts as fitted, the character of the fit being solely a matter of the personal judgment of the assembler. This incorrect idea of the method is not confined to a few, yet it is as far from the fact as guesswork is from mathematics.

Selective assembling is mathematics in its simplest form—addition and subtraction. Instead of being a hit-or-miss process akin to guesswork, it is the most highly refined type of assembling known to the mechanical art; and other things being equal, the method produces a unit of much greater uniformity in its mechanical characteristics than can be assembled from interchangeable parts. In other words, assembling by selection is a higher mechanical refinement than interchangeability.

Just what is meant by the term can best be made clear by a description of its application in the assembling of a certain type of ball bearing. Fig. 1 represents two hardened and ground thrust plates and a conventional type of ball cage. Theoretically, a bearing of this type might be 0.775 in. thick, made up of two thrust plates each 0.200 in. thick and a cage containing $\frac{3}{8}$-in. balls. In manufacturing for selective assembling, two methods may be followed: (1) Tolerances may be allowed on the thickness of the plates, and the parts may be gaged during the processes of manufacture to hold within these tolerances; or (2) no gaging at all may be done in manufacture, the department foreman being held responsible for keeping to a certain degree of accuracy established as a shop standard.

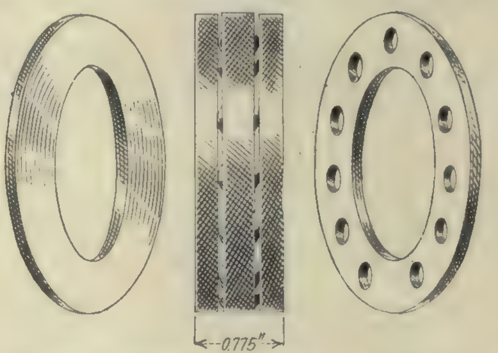


FIG. 1. TWO THRUST PLATES AND A BALL CAGE

In either case the process of selectively assembling such parts is the same and requires that the equipment include a gaging machine for rapidly testing the relative size of each part. This should preferably be a device that allows the parts to be gaged to slip very handily under a measuring point attached to a dial or pointer. The height of the measuring point should be adjustable within certain limits, so that when a size block or sample ring of the theoretically correct thickness is slipped under, the dial or pointer can be adjusted to zero. This gaging device must be mounted on a gaging table, the top of which is divided into classified sections, the general layout being shown in Fig. 2.

The process of gaging preparatory to assembling then consists of sliding every ring successively under the gaging point, reading from the dial whether standard or plus or minus so many thousandths, and piling the rings in the correct classified section on the gaging table. If the parts were manufactured to tolerances, the limit of variation from standard would supposedly be governed by these tolerances. It is not necessary, however, that they be so governed; and it is apparent that, where parts are to be assembled by this method, producing them to tolerances up to the point of gaging is in the nature of a needless expense. In actual practice a small percentage of parts will gage outside the greatest variation provided for, and these are marked plus 0.008 in., or whatever the odd size happens to be, and put all together in a special pile in the space marked plus.

Assembling now becomes a simple process of matching complements. Assuming that the balls gage standard 0.375 in., pairs from opposite sections give the correct total thickness. After all complements have been matched in a given lot, an account of stock is taken and some wrinkle worked to even up the mismated parts. If the balance is on the plus side, a certain quantity may be marked and returned to the grinding room and specially ground thinner. If on the minus side, the stock of oversize balls that every bearing manufacturer carries is drawn upon and the thin pairs combined with an extra-thick cage.

The foregoing is a special case, but it illustrates fully the principle involved in selective assembling. At the same time it shows that there is no relation whatever between a selectively assembled product and an interchangeable one. In fact, interchangeable is just what it is not; and wise manufacturers of selectively assembled parts openly advertise that their product is not interchangeable. They warn the user that, if anything goes wrong, the entire assembly should be returned to the factory for repair. Thus it will be seen that, while the expressions selective assembling and interchangeability are commonly used as closely corelated, they are really about as far from each other as east from west and represent entirely contradictory principles of manufacture.

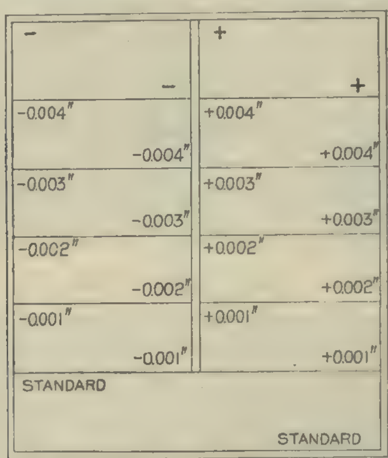


FIG. 2. TYPICAL GAGING TABLE

To what extent selectively assembled parts represent a greater degree of mechanical refinement over an interchangeable product will be clear from the following comparison: A hardened and ground pin is to be made a running fit in a bushing. The dimensions are: (1) For interchangeability—pin diameter, 0.750, minus 0.001 in.; diameter of hole in bushing, 0.751, plus 0.0005 in. (2) For selective assembling—pin diameter, 0.751, minus 0.003 in.; diameter of hole in bushing, 0.749, plus 0.003 in.

An analysis of the interchangeable dimensions shows that, while a clearance of 0.001 in. is possible, it is equally possible to have a difference of 0.0025 in., which on parts of this size would be a "sloppy fit." The parts of the second class, on the other hand, would be gaged and paired to give a uniform clearance of 0.001 in. between each assembled pin and bushing. Not only is the mechanical advantage apparent, but it will be noticed from the dimensions that selective assembling permits a much wider range of tolerance—a distinct advantage from the standpoint of economical production.

The choice of method as applied to the manufacture of a certain product must depend upon the judgment of the individual manufacturer. It is gradually becoming apparent, however, that the public demand that the separate components of any mechanism purchased be interchangeable—to the extent that broken or worn-out parts can be ordered from stock and fit into place without alteration—will limit the field of the selectively assembled product to such devices as constitute an assembled unit in themselves. Parts of this character, as for instance the standard types and sizes of ball bearings, are naturally purchased as a component of a larger assembly. While it is demanded that they be interchangeable to a high degree as an assembled whole, the proportioning of the separate parts is left to the manufacturer's judgment.

New Aluminum Material

Under the name "Acieral" the Acieral Company of America, 26 Cortlandt St., New York City, is introducing a metal that is 97 per cent. aluminum, in a chemical combination that gives remarkable results. It is silver white in color and is said not to oxidize either in air or water, fresh or salt. It melts at 1332 deg. F., has an expansion coefficient of 0.0000153 in., specific gravity of 2.82 and is sonorous like bell metal. It can be cast, in dies or in sand, forged, drawn and tempered to some extent.

Castings have a tensile strength of 30,000 lb. and an elongation up to 5 per cent. In rods and sheets the tensile strength runs up as high as 64,000 lb.; and when tempered, to 72,000 lb. with an elongation of from 5 to 25 per cent. and a reduction of area from 10 to 35 per cent., according to specifications. Its hardness in castings is 119 Brinell or 35 scleroscope.

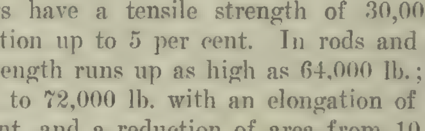
The metal was exhibited at the automobile show, one piece being a helmet such as is used by the French soldiers in the trenches.

Rapid Method of Laying Out Tapers

By J. H. Moore

The method of laying out tapers illustrated herewith is simple, though it is one that is seldom thought of or used.

Referring to the example illustrated, where it is desired to lay off a taper of 1 in. in 6 in., first draw a center line with perpendiculars at each end and 6 in. apart. The diameter at the large end is given as $3\frac{1}{2}$ in. On one perpendicular lay off two points, each one-half of $3\frac{1}{2}$ in., or $1\frac{3}{4}$ in. from the center line. As the taper is to be 1 in. in 6 in., subtract 1 in. from $3\frac{1}{2}$ in. The difference is $2\frac{1}{2}$ in. On the second perpendicular lay off two points, each one-half of $2\frac{1}{2}$ in., or $1\frac{1}{4}$ in., from the center line. Connect the points on the perpendiculars, and the required taper is laid out.



METHOD OF LAYING OUT TAPERS

Standardization of Airplane Parts*

BY F. G. DIFFIN†

The subject of standardization of airplane parts is very wide and sweeping. The growth of this industry has been and will be tremendous, and may rank very close to that of the automobile in size and influence. It is therefore of paramount importance that immediate and intelligent action be taken by recognized authorities toward the definite standardization of parts.

As my aëronautical experience has been entirely in the manufacture of metal parts and fittings, I am confining my remarks to the existing conditions and recommendations toward their permanent betterment. First, let me enumerate the troubles that are now met by parts manufacturers and passed along, many fold, to airplane manufacturers. Of screw-machine products alone, of a well-known type of machine, there are over 3000 separate parts. Many of these call for from two to ten operations.

While the majority of manufacturers run somewhat along the same line in their specifications, we today have orders for one specific size of bolt, for practically the same purpose on the various makes of machines, calling for the use of six different metals. We are also asked to make this bolt in over 60 different lengths, and practically the same conditions hold forth in eight different diameters.

Should such specifications become general, it will thus be seen that on hexagonal head bolts alone it would be necessary for us to be prepared to manufacture 2880 separate items in order to fill airplane requirements.

An additional bolt complication is the varying thickness of heads called for by the different manufacturers. There can be only one head necessary—that is, the head with the necessary thickness, giving proper factor of safety; at that point, any additional thickness is superfluous matter that adds very materially to wind resistance and weight. Less than that thickness is dangerous. It is our belief that fully 75 per cent. of these specifications can be eliminated.

As to clevis pins, we are asked to furnish nearly a thousand separate items involving various diameters, lengths, different sizes of cotter-pin holes, different radii on the nose and different radii and thicknesses on the heads. Orders call for many different thicknesses of castellated nuts, all largely for the same purpose. Of these designs, some are required in cold-rolled, casehardened and nickel steel. Many of these variations can be eliminated.

NICKEL STEEL HARD TO MACHINE

The machining of nickel-steel castellated nuts is one of the most difficult operations that we have had to contend with, and we are by no means satisfied with the results obtained so far, nor are we fully confident that satisfactory results can be obtained. The difficulty pertains to the cutting of a true thread.

We are asked to manufacture various other parts, such as eye-bolts, shackles and terminals, of various sizes, and other parts too numerous to mention, all with a wide range of specifications. It is obvious that the ultimate uses are the same, and it is of vast importance that the various dimensions and varied sizes of these parts be minimized as far and as quickly as possible.

I have enumerated, rather briefly, part troubles in general, from the manufacturers' standpoint. I will now tell what these difficulties mean to the manufacturer. With the wide divergence in size and with the many kinds of material called for, there are many small orders for each part, each urgently needed. In order to secure production for automatic machines it is absolutely essential that fairly long runs be made.

CHANGING MACHINES FOR SMALL LOTS

We have frequently changed our tools on a machine several times a day, in order to get out the small number of parts required. The buyer is frequently at a loss to understand why his order for 100 or 1000 bolts, as the case may be, is so slow in being manufactured. Could this wide range of parts be materially cut down, the parts manufacturer would be further warranted in running stock, provided he had any assurance that the size would be in demand in the future. Today, we are uncertain as to what will be required in that future.

Such a standardization would be of great benefit to the parts manufacturer and of much greater benefit to the airplane manufacturer. The number of airplanes manufactured will be dependent on the productive capacity of parts manufacturers. The situation has become very acute today, but will become very much more so in the near future.

With the average man, it would seem a simple matter for any manufacturer to furnish airplane requirements. We have found to our own satisfaction that the machining of airplane parts is a business by itself, to be taken up in a small way as machines can be adjusted to speeds, feeds, etc., for nickel-steel production and as men can be educated in the production of parts up to the absolute specifications required. All this takes time; and while we are not a large factor in the manufacturing of airplane parts, we have built up a good manufacturing organization. It has taken us over one year to accomplish this; and even if we could obtain the equipment, we would not feel able to double our productions, except as we could gradually increase our organization—keeping it up to necessary efficiency in all branches.

The metal fittings now required in airplanes are in the same class as the screw-machine products, as there are many and various types. Could these parts be standardized, the airplane manufacturer would find that the cost of many of them would be but a small fraction of the present cost. Probably the most important individual factor of airplane manufacture is the turnbuckle, and as such, it should be treated in a separate article.

I recommend the following points for early consideration:

The most important results to be gained from standardization are greater and constant production from parts makers, which would make possible the manufacture of a greater number of airplanes. This is of particular interest to the Government of this country, should an immediate need arise for the manufacture of large quantities of machines.

*Read at Pan-American Aëronautic Exposition.
†Sales Manager, Erie Specialty Co.

The airplane manufacturers will be able to effect large savings on their costs and general operation. They will be required to carry less stock, as the number of parts will be much less; and they will be sure of certain supplies of quantities needed and greatly reduced prices per item.

The manufacturers will find that uniform parts will be of great assistance in assembling.

Future owners, either Government or individual, will be able to obtain necessary repair parts quickly and cheaply.

Standardize Sizes and Material

Of particular interest to the Government in the near future, as it is to purchase various types of machines, is the fact that standardization will mean interchanging parts for the various types of machines and will be a very important item in supply depots.

Probably one of the greatest reasons, by far, for standardization is that unless standardized and rigid specifications are recommended and strictly adhered to by both parts manufacturers and the airplane manufacturers, a large element of danger will be introduced. For owing to the rush of work, improper metals will be used, heat-treatments will not be properly made, etc., with the inevitable result of serious accidents in flights, resulting in loss of life and lack of confidence by the public in the stability of airplanes. The big future of the airplane, which we are all anticipating, will only be secured by the pubic's having as much confidence in the safety of a flight as it now has in the automobile.

Now, to specific recommendations looking toward standardization. These may be embodied under a few general heads and with a few specific recommendations.

Material—The selection of the particular type of alloy steel is directly controlled by the function of the member for which the material is designed. In some cases there would be no direct advantage in using an alloy steel for washers, sheet-metal parts and nuts.

Designing Specifications—Such specifications must necessarily combine both the theoretical considerations and the practical methods of manufacturing. Consideration must be given to the material producer's point of view in order to avoid an unnecessarily severe specification to accomplish some minor purpose. While, at all times, a high grade of material, far above the average commercial type is demanded, full regard should be paid to the manufacturing methods of economical production.

Selection of the Material—This should depend on the ultimate use of the parts in question and their function. A part should have certain physical properties, ultimate strength, tensile strength, yielding point, etc. This recommendation, while only general, should be specifically applied to each and every individual part.

Needless Bolt Diameters

Referring to the subject of bolts, I would recommend:

That lengths be standardized as far as possible.

That needless diameters be eliminated; for instance, there is no practical need of both $\frac{3}{16}$ and No. 10 bolts.

More than one material for certain functions is surely unnecessary. In the majority of instances today, 3½ per cent. nickel steel, with proper heat-treatment, fills the requirements with a liberal factor of safety.

A certain standard should be fixed in regard to the thickness of head. Up to certain diameters, let there be one fixed thickness; above this diameter, each head should be a certain fraction of the diameter, all to be determined for necessary strength, plus a necessary factor of safety. On this specific item the parts manufacturer is asked to make upward of 15,000 separate items, and by standardization a very large percentage of these items will not be asked for.

My recommendation as to clevis pins is to use as limited a number of diameters and lengths as possible. Where a cotter-hole pin is required, let this be the same size in all pins of given diameters. As the head on the clevis pin need be no stronger than the cotter pin, it is only necessary that this head be of one thickness in proportion to its diameter. Different radii on the edge are absolutely useless.

Alloy-Steel Nuts Unnecessary

We have thoroughly investigated castellated nuts, both in our own laboratory and through the testing department of other manufacturers. We recommend—for economical production, accurate production and quantity production—that the use of a nickel-steel nut is no longer necessary. The function of a nut is to obtain good purchase on the threads of the alloy-steel bolts. Satisfactory results can be gained by using cold-rolled steel of proper carbon content and properly case-hardened.

For a certain diameter of bolts, desirable results can be secured by the use of one thickness of nut only, and the innumerable specifications as to thickness, radius, etc., in vogue today with various manufacturers should be reduced to the one practical dimension and radius required.

A source of ever-present manufacturing difficulties is in ball-head nuts and bolts, due to the varying radii required. The size of the ball head and nut is necessarily controlled by the function of the member in which they are placed; and as at present designed, they have several hundred per cent. excess strength.

As the different designs in heads and nuts, both as to radius and thickness, are many and varied, one radius, one thickness and one diameter in proper proportion to the metal and diameter of the shank are all that is necessary.

I cannot make too strong a plea as to the urgent necessity of immediate standardization of all parts used in the manufacture of airplanes.

Expanding Bronze Bushings

By A. B. Nelson

The following kink, which saved some large wristpin bushings from the scrap heap, may prove of value to others, as it is applicable to many classes of work.

The bushings were tough bronze castings and were finished 7.015-in. driving fit by 5½-in. bore. The bore is left $\frac{1}{8}$ in. small and finished to size after assembling with the connecting-rod.

In machining the pieces were turned to 7 in., leaving no drive and apparently spoiling the job. However, the following scheme was hit upon.

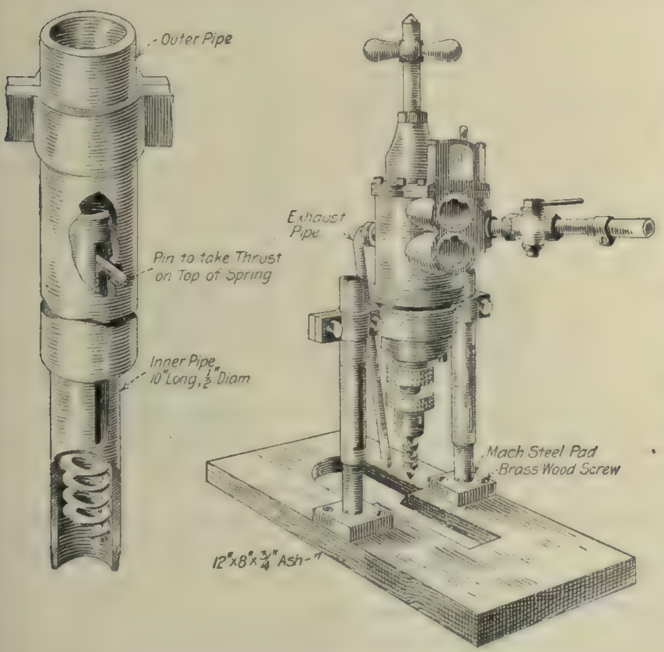
A plug was turned about 0.001 in. smaller than the bore for about 4 in. and then gradually tapered to 0.015 in. larger. It was then driven through the bushings by a hydraulic press, which expanded them enough to make a drive fit.

Letters from Practical Men

Portable Boring Machine for Molds

Which shall be done—carry the work to the machine or the machine to the work? This question can only be answered after a careful study of the product, for from such a study will be revealed the costs, which determine the answer. In many cases it is possible to rig up portable machines by the use of which the handling costs will be reduced many fold, but a reduction in cost can also be attained by fitting up a portable machine for boring templets in the mold loft.

In the mold loft it is customary to do all mold boring on a stationary boring machine. This means that the templets must be carried to the machine. These templets are usually of such size or length that two workmen are required to handle them to and from the machine. When it is taken into consideration that one of these men is usually a loftsman, it is readily seen that this process is not economical. When large or irregular-shaped templets, as frames in the fore- and after-body, are to be bored, two or more hands are required to hold the work; and some of these templets will be of such size that it will not be possible to handle them at the machine, the boring having to be done with brace and bit.



THE PORTABLE BORING MACHINE

The portable boring machine shown in the accompanying illustration does away with the carrying of molds. In this case, then, there is a cost reduction in carrying the machine to the work, as the boring can be done on any part of the floor, by the placing of a block of wood under the bit to prevent cutting into the flooring. A boy can do this work alone, as it requires no holding or handling. It is possible for one or two boys using this type of machine to bore all work, no matter what its nature.

In most instances air lines and connections will have to be run in order to make use of this machine. Where electric-light plugs are available, an electric machine might be practical. Before final decision it will be well to consider the advantages and disadvantages of each type. The air-line installation involves the following costs: Original installation, interest on investment, repairs, maintenance and depreciation.

All shipyards have pneumatic drills in stock suitable for this work, but not always an electric machine. There is invariably an expert pneumatic tool repairman, but seldom an expert on electric tools. The exhaust air from the pneumatic machine is of advantage in blowing the borings away, thus permitting the accuracy of the work to be observed; this cannot be done with an electric machine. When a loftsman starts a job on the floor, the first thing he does is to sweep the floor with a broom; sweeping the loft floor with brooms is a big job. But by detaching the hose from the pneumatic machine, and regulating the flow of air, the work of sweeping is expeditiously performed. The air hose readily removes the dust and dirt from stored molds and also from storage racks, nooks and corners. The electric machine cannot be applied to this work. So considering the increased facilities with which the same tasks are performed, the pneumatic machine is the better adapted to the work.

While in many yards paper has supplanted wood for plating templets, thousands of feet of wood templets, however, are still used for frames, beams, stiffeners, bounding angles, clips, stringers, staples, longitudinals and applying pieces. Anyone familiar with loft work will realize the amount of wood required for these templets.

Brooklyn, N. Y. WILLIAM M. KENNEDY.

Gear Cutting with a Quadruple-Thread Hob

When hobbing spur gears on a gear-hobbing machine of the usual type, it is common practice to use a single-pitch hob of the same lead as the pitch of the gear being generated. We make a great number of gears of a very fine pitch; usually about 25 diametral pitch with from 100 to 200 teeth. We use a high-speed steel hob, the revolutions of which bear a direct relationship to the revolutions of the work table. For every revolution of the work table, we use a downward feed of $\frac{1}{32}$ in.

When using a single-pitch hob and cutting a gear with 200 teeth in it, we had to revolve the cutter 200 times per revolution of the work table. The chips produced were very fine, and the whole operation was obviously slow, and we knew that the machine could be used to better advantage. We could not increase the speed of the cutter nor could we increase the downward feed, as then the feed would have been too coarse.

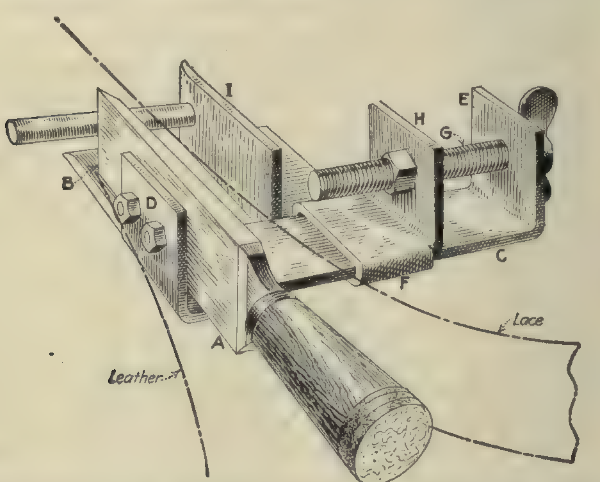
We finally adopted a quadruple-pitch hob with a lead four times the pitch of the gears which we were generat-

ing. This enabled us to revolve the work table four times as fast, thus multiplying our output by 4. We believe that we can go still further, but owing to the increased angle of lead in a quintuple or sextuple hob, it would be advisable to correct the section of the hob thread.

Philadelphia, Penn. STEVENS & PAGE.

Gage for Splitting Belt Lace

A practical device for splitting belt laces can be easily and quickly made as follows: It consists of three principal parts. *A* is a knife or wood chisel sharpened at the end and cuts with the front edge *B*. It is fastened



CUTTING LACE OF DESIRED WIDTH FROM LEATHER

to the bent-up part of *C* (marked *D*), which is made of brass or iron plate, with two small bolts. The opposite end *E* is likewise bent up, after *F* has been slid on, and has a hole for the adjusting screw *G*. The third part *F* is made so that the loop *F* can slide over *C*, and part *H* also has a hole for the adjusting screw. A guide *I* for the side of the leather has a top guide, which serves to keep the leather down flat.

The leather is placed on the floor or bench and the screw *G* adjusted to the desired width of the lace. A cut 3 or 4 inches long is first made in the leather the width of the lace and serves to get a right start. This part of the lace is put between the knife and the guide, and the leather is held with the left hand while the right hand pushes the device forward, raising the leather slightly from the bench.—B. Z. Reiter in *Power*.

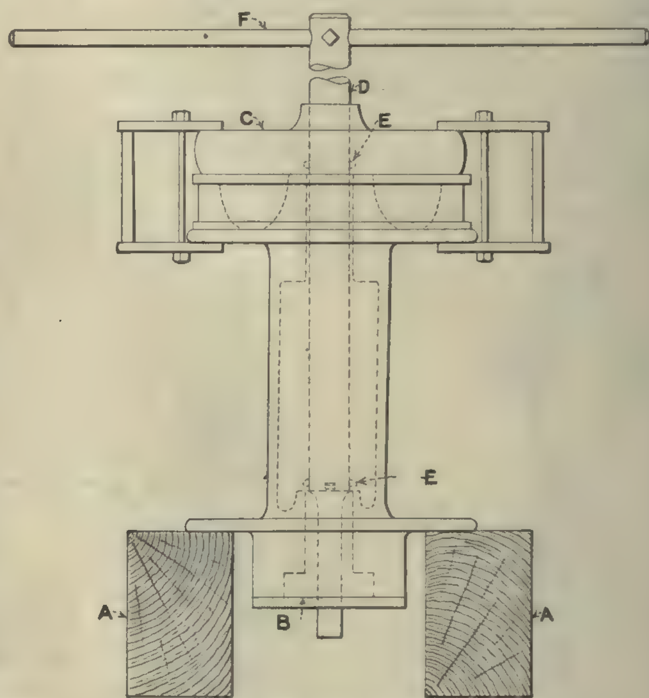
Boring a Large Winding-Engine Drum by Hand

A description of the manner in which a large winding-engine drum was bored by hand in the machine shop of a large harbor works in Wairoa Hawkes Bay, in a remote part of New Zealand should prove of interest to readers of the *American Machinist* as the job had to be done without the customary machines.

Among the equipment of the concern was a large winding engine, the drum of which was of the friction type commonly used.

This drum revolved on the shaft when the rope was being unwound, and in consequence the bore had become so badly worn that the friction blocks would be in contact when they were meant to be clear, and they would not hold when engaged. It was decided to rebore the drum, to admit of bushing it with phosphor bronze, and also to machine the shaft journals, which fortunately had been left big enough at the bearing points. The shaft was easily trued, the difficulty being to bore the drum, as we had no lathe or machine large enough to take it.

We overcame the obstacle in the manner shown in the illustration. The drum was stood on end upon two wooden blocks *A*; in the small end was inserted a bushing *B* that was slotted on the inside to allow the chips to fall through. On the large, or friction, end we placed a



THE BORING BAR IN POSITION

pulley wheel *C* that had been machined all over. A long piece of 4-in. round steel *D* was used as a boring bar; this was turned to fit the pulley and the bushing, and was fitted with four $\frac{1}{2}$-in. square bits *E*.

The first two cutters took the main cut, leaving very little for the two following cuts. The drum was clamped to the blocks, these in turn being nailed to the floor. The top end of the bar had a $1\frac{1}{4}$-in. hole drilled through, and in this was inserted a 7-ft. steel bar *F*. The power was supplied by two men pushing the bar around. The feed was obtained by the weight of the bar itself and additional weights placed on top of the bar. One end of the drum was bored from $4\frac{1}{2}$ to 5 in. in diameter by 7 in. long, the other end being enlarged from 3 to $3\frac{1}{2}$ in. in diameter by 5 in. long. The material was a rather soft cast iron.

When the cutters were coming through we met with a little difficulty, as we had to take off some of the weights and substitute a ratchet on the lower end, which was eased off bit by bit until the cutters were all through. The job, which was smooth and parallel, was finished in one cut, and proved to be entirely satisfactory in every way. It was done quickly and easily and did not involve any undue amount of labor or expense in its execution.

Wellington, New Zealand. VINCENT FAMA.

Discussion of Previous Question

Flexible-Coupling Trouble

On page 132, Mr. Orr has endeavored to explain the vibration set up by the incorrect lacing of a flexible coupling. By way of example, he states that a man in the act of turning a crank would be changing the force that his feet exerted upon the floor. This illustration merely shows that the turning moment he describes causes vibration, but it does not show why there should be excessive vibration (with the coupling laced incorrectly) when the power is applied and none when the current is shut off.

Perhaps this can be explained in the following manner: Referring to Fig. 1, when the current is applied the torque induces tension in the strap *A*. This tension

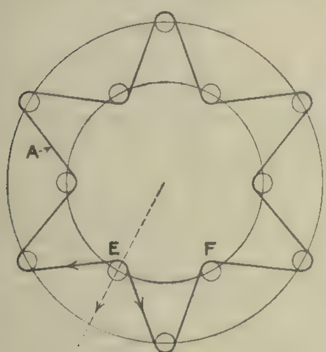


FIG. 1. A CORRECTLY LACED COUPLING

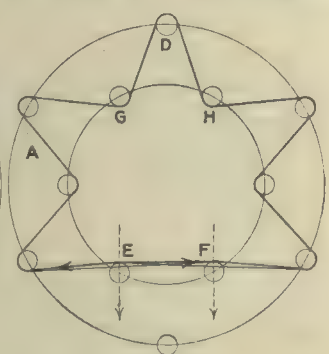


FIG. 2. AN INCORRECTLY LACED COUPLING

exerts a radial force on pin *E* and similarly on all the other pins. The pins are evenly spaced and therefore the forces are balanced.

Now, referring to Fig. 2, when the power is applied the tension in *A* is as before, but the forces on pins *E* and *F* are not radial; this breaks the balance of forces and vibration is set up. When the power is shut off the tension in strap *A* is removed and the forces on the pins cease, with a consequent cessation of vibration.

When Mr. Orr took the strap off pin *D* he caused forces similar to those acting on *E* and *F* to act on pins *G* and *H*, and therefore the balance was renewed.

Ontario, Canada. H. C. MABEE.

The "Coincider" Who Always Agrees with You

I was interested in Mr. Brophy's recent article on the coincider, page 88.

Just as bad, if not worse, is the knocker who invariably disagrees with you. No matter how meritorious an idea or how accurate a statement, he will make it his business to disagree. Nearly every shop has this "pest," either as employer or employee.

However, he is most prevalent among foremen; and when those under him broach an idea that might be profitable to the firm, he says: "Oh, we've tried that! It won't work." And every time this happens three parties are directly affected: The workman, whose spirits are dampened—he will hesitate to propose other ideas and forthwith becomes grouchy; the firm, which suffers because a know-it-all, knocking foreman checked a possibly good idea; the foreman, who loses the good will of his men.

The coincider may be dangerous, but look out for the fellow who is so brilliant that he can criticize and condemn anything you propose—before you have had a chance to explain its qualities.

How different is the foreman who, whether he really thinks well of the idea or not, diplomatically says: "Sure! It sounds good! We'll think it over and try it. It might be all right." And the chances are that it is all right; and instead of adversely affecting all those concerned, everybody is happy.

When one is asked to give an opinion on anything new, is it not better to take into consideration the fact that the one who makes the suggestion has spent some time on the subject and, therefore, is entitled to at least a fraction of that time for a verdict?

Chicago, Ill. NORMAN V. CHRISTENSEN.

Drafting Room Versus Shop

It is refreshing to find some one willing to admit that there is strife between the drawing room and the shop and sympathetic enough to analyze the causes of this ancient feud. Draftsmen are prone to dismiss the really legitimate howls that are heard from the shop with a sniff of contempt. The shop is always howling, let them howl! But, as Mr. Horton says on page 147, after making due allowance for the unholy joy of the machinist who catches the draftsman in a bull, there is usually just cause for complaint.

In the first place, draftsmen might just as well admit at the outset that machinists are as they are and are likely to continue to be so. In the second place, they should keep in mind that the machinist is the ultimate consumer of their product—the drawing. With these two points in mind, the draftsman will soon come to understand that his lot in life will be happier if he makes his drawings to suit the shop, instead of trying to educate the shop to like his drawings!

The attitude of the shop is perfectly natural. To the machinist the drawing is merely one of his tools. It is one of the means he has to use to get the result wanted. If this tool is deficient in any respect, he has a right to cry loud enough for the drafting room to hear. He raises just as loud a howl when his other tools are not to his liking; and it is only a demonstration of the fact that machinists are real human when the chance to crow over the "white shirt and collar" is made the most of. But there should be no cause for regret over this strife. It is worth a lot in the shop organization. If any sort of a drawing could get by in the shop without this howl, it would not be so

very long before drawings would be checked in the shop—with a cold chisel or a chipper or a mounting pile of scrap!

Most of the trouble lies in the drafting room. Whether, as Mr. Horton says, the draftsman is a graduate of a technical school or one who slipped into the drawing room through the side door, he is apt to possess two fundamental faults. One is a tendency to look upon the drawing as the finished product instead of what it really is—a very humble instrument in the making of the finished product. As a result of this tendency drawings get into the shop—drawings that are works of art as *drawings*—that the machinist finds hard to read. Hence the howl, and a perfectly legitimate howl too. The other fault lies in the tendency of draftsmen to dimension the *drawing* instead of the part represented on the drawing. This fault is more common among college draftsmen than among those who arrive at the board by way of the school of hard knocks. The trouble here lies in the fact that draftsmen do not know enough about shop methods. This excuse does not, however, make the howl that comes from the shop over such bulls any less just.

Some of this friction could be eliminated by conferences between the drafting department and the shop and a better spirit of coöperation. But some of it is healthy and does the organization good. The shop is always howling, let them howl! It does a lot of good up in the drafting room. F. G. Higbee.

Iowa City, Iowa.

Reclaiming Parts Too Large in the Hole

Reading Mr. Reuping's article, "Shrinking Steel Pinions Too Large in the Hole," recalls a similar article published, I think, in the *American Machinist* some twelve or fifteen years ago.

In that article the piece to be reclaimed, as I remember it, was a sleeve about 16 in. long. It was heated and dipped to about two-thirds its length, then reheated, and the other end quenched in the same way.

It would seem that this method is a roundabout way at best and would not produce a hole of uniform size throughout its length, especially if the piece is of considerable length.

Why not keep the water out of the hole, thereby keeping the surrounding metal hot until it is compressed by the sudden cooling of the outside when it is immersed in the water?

Some time after the publication of the first article I had an opportunity to try this latter method. In boring drop arms for a Corliss valve gear the material built up on the tool during the finishing cut, with the result that the hole was about 0.005 in. large throughout the greater part of its length. To avoid the delay of obtaining another steel casting, as well as the unpleasant duty of reporting a spoiled job, the piece was heated to a red heat and then taken out of the fire, and a piece of sheet asbestos placed against each end of the hub, these being held in place by short pieces of board and a C-clamp. With these parts in place the piece was immersed in water.

In this way the hole, which was about 2¾ in. in diameter by probably 6 in. long, was reduced about 0.015 in. and was practically uniform throughout. This permitted the rechucking and boring to size with nothing to indicate that its handling differed in any way from that of its fellows.

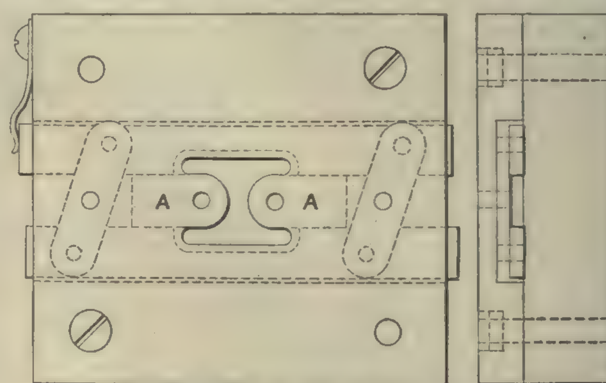
Mr. Reuping no doubt could have secured a pair of blacksmith's tongs with about the proper opening of jaws to grip the pinions over the ends, and with pieces of sheet asbestos wired to the jaws he could have quenched the pinions as fast as they were heated, doing a good job in one operation L. J. Evans.

Wilkinsburg, Penn.

Centering Stock in the Press

The centering device shown on page 31 is all right, but Mr. Leck did not state that the cross-links must be pivoted at their center to the stripper as well as being pivoted to the guide bars; otherwise the device will not hold the stock central.

In order to use this contrivance on work that must be stripped from the punch, as would be the case if holes



CENTERING STOCK IN THE PRESS

were being pierced in the blanks, the stripper must be cut out to receive the guide bars and cross-links, leaving the cutter *A* below the cross-links.

Ontario, Calif. E. T. Casler.

Fitting Lathe Carriages and Ways

On page 58, Edward Moreau gives his views on fitting carriages and ways. It is better practice to take the wind out of the carriage first by scraping it to a straightedge or master. After that the carriage should be used to scrape the bed, and only a little additional scraping of the carriage is necessary to make it hug the bed. As for adorning hand-scraped surfaces, few people seem to realize just why this is done. It may be true enough that some bearing surfaces are polished with emery cloth, then decorated with a hand scraper to cover up the fact that they have not been hand-scraped at all. In other cases fancy decorating may make the machine more pleasing to the eye.

I should like to explain just what decorating is and why it is done. If you oil the ways of a lathe that has the carriage properly fitted without any decorating, then slide the carriage along, you will wipe the oil off slick and clean; but with decoration marks on the ways enough oil will remain in them to keep the bearing surfaces wet. Decoration marks are quite often called "oil spots." When they disappear in any one place, it is evident that the bed is worn at that point and should be surfaced and newly oil-spotted. J. A. Raught.

Janesville, Wis.

Editorials

Health Insurance in the West and East

The advocates of health insurance are certainly waging a vigorous campaign and cannot help feeling much encouraged at the results so far obtained. On Jan. 25, 1917, the State Commission appointed by the Governor of California to investigate social insurance made its report to the legislature. This report, from the first official commission of its kind in America, is of especial interest and significance.

After a preliminary survey of social insurance ideas, the commission decided to center all its efforts on health insurance, as being the most logical and practicable step to follow the Workmen's Compensation acts. The findings and recommendations of this commission are summed up in a unanimous agreement upon the essential provisions as follows:

In order to meet the problem of destitution due to sickness, and in order to make health insurance a valuable adjunct to the broad movement for the conservation of public health, any legislation on this subject should, in the opinion of this commission, provide for a compulsory system for the conducting of the insurance by nonprofit-making insurance carriers; for a thoroughly adequate provision for the care and treatment of the sick, and for contributions from the insured, from industry and from the state.

These findings are for the most part in complete harmony with the American Association for Labor Legislation, which is working for health insurance in various parts of the country. The association plan, however, has behind it the authority of the successful, practical experience of nine European countries and has been worked out with the advice and assistance of hundreds of people throughout the United States during the past four years.

In selecting health insurance as the particular branch of social insurance best adapted for earliest action, the commission was guided by the following conditions: Health insurance appears logically to be the next step in development after accident compensation. It offers the least actuarial and organizational difficulties as compared with other more complicated branches of social insurance, which require provision of substantial reserve. Further, in investigating the relief work which charitable organizations, public and private, are called upon to perform, sickness was found to be the largest single cause of dependency, clearly indicating that individual responsibility for illness threatened hardship and economic dependence of wage workers.

The annual loss which the individual will suffer because of illness cannot be foreseen. It may be nothing, or it may be disastrously heavy. Yet the annual loss to the community consequent upon illness is a comparatively steady and computable loss. The sickness rate in California averaged six days per year in contrast to a nine-day average, as found by the Federal Public Health Service.

The commission finds that group responsibility for illness through health insurance is the practical way to meet the problems created by illness in California. Health insurance to be effective must be made compulsory upon the individual workers, but some contribution from other sources than the wage earners themselves is necessary to secure adequate health insurance. Contribution from industry and the state to the health insurance of wage earners is held to be just and desirable.

Massachusetts has also just come into line in a report filed by the Official Legislative Commission. Emphasis is laid upon the necessity of making such insurance compulsory and of prohibiting private insurance companies from doing business in this field. The report considers that the plan most likely to prove successful is one in which the carriers are mutual associations managed equally by employers and employees.

In reaching its conclusion favorable to the introduction of health insurance, the commission calls attention to the fact that vastly more suffering is caused by sickness than by industrial accidents. It finds that the heavy burden imposed upon society by destitution and dependency is largely the result of sickness among breadwinners. Since the individual, industry and the state all share in the responsibility for conditions that induce sickness, and will all benefit by improved public health, the commission believes that the employer, employee and the state should contribute to the funds necessary. It is interesting to find that these two states, so widely separated both geographically and in laboring conditions, agree on both the desirability of health insurance and the method of securing it.

Standardization of Airplane Parts

The airplane section of the automobile engineers' society is acting wisely in advocating that the standardization of parts be carefully considered at once. With our existing knowledge of the advantages of standardization and what it has done for the advancement of the automobile, there is no reason for not beginning to apply this knowledge to airplane work immediately.

When we compare the cost of airplanes and airplane motors with that of automobiles, even allowing for all the differences that exist between them, we cannot fail to be impressed with the huge excess of cost per horsepower of the former. Small production and the lack of standardization of parts are largely responsible for the present high cost. And although reliability rather than price is the prime factor just now, the time must come when the production of airplanes will be carried on along lines similar to those adopted in automobile manufacture.

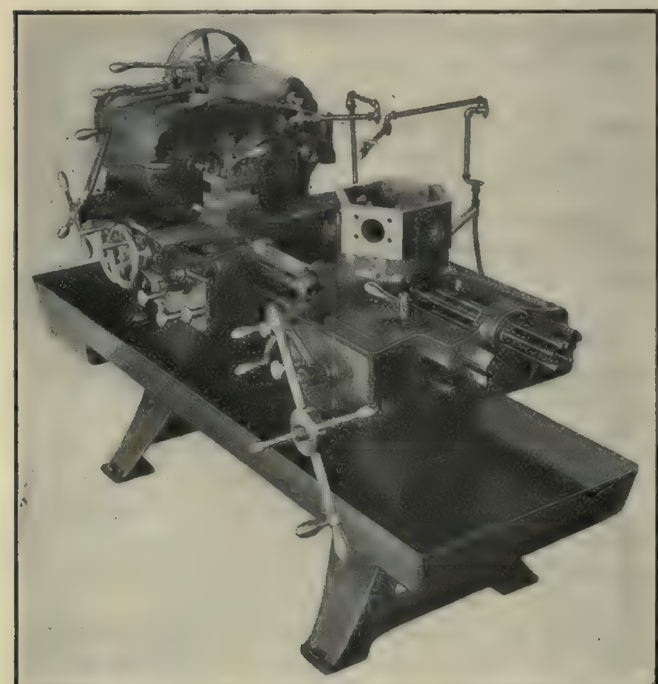
The standardizing of such parts as bolts, nuts, cotters and similar details, will do much to help the rational development of the airplane. Nor should we confine ourselves solely to the practice of this country, for unless we take advantage of the airplane development of Europe, we shall be sadly behind the times. Foreign manufacturers have had the opportunity of watching the effect of various materials and designs in strenuous action, and we will do well to profit by their experience so far as it can be secured.

Shop Equipment News

Universal Turret Lathe

The universal turret lathe shown in the accompanying illustration, built by the Foster Machine Co., Elkhart, Ind., is of the geared-head type and capable of handling both bar and chucking work. A hollow hexagonal turret is mounted on the bed, and a square one adapted for forged cutters is carried on the forward end of the cross-slide that extends across the bed. The rear end of the slide is in the form of a table with tapped holes for mounting special toolholders. The machine is shown equipped with an automatic draw-back chuck for bar work, but this can be replaced by a three-jaw geared scroll chuck.

Arrangement may be made for either motor or belt drive; twelve spindle speeds in either direction are provided for. These are obtained by means of the three



UNIVERSAL TURRET LATHE FOR BOTH BAR AND CHUCKING WORK

sets of sliding gears operated by levers on the top of the head casting and range from 20 to 480 r.p.m. The gears are of the stub-tooth form with a 20-deg. pressure angle and run in an oil bath. Some of the splash from the gears is caught by a system of overhead ribs and conducted to oil cups at the top of the bearings, and after passing through these, is carried back into the main cavity of the head. A friction clutch is also provided in the head. The spindle is journaled in bronze boxes.

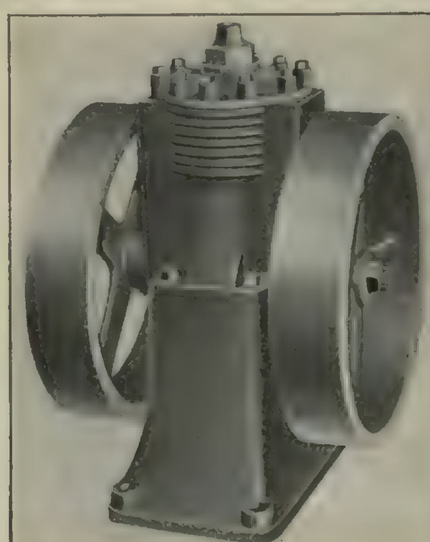
The feed changes are located in the apron and are obtained by means of plunger-operated gears. Sufficient range from 0.0016 to 1 in. per spindle revolution is incorporated, to cover any work which the machine will handle. The driving of the gear train from the feed rod is by means of a worm and gear. The automatic drop-nut friction that engages and disengages the longitudinal feed movements is operated by means of six screw stops mounted in a revoluble spool on the carriage. When one of these stop screws strikes the adjustable stop rod a catch is released and the friction feed drops out. The friction release for the cross-slide movement is similar but is hand operated. A large dial is mounted on the front end of the cross-feed screw.

For the purpose of thread cutting, a mechanism is provided on the cross-slide that permits the tool to be withdrawn the proper amount and reset again for taking the next cut.

The hollow hexagonal turret is controlled by seven stop screws, one of which is for the corner stock stop. They are held in a spool carried on the saddle and strike against a stop mounted between the ways. Movement of the stop spool releases a catch that drops out the friction feed, arresting the motion of the saddle.

Air Compressor

The illustration shows one of a line of air compressors being marketed by the Yokom Sales Co., Port Huron, Mich. These compressors are made in two sizes, with cylinder bores of 3 and 4 in., and in a variety of styles for either belt or motor drive. A noteworthy feature is



AIR COMPRESSOR

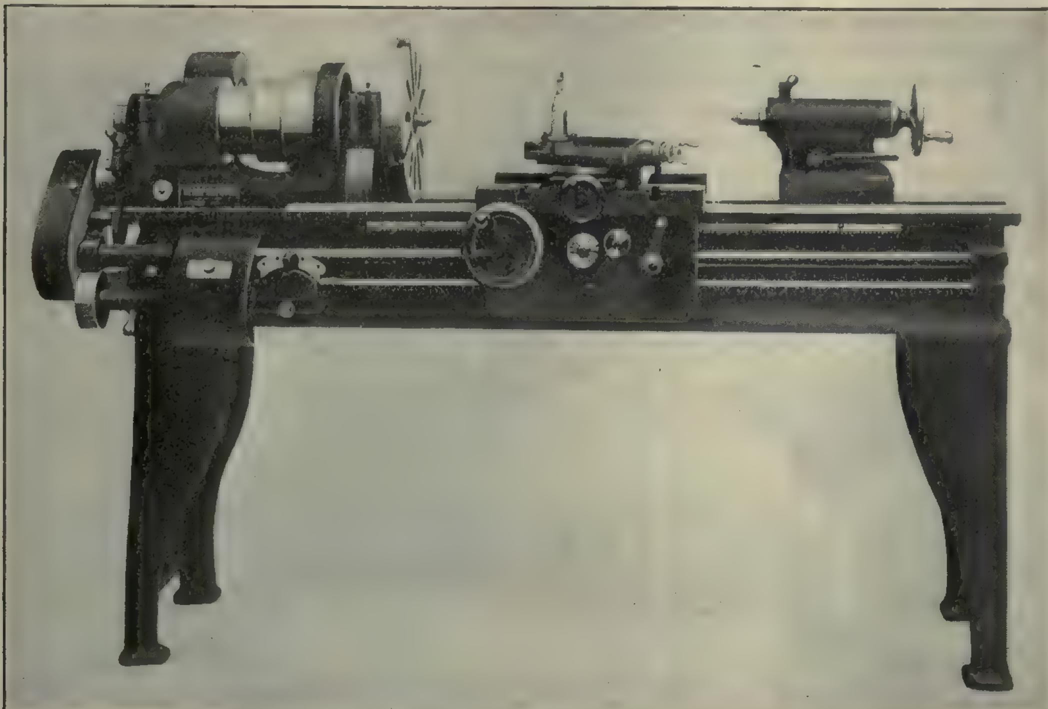
the absence of a crank and connecting-rod, the reciprocating motion of the piston being secured by means of a ball-bearing eccentric. The bottom of the piston is held in contact with the outer ring of the ball bearing by means of springs. At each revolution the ball bearing dips into oil held in the base and transfers the oil to the base of the piston and the cylinder walls. Three piston rings are used.

The air enters the cylinder through a poppet valve in the piston head and leaves through a ball valve in the

cylinder head. The small compressor has a capacity of 1.8 cu.ft. of air per minute at 600 r.p.m. and consumes $\frac{1}{4}$ hp. The large machine delivers 4 cu.ft. of air per minute at 400 r.p.m. and requires $\frac{3}{8}$ hp.

Double Back-Geared 13-In. Lathe

The headstock of this lathe is of the solid full-webbed type, rigid and well made, and will not chatter on heavy cuts. The spindle is of 50-point carbon crucible steel carefully ground and runs in phosphor-bronze bearings. The bed is wide and deep, with heavy box girders. The tailstock is so made that the compound rest may be used at right angles when turning work of small diameter. The carriage has an 18-in. bearing on the V's. The bridge is $7\frac{1}{4}$ in. wide and has T-slots for clamping special work. The compound rest is unusually large and rigid. It is taper-gibbed and graduated for angular work. The apron and its bearings are cast in one piece; all the studs are hardened and ground. Power crossfeed and compound-rest screws are provided with graduated collars. The head spindle is self-oiling. A quick-change feed mechanism gives four changes of feed. The gears are well guarded; the rack is cut from one piece of steel; all sliding surfaces are carefully scraped to a bearing and all cylindrical parts are ground. The standard equipment includes compound rest, follow rest, steadyrest, double friction countershaft and wrenches. Special equipment can be furnished as follows: Draw-in chuck, 0 to $\frac{7}{8}$ in. capacity; draw-in chuck, 0 to $\frac{5}{8}$ in. capacity; chuck plates; taper attachments; automatic stop; chasing dial; bed lengths, 6, 8 and 10 ft. This lathe is made by the Philip Smith Manufacturing Co., Sidney, Ohio.

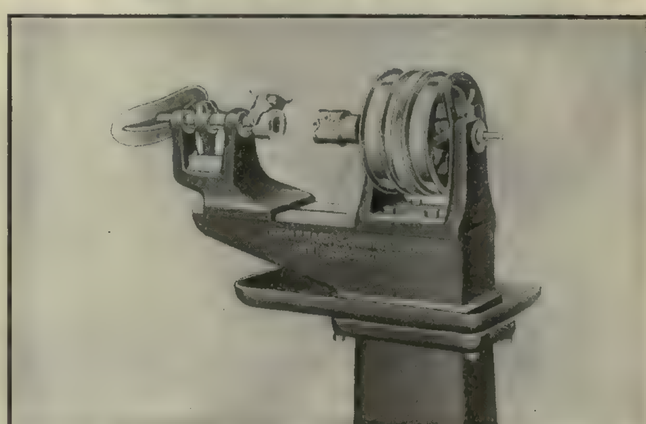


13-IN. DOUBLE BACK-GEARED LATHE

Swing over bed, $13\frac{1}{4}$ in.; swing over carriage, $8\frac{1}{4}$ in.; distance between centers (6-ft. bed), 35 in.; tailstock travel, $5\frac{1}{2}$ in.; tailstock spindle diameter, $1\frac{3}{4}$ in.; centers, Morse taper No. 3; front bearing (self-oiling), $2\frac{3}{8}$ x 4 in.; rear spindle bearing (self-oiling), $1\frac{13}{16}$ x 3 in.; hole through spindle, $1\frac{5}{16}$ in.; diameter of spindle nose, $2\frac{1}{16}$ in.; number of threads (U.S.S. Standard), 6 to the inch; cuts threads—English lead screw, 4 to 20, or with metric lead screw, $\frac{1}{2}$ to 8 mm.; cone diameters, $5\frac{1}{2}$, $6\frac{3}{4}$ and 8 in.; width of belts, $2\frac{1}{2}$ in.; size of countershaft pulleys, 10 x $3\frac{1}{2}$ in.; first back-gear ratio, 3 to 1; second back-gear ratio, 8 to 1; number of spindle speeds, 18; countershaft speeds, 300 to 400 r.p.m.; minimum and maximum speeds, 27 to 600 r.p.m.; toolpost takes tools $1\frac{1}{4}$ x $\frac{5}{8}$ in.; net weight, 6-ft. bed, 1250 lb.; extra weight per additional foot, 90 lb.; crated weight, 1400 lb.; boxed weight (38 cu.ft.), 1600 lb.

Tapping Machine

The machine illustrated has recently been placed on the market by the H. E. Harris Engineering Co., Bridgeport, Conn., and is known as the No. 2 precision tapping machine. The tapping head consists of a single casting to which are clamped the two bearing bushings. The bushings are extended inward from the head pillars and not only provide bearings for the spindle in their bores, but bearings on their outside surfaces for the two belt pulleys. The bushings also take the end thrust of the pulleys, being turned with a shoulder for this purpose. The inside of the inner edges of both pulleys bored on a taper, so that they serve as female members for the two clutches. The male member consists of a double cone-shaped aluminum spider mounted permanently on the tapping spindle, which is given sufficient end play to allow either the forward or reverse to be engaged. The clutching surfaces are leather covered, and the edges of the spider are spun outward beyond the surface of the leather so that neither centrifugal force nor gravity can carry oil to it. The pulleys are constructed in such a manner that oil is carried away from the clutch surfaces. The work-carrying head slides on the bed in order that various sizes of work and taps may be accommodated.



PRECISION TAPPING MACHINE

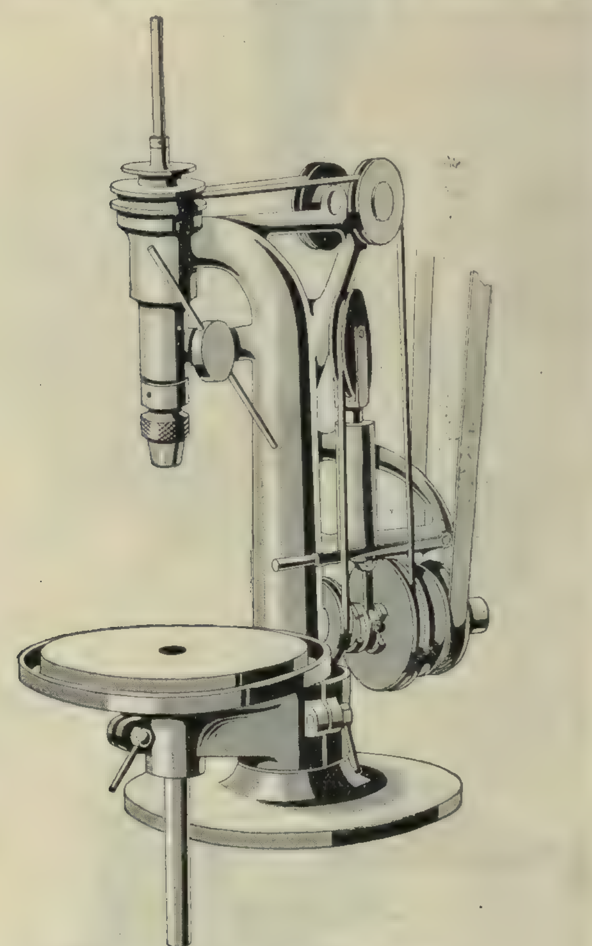
Maximum distance between spindles, 9 in.; taper in work spindle, No. 7 B. & S.; tapping speed, 198 r.p.m.; reverse speed, 332 r.p.m.; center of spindle to bed, 6 in.; movement of work spindle, $2\frac{1}{4}$ in.; maximum size of tap in steel, $\frac{1}{2}$ in.; height from floor to center of spindle, 44 in.; floor space, 24 x 36 in.; weight, 276 lb.

The work is held in a fixture that fits into the sliding spindle. Rough adjustments for the size of work, length of tap and depth of tapping are made by sliding the head lengthwise on the bed. The final adjustment for exact depth of thread is made by means of an adjusting screw and a stop located on the tailstock casting.

In operation, a slight pressure on the end of the tap by the edge of the hole to be tapped moves the spindle longitudinally and engages the spider in the forward drive pulley. When the proper depth of thread is reached the motion of the work is stopped, and the resulting pull on the tap disengages the clutch. Further backward pull on the tap engages the reverse clutch and backs out the tap. The work spindle is equipped with a breastplate for starting the tapping operation, it being the intention to have the operator feed the work with his right hand and remove it with his left.

Sensitive Drilling Machine

The sensitive drilling machine shown in the illustration is the product of the De Mooy Machine Co., of Cleveland, Ohio. It is of the bench type and is fully equipped with



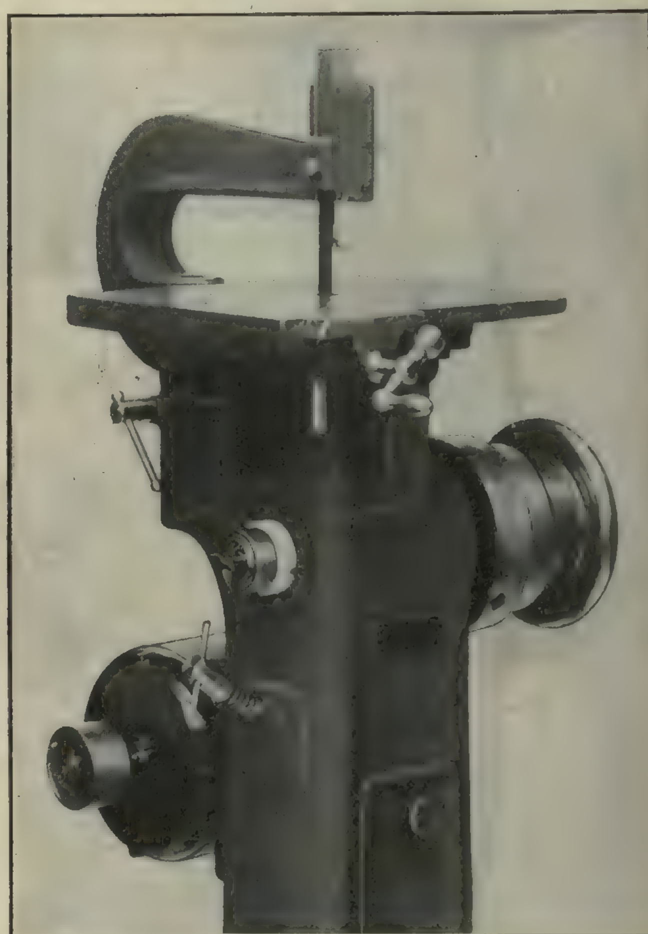
BALL-BEARING SENSITIVE DRILL

Maximum distance chuck to table, 8 in.; vertical movement of spindle, 4 in.; vertical movement of table, 7 in.; diameter of table over oil groove, 14 in.; distance from center of spindle to frame, 7½ in.; drilling capacity, up to ⅜ in.; weight, 150 lb.; floor space, 28 x 16 in.; height, 36 in.; spindle speeds, 2000, 3000, 5000 and 8000 r.p.m.

ball bearings. Four spindle speeds are obtained by means of a cone pulley and jaw clutches, the drive being by a round belt having an automatic belt tightener. The machine has a cone clutch and an automatic brake for stopping the spindle, which is counterbalanced to prevent vibration. The edges of the table, which is adjustable, form an oil groove. The spindle is returned to its upper position by an adjustable spring. The spindle pulley is inclosed in a guard. Ball thrust bearings are used on the spindle. Motor drive can be arranged for when required.

Sawing, Filing and Lapping Machine

The Oliver Instrument Co., of Detroit, Mich., has recently placed on the market the sawing, filing and lapping machine shown in the illustration. The tool is intended



MACHINE FOR SAWING, FILING AND LAPPING

especially for the making of dies, gages, templets or other similar parts. All moving parts operating in the column of the machine are inclosed and run in a bath of oil, and all bearings are protected from dirt and chips. The reciprocating parts are balanced to prevent vibration. The table is 12 in. square and tilts to an angle of 10 deg. either way, the axis of rotation being in the plane of the table surface. This feature makes it possible to use a smaller hole through the table than would otherwise be necessary and insures the file or saw being always in the center of the hole.

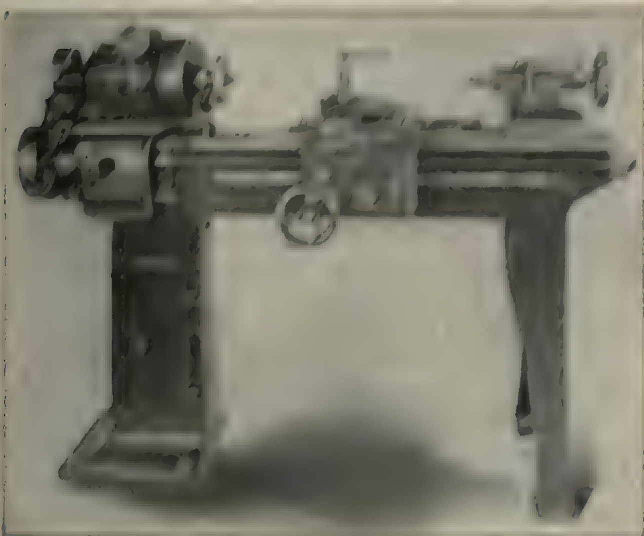
One side of the table is fitted with a slide which has a 5-in. travel controlled by a screw. The slide is 4 in. wide and has three rows of tapped holes for securing work to it. The overarm is used for sawing, the throat at the rear permitting work to be done to the center of a 19-in. circle.

The machine as shown is equipped with motor drive, the motor being attached to the pedestal and belted to

the pedestals. Tight and loose pulleys are provided for belt drive if so desired. The doors in the base open and spaced steps and are provided with pockets to hold tools or fixtures.

Toolroom Lathe

The lathe shown is one that has recently been put on the market in answer to the demand for a light machine for toolroom purposes. It is being manufactured by the Reeder Machine Works, 110 West 40th St., New York City, and is known as the Reeder Lathe, No. [illegible] The



LATHE FOR TOOLROOM WORK

[illegible]

bed has two V's and two flat bearing surfaces. The wheel-feed screw is placed immediately under the guides. The headstock is all geared, with six spindle speeds. The gears are so arranged that only one speed may be thrown in at a time. The spindle is hollow in order that spring collets may be used and runs in phosphor-bronze bearings. The crossfeed screw is provided with a micrometer collar. Four feed changes are provided by means of gears. The tailstock is provided with a side adjustment for taper turning. The equipment includes countershaft, large and small faceplates, follow and steady rests and wrenches.

Rustproofing Material for Ferrous Metals

A material for rustproofing ferrous metals has been placed on the market by Shaw & Son, Philadelphia, Penn., under the trade name of "Sprocoat." While new in this country, Sprocoat has been in use in Germany for some time.

The material is a powder made up of varying percentages of tin, lead, zinc or these metals, according to the results and to which it is to be put. It is mixed with a suitable fluxing reagent to the consistency of thick paste and applied either by dipping or with a brush. After that the articles are heated until the coating melts down. The parts must be thoroughly cleaned before the coating is put on. The material lends itself readily to local use, such as patching worn or damaged coatings of tin, lead or zinc, heating in each case is accomplished with a torch.

Tool and Surface Grinder

In answer to a demand for a grinder intended for general shop and toolroom service the Metz Machine Tool Works, Chicago, Ill., is marketing the machine shown in the accompanying illustration. The spindle runs in split conical boxes of phosphor bronze with adjusting nuts to compensate for wear. The vertical feed screw has a large dial graduated to read in thousandths. The crossfeed is by screw and handwheel. The longitudinal table movement is by a rack and pinion operated by means of a handwheel.

The spindle carries two abrasive wheels. One is over the table, the other, at the opposite end of the spindle

COMBINATION TOOL AND SURFACE GRINDER

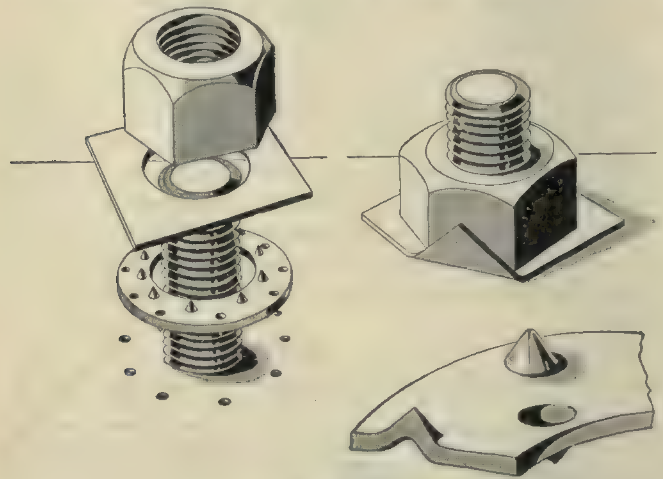
[illegible]

is fitted with an adjustable tool rest. The table has a 5/8-in. T-slot in the center, and a dovetailed slide with gib for taking up wear. All the controlling handwheels are at the front of the machine within easy reach of the operator.

Nut-Locking Device

The device shown in the illustration is known as the [illegible] nut lock. It is being marketed by F. E. [illegible] & Co., Inc., 90 Church St., New York City. The arrangement consists of a hardened washer, provided on both sides with small pointed projections, and a second washer of some softer material, which is square and large enough so that its corners extend out beyond the side faces of the nut to be locked.

In use the hardened washer is dropped over the bolt; the soft washer is placed on top of the hardened washer, and the nut is tightened down on the soft washer. A corner of the soft washer is then bent up against one of the side faces of the nut, and the job is complete. The

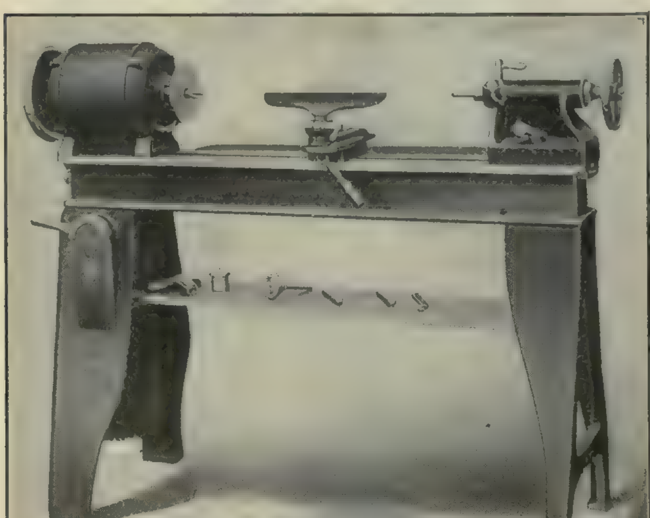


LOXON NUT LOCK

hardened points dig into the surface of the part to be fastened and the surface of the soft washer and prevent it from turning, while the corner of the washer bent up against the face of the nut prevents that from turning.

Motor Headstock for Woodworking Lathes

In order to eliminate belts and provide a safe drive for small woodworking lathes, the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has placed on the market a line of motor headstocks similar



ELECTRIC HEADSTOCK EQUIPMENT

to the one shown in the accompanying illustration. The faceplates, or centers, are mounted directly on the motor shaft, and various speeds are obtained by means of a controller mounted at the front of the lathe. The motors are provided with ball bearings, and solid end brackets are used to exclude dirt and shavings. End thrust on the motor shaft is taken up by ball bearings. The front end of the shaft is provided with an internal taper for centers and with a male thread for mounting faceplates. The shaft is threaded at the rear for a handwheel.

Motor speeds of approximately 570, 1140 and 3460 r.p.m. are provided with alternating current, and dynamic braking effect is obtained by manipulating the controller for the next lower speed. When direct current is used, a commutating-pole shunt-wound motor is provided, and speed control is secured by varying the field current. The speeds range from 600 to 3000 r.p.m. Protection against low voltage or overloads is afforded by relays that open the line current and stop the motor.

Importance of Conserving Paper Products in the Factory*

By W. Rockwood Conover†

Under present market conditions, both as regards abnormal prices and scarcity of raw materials, it becomes increasingly important to make investigations of the consumption of paper products in the shop. Not only have prices increased at an alarming rate during the past year, but the difficulty of obtaining nearly all grades of papers, especially those made from rag stocks and imported materials, has also multiplied to an extent that is causing uneasiness among consumers as to what future developments will be. So long as the European conflict continues, we may naturally look for readjustments of values and increases in cost the same as are occurring in nearly every other kind of fabric or merchandise used in private, public or industrial life. The elements of increasing demand and depletion of sources of supply, however, press themselves upon our attention in a manner that should lead us to make every effort possible toward conserving paper stocks and materials to a far greater degree than we have ever done before.

Papers used for productive purposes in the shop, such as insulation papers required in electrical manufacture, asbestos papers, press-board stocks, fiber sheet and other like products consumed in manufacture, should receive attention. Care should be taken to see that sizes are purchased which closely approximate the required finished dimension, or sizes that will cut to dimension with economy and with as little scrap or waste as the conditions will permit. The question of substitution should be frequently raised and changes made in kind, quality and even in the fabric itself, when this can be done to advantage and without detriment to the finished product.

Papers Used for Shipping

The factory shipping department is usually a fertile source of waste. Little attention is given to economy in the method of wrapping finished apparatus and supplies or to the amount of paper consumed. Sheets double the size required are often employed, and several layers or thicknesses are frequently used when half the number would be adequate. A study of conditions should be made, methods of wrapping analyzed; and system established providing strict rules of practice that will develop and maintain permanent economy. Certain kinds of apparatus require certain sizes of sheets, and the amount used

†Industrial economist, General Electric Co., Schenectady Works.

by the packer should be restricted within these limits. Protective paper hoods may sometimes be substituted for complete wrapping where apparatus is inclosed in strong crates or boxes and it is desired simply to protect from dust.

It is desirable to make comparative analyses of various grades or kinds of containers, packing materials, etc. The value or economy of fiber pulp-board and straw-board boxes and cartons in comparison with wooden boxes, or of metal containers in comparison with wood, press board or paper containers, should receive consideration. Packing materials, such as excelsior, straw, waste fiber fabric and paper cuttings need investigating as to relative cost and availability in reference to market conditions. At the present prices for waste paper, excelsior is not only more economical, but it is also more desirable and practical because of its cleanliness and character as the best material for providing a cushion and protection to apparatus.

The wrapping of lacquered and polished parts or of various plated devices that are put into shipping-department stocks or into shop storerooms is often a source of extravagance in the use of paper. If tissue is employed for this purpose, several sheets are often taken where one or two would answer. It is sometimes possible to protect these small polished parts on stockroom shelves with light wooden hoods or covers that keep off the dust and can be used permanently for this purpose.

Office Papers

Valuable economies can usually be established in the consumption of paper in executive and commercial offices and in shop-department offices of both the large and the small factory. Routine practices are set up which are wasteful and extravagant and which in frequent instances can easily be proved to be unnecessary. Reports, bulletins and notices are sent to department heads who do not require them. Copies of correspondence are, as a matter of interest, often mailed to parties who rarely read them. Their chief function is to cumber office files and occupy space needed for more valuable records. New forms are made up and continued in use which have little practical value to warrant their existence. Full-size, printed, executive letter sheets are frequently employed for short, internal and unimportant notes and memorandums of a few lines, which could well be written on small-size, plain pad paper. In these and many other ways extravagant and expensive routine is established.

In general, a considerable saving can be effected in almost any industry by placing restrictions on the development and use of all blanks and office forms of every kind. All printed forms should be condensed within the limits of practical value and necessity and thus reduce the amount of paper required. The existence of some forms will also be found to be unwarranted. The mailing lists of schedules and reports should be cut down to those persons who will make actual use of them, and pads or small-size sheets should be provided for the writing of short memorandums and letters. The plain backs of factory-order blanks, engineering notices, reports, etc., which have served their original purpose, may often be cut and glued into convenient sizes for scratch-pad purposes, and in this manner reduce the purchases of new stock.

All waste-paper product—cuttings and trimmings from papers used in production, waste wrapping removed from incoming packages, office papers, paper towels and in fact all scrap paper—should be saved and utilized or baled and shipped to the dealers or paper manufacturers. The wrappings received on incoming packages can serve to good advantage in the storehouse for sending materials out to the various shop departments.

Waste-paper products at the present time are bringing unusually high prices in the open market. Clear white book or rag stocks sell for $3.75 and above per 100 lb. Good clean trimmings from miscellaneous printing-paper stocks are worth $1.60 and higher; clean first-grade manila shavings, above $2; while magazines, office papers, newspapers, etc., are bought at fabulous prices as compared with previous years, the figures ranging above $1 per 100 lb. for magazines and from 75c. upward for miscellaneous office papers. The prices paid by dealers for all waste-paper products are subject to fluctuation and are governed largely by local conditions, freight rates to the mills or other points of shipment, etc.

Method of Destroying Important Data

Where the accumulation of office papers is large, as in big industries, they can be run through a paper-slitting machine, which destroys any important data written or printed thereon and renders them available for baling and shipping. The value of these miscellaneous papers as fuel under steam boilers is exceedingly small as compared with their market value as scrap products, the steam value being approximately one-tenth of the scrap value.

Apart from the profit that may accrue to the individual manufacturer through conserving the waste paper of his factory and, through the sale of this waste, the return to him of some percentage of the increased purchase price of raw stock, the question of the growing scarcity of pulp products deserves our serious consideration. It is apparent that our coöperation in helping conserve and increase the pulp supply of the country is of far greater importance and that in giving any measure of aid and relief to the mills we are also directly exerting a beneficial influence upon the market and upon our own yearly expenditures for these materials.

Convention of the American Supply and Machinery Manufacturers

The convention of the American Supply and Machinery Manufacturers Association will be held in Memphis, Tenn., Apr. 12, 13 and 14, 1917. This will be a combined convention of the National Supply and Machinery Dealers Association, the Southern Supply and Machinery Dealers Association and the American Supply and Machinery Manufacturers Association.

The officers of the latter association are: H. E. Dickerman, of the Chisholm-Moore Manufacturing Co., Cleveland, Ohio, president; Charles W. Miller, of the Jeffrey Manufacturing Co., Columbus, first vice-president; George E. Hall, of the Boston Woven Hose and Rubber Co., Boston, second vice-president; H. S. Demarest, of Greene-Tweed & Co., New York City, third vice-president; and F. B. Mitchell, 4106 Woolworth Building, New York City, secretary-treasurer. The entertainment features of the convention are in the hands of a local committee in Memphis and have not as yet been announced.

Selling Machinery in Siberia

The following article published in *Engineering and Mining Journal* may be of interest to some of our readers:

A correspondent—a commission house—in Vladivostok sends us this letter and asks us to publish it, which we are glad to do, for we think that it offers advice that may advantageously be taken by concerns that desire to increase sales of American machinery in the Russian market.

We have been dealers in machinery for the last 10 years, beginning with typewriters and ending with almost everything used in installing ice plants and flour mills. All this machinery was formerly made in Germany, and the Germans knew their business. Giving an agency, they would not only furnish Russian catalogs, but also electric or hand-operated models, so that people investing $100 could see with their own eyes how the thing looked and how it worked. This is the right way to sell anything. It can't be done with English catalogs, which are not understood by Russians.

The Germans would also pay a bonus if a certain number of machines were sold in a year, and even would give so many rubles' worth of machinery for starting the business, printing catalogs and advertising. American manufacturers, on the other hand, are so short-sighted even as to refuse to send a sample worth a couple of dollars. Yet they will send for a couple of years catalogs that simply go in the waste paper basket, for they are not understood.

The mining of coal and gold, lead and other ores is done in a primitive way. Gold gravel is dug with pick and shovel and handled with a horse and cart or a wheelbarrow. This pays well, but how much more could be done if worked with capital and machinery?

We request American manufacturers to state what they ask for all kinds of machinery and urge them to send models also. If we take up the agency, we will print the catalogs ourselves.

Gold, coal, cement, wood, lead and iron are plentiful here, and also other mining properties. We would be glad to answer all inquiries and give all particulars regarding these properties, which are not developed owing to lack of labor-saving machinery and capital and to enemy ownership.

Our main point is to get labor-saving machinery for mining, and also flour, cement and ice-making mills.

New Publications

Lubricating Engineer's Handbook. By J. R. Battle, B. S. in M. E. Published by J. B. Lippincott Co., Philadelphia, Penn., 1916. Cloth; 6 x 9 in.; 333 pp.; 114 illustrations; 27 tables. Price, $4.

A reference book of data, tables and general information for the use of lubricating engineers, oil salesmen, operating engineers, mill and power-plant superintendents and machinery designers, etc. The author in the preface states that the book is the result of his many years of experience, during which time he collected data and kept a notebook. These data and such descriptions and tables as have been found to be of practical value in everyday work are included in this compendium.

The work is divided into 34 chapters and treats of friction, theory of lubrication, petroleum and other lubricants and greases, lubricating oil and grease tests, oil data and miscellaneous notes, mechanical and lubricating engineering data, a brief description of the steam engine and steam turbine, their construction and operation, elementary electrical data, rolling and sliding friction and its application to bearings, the lubrication of steam cylinders, oil cups, grease cups and filters, oilhouses and oilhouse methods, the steam-engine indicator and its use, the lubrication of air compressors, automobiles, coal-mining machinery, baking machinery, electrical- and steam-railway equipments, passenger and freight elevators, flour-milling machinery, refrigerating machinery, internal-combustion engines, marine engines, motors and dynamos, printing machinery, pneumatic tools, rolling mills, textile machinery, steam turbines and water wheels, wiredrawing and its lubrication, the cost of lubrication and oil specifications, which are briefly touched upon.

Probably the work would appeal to the lubricating engineer more forcibly if greater space had been given to the scientific side of the lubricating problem and not so much to the descriptive. A mistake that the author seems to have made is that of attempting to treat too many subjects in the allotted space, consequently the treatment in many cases is superficial. Several subjects that have little bearing on lubrication have been included, the space taken up by which might well have been given to the lubricating subject with profit to the work as a whole. Nevertheless, the book contains a lot of valuable data and general information and will no doubt find a field of usefulness among those it is intended to serve.

Unified Accounting Methods for Industrials—By Clinton E. Woods. Three hundred and eighty-four 5½ x 8½-in. pages; illustrated; half-leather binding. Published by the Ronald Press Co., New York City. Price, $5.00.

The author in the preface to this book states: "Somewhere, somehow, sometime, in the universal make-up of things, a relationship will be found to exist between all things that function toward a common end. Activities using the same elements must in some way be guided by a common principle. If this can be discovered, it will serve as a clue to guide the investigator to his goal or enable him to return to the beginning of things for a fresh start."

Acting on the line of thought suggested above, the author has evidently made the attempt to tie together in the 384 pages of this book the fundamentals underlying accounting for industrials. As might be expected when so much has been attempted in such a small space, the result can hardly be said to be more than a mere touching of numerous high spots. For example, Chapter 1, in 24 pages, attempts to state "the development, elements and results of industrial or efficiency engineering." Purchasing and receiving are covered in 16 pages, analyzing and grouping tool equipment in 16 pages, and so on.

As a matter of fact, the author reaches out considerably beyond the title of his book, taking up the principles involved in some of these divisions of industrial management as well as accounting methods. Some 124 pages are given to a reproduction of forms, tables, financial statements and reports. This book will recommend itself more to the reader who wishes to obtain a general idea of the principles underlying industrial accounting and certain phases of efficiency engineering than to one who looks for exhaustive information concerning any one of the divisions treated.

High Frequency Apparatus—By Thomas Stanley Curtis. Two hundred and forty-seven 5 x 7-in. pages; illustrated; cloth binding. Published by Everyday Mechanics Co., New York.

This work, which has been prepared for the nontechnical reader, takes up the subject of high-frequency apparatus, first telling the uninitiated reader what high-frequency current is and what it is used for, leading up through the principles of the transformer, condenser, etc., into the actual construction of apparatus. It is a useful and practical book for amateurs who wish to familiarize themselves with the subject and experiment with high-frequency apparatus.

Riveted Boiler Joints—By S. F. Jeter, B. S., M. E. Four hundred and fifty 8 x 10¾-in. pages; 52 illustrations, 75 charts; cloth binding. Published by McGraw-Hill Book Co., New York City. Price, $3.

This book is an exhaustive treatise on the design and failures of riveted boiler joints. The author, through his method of handling the subject, has simplified the calculation of factors entering into the design of boiler joints. The previous methods of determining the strength of boiler joints have been by means of tables of joint efficiencies. This method has been very crude and laborious and, in cases which were out of the ordinary, has forced the designer to resort to cut-and-try methods without any definite idea as to the best rivet spacing. The diagrammatic method worked up by Mr. Jeter has not only the advantage of saving considerable time and a large amount of calculation, but also another advantage in that it furnishes an automatic warning or indication when rivet spacing is chosen which is either too wide to permit of proper strength or so close as to result in interference of rivets. The divisions of the subjects treated in this book are: Methods of point failure; types of boiler joints; efficiencies of boiler joints; boiler-plate material; strap thickness and rivet diameter; limiting pitches; boiler-joint diagrams; and rivet joints of maximum efficiency. The diagrams of joint efficiencies range from ⅝- in. rivet holes from 1½- to 4½-in. spacing for plates of ¼ to $\frac{3}{16}$ in. in thickness, up to 1½-in. rivet holes with rivet spacing from 2 to 6 in. and plate thickness from $\frac{5}{16}$-in. lap joint to 2½-in. butt joint.

In addition to presenting 75 of these diagrammatic charts for the solution of boiler-joint problems, the author gives a thorough presentation of the principles employed in constructing such charts for the use of the designer who may find it of advantage to construct such diagrams for special purposes.

While this book is primarily intended as a treatise on boiler construction, the same principles of joint efficiency apply equally to riveted joints used in structural work.

Business Item

The Shambo Shuttle Co., Woonsocket, R. I., is completing a two-story addition, 60 x 40 ft. Six steel storehouses are also being added.

Personals

Allen Knapp, formerly supervisor of the toolroom of the Colt's Patent Firearms Manufacturing Co., is now head of the grinding department of the Southworth Machine Co., Portland, Maine

Merritt R. Carson has resigned his position as general manager of the Ideal Oil and Manufacturing Co., Beaver Falls, Penn., and has joined the Craven Automatic Grease Cup Co., of Pittsburgh, Penn., in the same capacity.

The National Metal Trades Association, Cincinnati Branch, has elected the following officers: A. H. Teuchter, president; J. B. Doan, vice-president; W. T. Emmes, treasurer; J. A. LeBlond, secretary. M. Shipley, E. A. Muller and C. H. Fox were elected to membership on the executive committee.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

Towing a Big Naval Vessel

By Frank A. Stanley

SYNOPSIS—With the exception of towing the dry dock "Dewey" to Manila, the biggest long-distance towing enterprise ever carried out is that described in this article. A special towing machine was constructed, and engineering talent and invention grappled with such problems as measuring the tension on the hawser, and compensating for the effects of wind and wave.

As will be recalled, the "Prometheus," which is under the command of Capt. F. D. Karns, has a displacement of over 12,500 tons, her length over all being about 466 ft. Her two engines are vertical triple-expansion machines of a total maximum indicated horsepower of 7500. The "Maumee" is a 14,000-ton oil tanker, whose hull was completed in Mare Island yard in 1915, her engines of the Diesel oil type having been under construction at the same time at the New York yard.

It had been decided by the Navy Department that, as the "Maumee" was to be assigned to service with the Atlantic fleet, it would be economy to tow her around to the East coast for the installation of her engines at the New York yard rather than to ship her machinery to Mare Island for installation and then propel her under her own power around to the East. The "Prometheus," which had just been in dry dock at Mare Island, was selected to do the towing and was equipped for the work by the installation of a special towing machine. A strong towing arch was erected over the stern of the ship, and she was supplied with a new $7\frac{1}{8}$-in. wire cable, the figures given referring of course to the circumference of the hawser, its diameter being $2\frac{1}{4}$ in. and its ultimate strength 300,000 lb.

FIG. 1. THE "PROMETHEUS" IN DRY DOCK

A general view of the "Prometheus," taken while she was still in dry dock at Mare Island, is presented in Fig. 1, to show the location and proportions of the towing arch at the stern and the position of the towing machine, located approximately 50 ft. forward of the arch.

Some Towing Considerations

In towing big vessels the resistance of wind and wave becomes a most important factor in the determination of the maximum practicable speed, and even a moderate change in conditions of weather and current may necessitate a marked reduction in the velocity at which the ship may be towed through the water. A ship of a given fineness of line may be towed best at a given rate of speed, which, if exceeded by any appreciable degree, means a marked increase in the stress upon the hawser and a similarly important increase in the consumption of fuel on the towing vessel. So many considerations enter into the problem of safe, satisfactory and economic towing of big vessels over a considerable distance that it is not at all remarkable that no exact estimate was possible at the outset of the journey from San Francisco Bay as to the approximate rate of steaming and the probable date of arrival at Balboa, Panama, the first stop scheduled on the itinerary. As a matter of fact, the average rate of speed maintained throughout the voyage was nine knots.

Passing out through the Golden Gate on the evening of Feb. 27, 1916, the "Prometheus," with the "Maumee" in tow, steamed without stop for 15 days, or until Balboa Harbor was reached, the two ships then passing through the Panama Canal. After a 9 days' stop at Cristobal they proceeded to New York, where they arrived 11 days later. The steaming time on the journey was 26 days and the distance covered 5260 mi. From beginning to end the undertaking was carried out with complete success, and the time required for the voyage was much shorter than had been anticipated when the ships left San Francisco.

Towing Equipment and Method of Control

It will be understood that in heavy towing work every precaution must be taken against possible disaster, and in the case under description special means was adopted for measuring the tension on the hawser due to the load and to the varying conditions of sea and weather. The apparatus and methods by which the stress was weighed are extremely interesting in their details and will be described later.

The towing machine, shown in Fig. 2, embodied many features of importance. It was built by the American Engineering Co., of Philadelphia, Penn. The illustrations show clearly the method of installation. Plan and side elevation of the machine are given in Fig. 3, the latter showing the general arrangement of the automatic control gear. This is shown somewhat more in detail in Fig. 4.

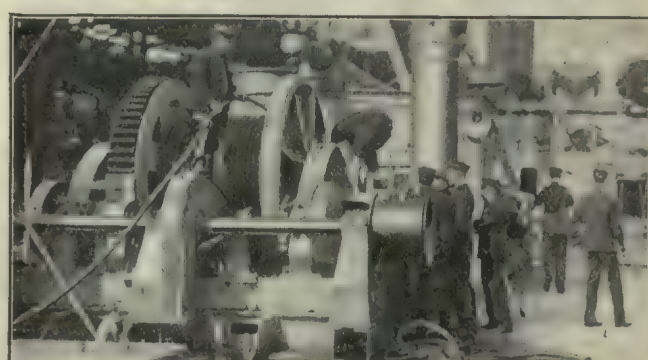


FIG. 2. THE TOWING MACHINE

Referring to Fig. 4, the pilot valve, which admits steam to the cylinders through the reverse valves, is seen at K. This pilot valve is operated by a pin sliding in the slot

in the valve stem J. The pin forms a part of the crank H, which is actuated by the segments mounted upon the same shaft as the hand lever G.

Steam can be admitted to the cylinders by hand by moving this lever, or the lever is operated automatically by means of the link F, which engages the cams 1, 2, 3 and 4. These cams are operated by a pinion A, which is fastened to the end of the drumshaft and meshes with the gear B, carried by the gear plate C.

When picking up a tow, the hawser is paid out by disconnecting the automatic gear and throwing the reverse valve lever G away from the drum. After the required amount of hawser has been paid out, the machine is set for towing automatically by swinging the automatic out of gear with the hand lever. Then the two large gears on the automatic gear plate C are revolved independently of each other until the cam E, which is controlled by the cam in the gear D, is completely exposed and on top. Then the reach rod F is dropped and the automatic gears are swung into contact with the pinion, care being taken that the cam just engages the slot in the reach rod and that the main valve is closed. The towing machine is then ready for towing automatically.

The three fixed cams 2, 3 and 4 on the disk of the automatic gear are used only for closing the valves to a

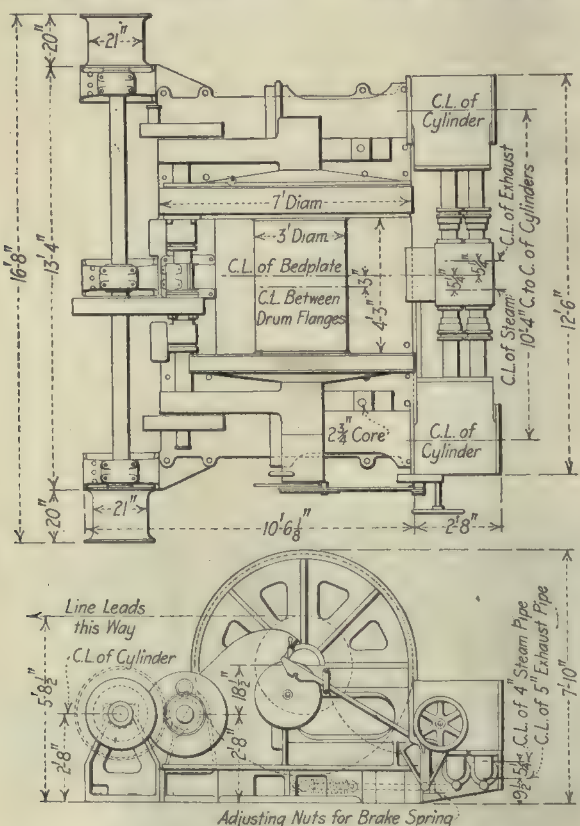
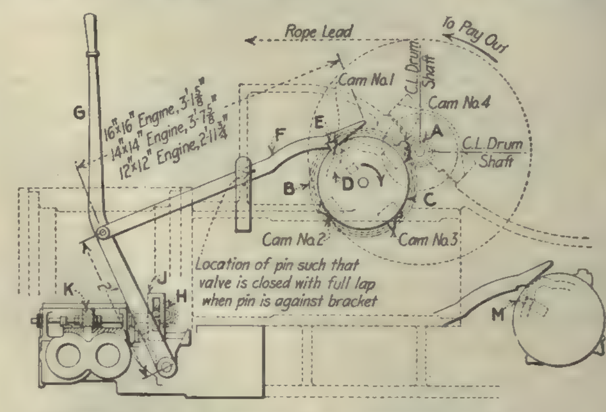


FIG. 3. DETAILS OF THE TOWING MACHINE

safe opening when the valve has been opened full, due to paying out more line than is required for ordinary towing. This closing to a safety opening stops the engine from racing when taking in the line under full head of steam.

The cams 1, 2 and 3 are carried by the gear plate C, which is rigidly connected to the cam gear D and rotates on a pin. It is carried by a hand lever, not shown. The cams 2 and 3 are rigidly fastened to the plate C, but the cam 1 slides in a radial slot. It is shown in its extreme outward position. It is guided by a cam slot in the cam gear D, which has 43 teeth on its outer periphery. The automatic gear B and the automatic cam gear D are driven by two pinions on an extension of the drumshaft. The pinions have the same number of teeth, but one of the gears has a few less teeth than the other.

The proportions of the two gears and the cam slot D are such that in one revolution of the cam gear D the cam 1 will move from its extreme outward position to its extreme inward position. The cam 1 will, when out to its full extent, operate in the slot of the reach rod to open or close the valve to its full movement. The cam 2 will



A-Pinion on Drum Shaft B-Automatic Gear C-Automatic Gear Plate D-Automatic Cam Gear E-Movable Cam F-Hook Lever G-Reversing Lever H-Crank, Operating Automatic Valve J-Automatic Valve Stem Head K-Automatic Valve M-Movable Cam in Idle Position

FIG. 4. DETAILS OF THE CONTROL GEAR

operate in the slot in the reach rod to open the valve to its full extent, while the cam 3 will close the valve down to a correct opening for safe speed when hauling in.

If, when towing, the load falls off, the engine will start to wind in and will turn the gear plate C in the left-hand direction. This action closes the valve, thereby admitting less steam to the engine until the load balances the engine power. If the load increases and the engine is overpowered, the gear plate C will turn in the right-hand direction and will open the valve to its fullest extent. If the line continues to pay out, the cam 1 will leave the slot in the reach rod F and be drawn to its inner position by the cam slot D, so that as it passes the slot in the reach rod F on the next revolution of the gear plate C, the cam 1 will not engage the slot in the reach rod F.

When the load falls off, so that the engine overpowers it and begins to wind the line in again, the cam 3 will almost immediately engage the slot in the reach rod F and close the valve down to the predetermined extent at which it gives ample admission of steam to run the engine ahead at suitable speed, but not sufficient steam to let it run away under any circumstances.

The engine will then continue to wind in until it has made the same number of revolutions that it did in paying out, when the cam 1 will once more be thrust out by the cam slot D and engage with the slot in the reach rod F, bringing the engine to rest at the same position that it was when overpowered by the load. If, however, it should happen that when the engine is winding in the line, the load is again augmented and the engine overpowered, the cam 2 will engage the slot in the reach rod and at once reopen the valve to its fullest extent.

The valve K has ⅜-in. lap on each end. A motion of ⅝ in. from the center position to the right gives a port opening ¼ in. wide, which is correct for forward running, and the safety cam 3 is set to close the valve to this point.

When the admission port is thus at safety opening for free forward running, the exhaust port is wide open. A further motion of $\frac{3}{8}$ in. to the right of the valve K gives a total steam opening $\frac{5}{8}$ in. wide, which is not, however, for forward running of the engine, but to admit quickly the steam required to meet and oppose the retreating pistons when the engine is being overhauled by the load and the piston reverses its direction at the ends of the stroke.

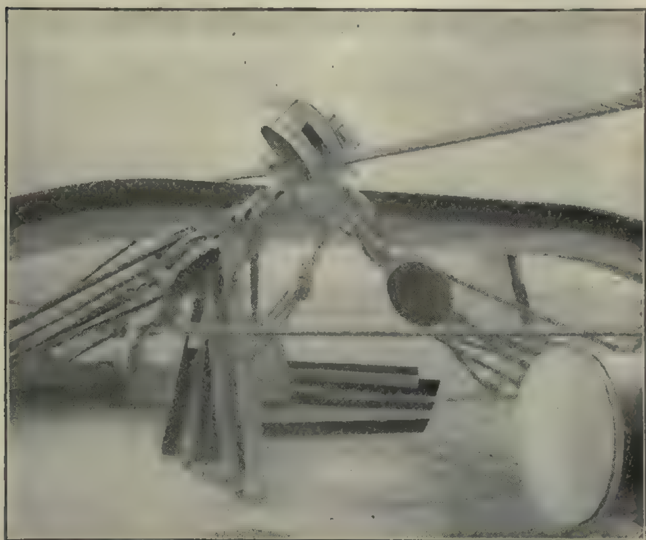


FIG. 5. METHOD OF GUIDING THE HAWSER

The cams 1 and 2 are set to move the valve to the right to this extreme position, when engaged with the slot in the reach rod F.

It will be understood from the foregoing that the valve is operated through intermittent gearing opening the port fully when the engine is overhauled before the drumshaft has made a single revolution, thus giving immediate increase in steam pressure up to full pressure in the admission pipe.

After the valve is opened, it cannot be closed until the same length of line that has been paid out has been recovered. The engine may be overhauled to pay out an indefinite length of line, but will bring it all back. The valve is closed by intermittent gearing, in stages, bringing the line back to the same length to which it was originally set.

All of the steam passages are large, enabling the steam to flow freely from end to end of the cylinders and to bank up quickly in front of the overhauled pistons after each reversal at the end of each stroke.

The valve opening, while the engine is being overhauled, is much larger than is necessary to drive ahead at proper speed, in order that full power may oppose the paying out at all times; but after the engine starts to wind in, the valve is partly closed to a point where the opening is sufficient to drive the engine at proper speed but under safe control.

Towing Arch and Hawser Guide

The towing arch on the stern of the ship is of very heavy construction, stiffly supported on a series of A-shaped brackets rigidly secured to the deck. The purpose of the arch is of course to carry the hawser well clear of the ship structure and to take the load of the hawser at any point to which it may whip or slew while towing.

As originally arranged at the outset of the voyage, the hawser was guided immediately in front of the arch by a pair of very heavy tackle blocks, which in turn were controlled by block and tackle at either side, as clearly shown in Fig. 5. After thorough test at sea it was found that this arrangement was not entirely satisfactory, as the sharp slope of the hawser from the arch astern, together with the weight of the hawser bearing heavily upon the edge of the towing arch, tended to produce a condition under which the hawser did not slide freely to and fro. Therefore, it was decided to place a sliding guide to carry the hawser free above the top of the arch. This was constructed as in Fig. 6. This guide acted freely as a sliding carriage on the top of the arch rail and was prevented from rocking on its bearing surface and from lifting from its seat by suitable side plates and by straps under the arch. The hawser and bearing surface upon which the sliding guide operated were well slushed with grease.

Weighing the Load on the Hawser

Captain Karns adopted a method for determining the actual load upon the towing hawser. The hawser did not lead directly back to the "Maumee" in the manner in which most of us have been accustomed to seeing tow lines arranged; but instead the ship's commander chose a plan whereby the towing action would be very much smoother and much easier on the towing apparatus itself, with far less likelihood of suddenly increased stresses affecting disastrously the hawser or its connection.

The anchor chain of the "Maumee," made up of stud links 18 in. long, $2\frac{3}{4}$-in. iron and weighing 400 lb. per fathom, was run out to a length of, say, 50 fathoms. To this chain the end of the towing hawser was shackled. This great weight of chain, together with the length of hawser extending from the arch of the "Prometheus," formed a deep catenary curve dropping under normal conditions some 50 or 60 ft. under the surface of the water. The "Maumee's" cable thus constituted a form of spring connection giving a very smooth towing action, in that the slewing effect of the wind and current and the heaving

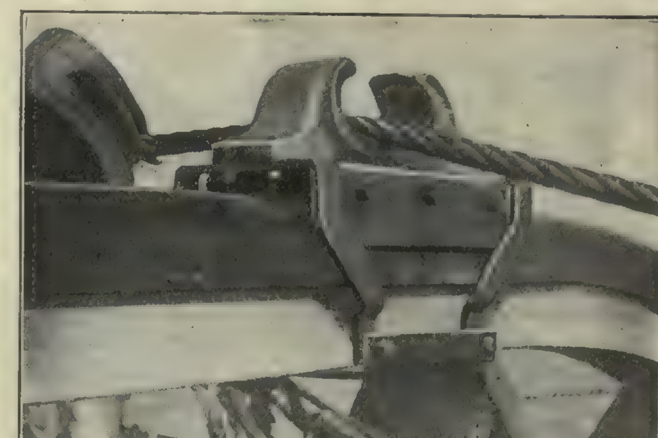


FIG. 6. IMPROVED HAWSER GUIDE

effect of the seas brought no excessive stresses on the tow line. Any retarding efforts on the part of the elements were compensated for by the slow lift of the long, heavy chain cable from the "Maumee."

The actual tension on the hawser was weighed by means of the apparatus shown diagrammatically in Fig. 7. The apparatus consisted of a heavy platform scale located midway between the center of the towing-machine drum and the bearing on the towing arch. On the platform of the scale a hydraulic jack was placed in in-

verted position, and to the body of this jack was rigidly attached, by means of two heavy straps, a stiff piece of timber to the side of which was bolted a short strut extending upward into contact with the under side of the hawser. This formed a means by which the load on the hawser could be taken directly upon the jack and consequently weighed on the platform scales.

The height to which the hawser was elevated at this point was measured by means of a tall standard at the side of the scale. Upon the standard was placed a frame-

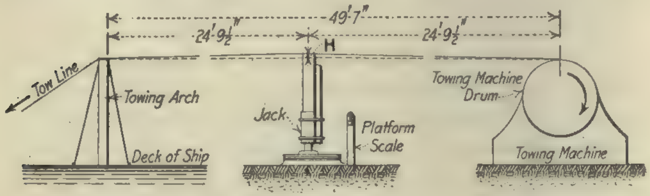


FIG. 7. METHOD OF MEASURING TENSION ON HAWSER

work which could be slipped up and down on the support and which carried a projecting arm passing out over the top of the hawser. The apparatus resembles a large height-gage. The adjustable measuring arm was made with an open frame that passed over a graduated scale attached to the side of the upright column, as illustrated. Readings were taken from this scale at regular intervals during each day's run, and from these readings the actual tension on the hawser was computed. From these computations the speed of the towing ship was regulated so that the stress should at no time exceed a certain amount.

Computation of the Tension on the Hawser

The method of applying the load and of making the calculations was as follows: The weight of the jack and wood uprights on the scale was 213 lb. The net load—that is, the load due to the downward thrust when the hawser was lifted by the jack—was maintained at 420½ lb., the scale beam weights being so applied that the scale was in balance when the total actual load upon the platform was 633½ lb.—that is, 420½ lb. plus 213 lb. tare.

From the dimensions, reproduced in Fig. 7, representing the length of hawser between the towing drum and towing arch a table was computed so that at each test, when the predetermined load of 420½ lb. net, due to the lift against the hawser, was reached, the scale on the upright of the height-gage was read. The actual load on the hawser itself was then found directly on the table opposite the quantity representing the height to which the center of the hawser was deflected in applying the jack. This table is reproduced herewith, the first column giving in sixteenths of an inch the vertical height *H*. Fig. 7, or deflection from a straight line; the second column gives the corresponding tension, in pounds, to which the hawser is subjected.

This table was computed by the formula

$$\frac{W \times 49 \textit{ ft. } 7 \textit{ in.}}{4 \times \textit{deflection in feet}} = \textit{tension}$$

W represents the net weight on the scale, and the distance 49 ft. 7 in. represents the length of hawser between the center of the towing drum and the bearing on the arch.

The formula is applied as follows: Taking, say, the quantity 40 from the table, this number representing 40/16 in. as the deflection under a given test, we then have

$$\frac{420.5 \times 49 \textit{ ft. } 7 \textit{ in.} = 20{,}841}{4 \times \frac{40}{16} \times \frac{1}{12} = \frac{5}{6}} = 25{,}000 \textit{ lb.}$$

tension on the hawser.

This method of determining the hawser tension was found to be most convenient and satisfactory. It enabled

RELATION OF DEFLECTION TO TENSION ON HAWSER

H = Deflection, in Sixteenths of an Inch	Tension on Hawser, in Lb.	H = Deflection, in Sixteenths of an Inch	Tension on Hawser, in Lb.
10	100,000	26	38,500
11	91,000	27	37,000
12	83,500	28	35,500
13	77,000	29	34,500
14	71,500	30	33,500
15	66,500	31	32,500
16	62,500	32	31,500
17	59,000	33	30,500
18	55,500	34	29,500
19	52,500	35	28,500
20	50,000	36	28,000
21	47,500	37	27,000
22	45,500	38	26,500
23	43,500	39	25,500
24	41,500	40	25,000
25	40,000		

the towing undertaking to be carried out with definite knowledge that the pull on the hawser was never allowed to exceed a safe amount. As a matter of fact, the speed of the "Prometheus" was so regulated from these tests that the tension on the hawser was seldom as high as 50,000 lb. and was usually very much less, so that the factor of safety with the total strength of hawser at 300,000 lb. was never lower than six and usually ran as high as nine or ten.

As already pointed out, the towing project was completed with the utmost degree of success, and the commander of the expedition and his assistants are entitled to the highest degree of credit for the satisfactory outcome.

Patterns for Work with Projecting Members

By M. E. Duggan

Almost every day patternmakers are called on to make patterns for castings with projecting members, fitting strips, pads, bosses, hubs and the like. The position and

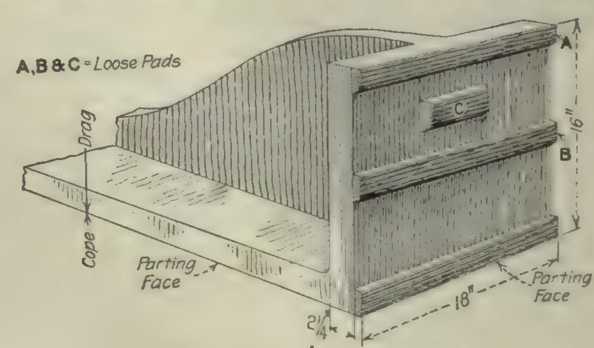


FIG. 1. THE PATTERN

location of these members on the body of the pattern often make it necessary to attach them loosely and hold them in position by means of dowel pins. This is one way of making and molding a pattern that has these projecting members. They can also be molded with the aid of dry sand cores, but this method also has certain disadvantages.

Both these methods are objectionable and in a great many instances could be avoided if the designer had a knowledge of general foundry practice. The fitting strips *A B C* in Fig. 1, if placed at right angles to the position shown—that is, vertically—would simplify the work in the pattern shop and in the foundry and answer every requirement in the assembling of the parts.

The pads *A B C*, Fig. 1, are made loose on the pattern. I held them in place on the pattern by means of

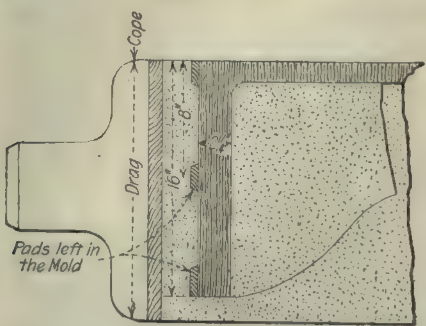


FIG. 2. THE MOLD

dowel pins, following what I consider to be the accepted and practical method for holding loose members to the body of a pattern.

The pattern was returned from the foundry and I was requested to change the dowel pins so that they would enter the holes in the pattern from the "right" side. Which is the right side? Which is the wrong side? How does inserting the pins from the *wrong* side affect the making of the mold? What are the chances for a bad casting, and why? Which is good practice, to use wooden dowel pins, wire or wire nails? How would you mold the pads in the core? The pads shown in Fig. 2, remain in the mold after the pattern has been lifted or drawn out of the mold. How does the molder extract these pads? What kind of tool does he use? You should know. You planned the operations of the molder when you made the pattern.

Suggestions to Apprentices

By John Black

The young man who is just starting in the mechanical field cannot form a better habit than to read every mechanical journal or article he can lay his hands on. It may be hard at first to get interested and understand some of the articles, but they should be read over again if not quite clear at first. And before the boy is out of his time, he will be able to tell some of the old-timers some things that will open their eyes.

If he forms the habit of reading the *American Machinist*, he cannot help but take an interest in his work—and not only his work, but every new job that comes into the shop. This is the sort of curiosity that makes for a bright future, and it will do no harm.

Go to the best mechanics in your shop, the men whom you look up to for advice. They will all tell you that they read some mechanical journal. Those who cannot give you any advice are the ones who do not read. The drawing and mathematics that most large concerns now teach their apprentices should not be neglected under any circumstances. While you may not be able to see any use for them now, you will later.

The Apprentice Question

By E. W. Wrigley

Regarding the apprentice question, we hear, sometimes, the remark that the boy of today who wants to become an all-around machinist has just as good a chance as ever, if he is the right kind of boy. This is doubtless true, for the opportunities for self-instruction now are as good and probably better than ever before; but a problem arises here that could be given more attention with profit. It is the problem of guiding this self-instruction.

Our libraries are full of books on technical subjects, so full, in fact, that it causes trouble for the young man seeking knowledge to supplement what he is learning in the shop. In the average city library, an inquiry for books on machine-shop practice is followed by the applicant being shown book cases containing several hundred volumes on the subject. Most of them are obsolete, and many are mere trash; and he will only be wasting his time to read them. However, he cannot be expected to know this. Neither can the librarian, for it is out of his province. The result is that much time is wasted that could have been made very profitable, if there had been someone to guide the student.

Difficulties in Selecting Books

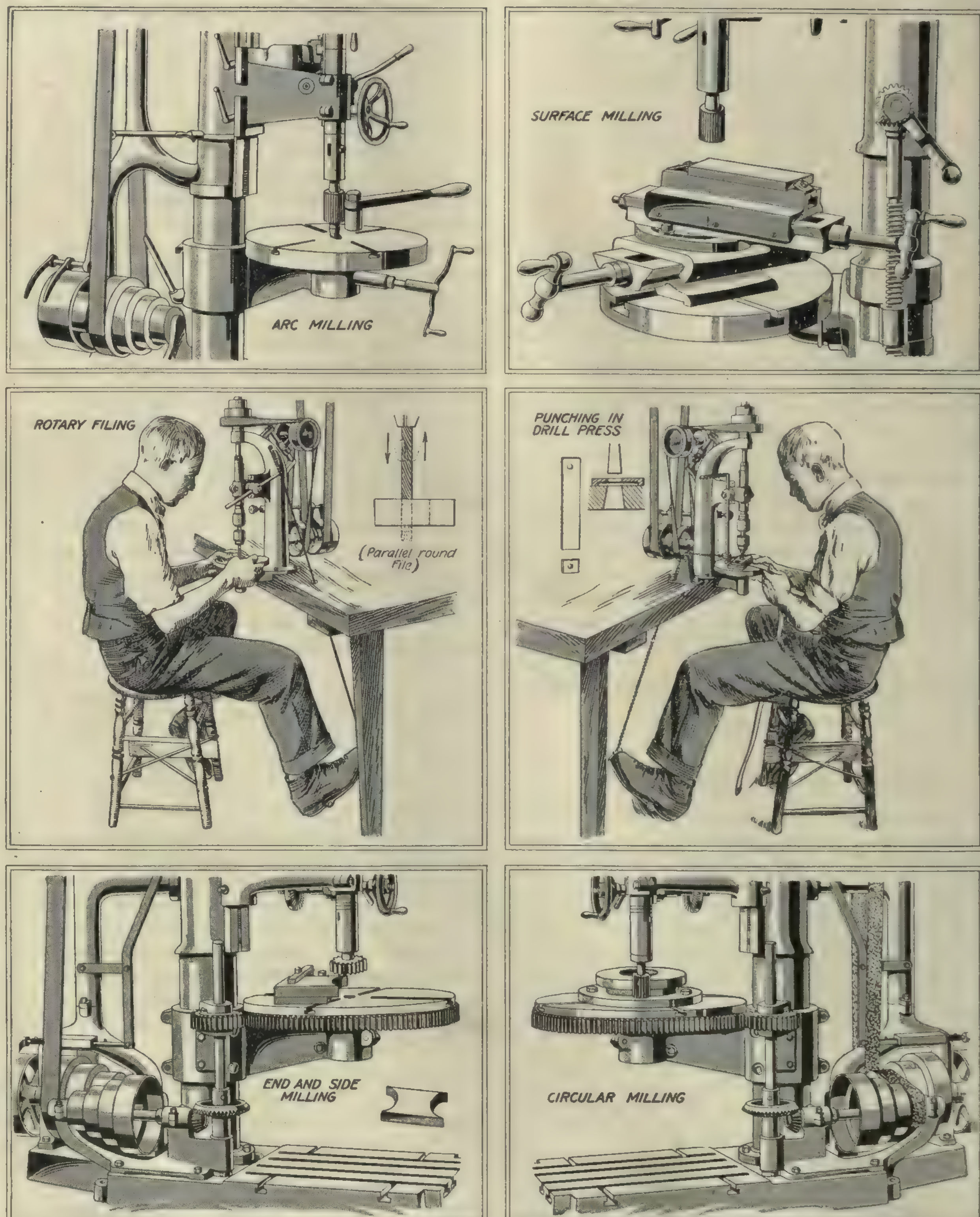
Also, it is often difficult to distinguish, at first, between books for technical graduates and those for men who have not had a college training. I saw an instance of this recently. A young machinist told me that he had spent a number of evenings trying to find a book from which he could get some practical information on hardening and the heat treatment of steel. He had carried several volumes home at the suggestion of the librarian, only to find that they were like so much Greek to him, being intended for men who had some training in chemistry and metallurgy. He had about concluded that the subject was too deep for anyone not a college graduate. I loaned him a volume of the recently published "Machine Shop Library," dealing with the subject, and he was enthusiastic. After studying the subject as it is presented in this book, he was able to go back and understand considerable of what was in the other books.

Of course, the technical magazines are the best sources of up-to-date mechanical information; but judging from the number of copies printed, of the better of these magazines, only a small proportion of the apprentices of the country are subscribers. It is quite astonishing to find how few of the younger, and even the older, mechanics know which are the really standard works on mechanical subjects. Many who are really trying to study and improve themselves never heard of Kent or Marks' "Handbook for Mechanical Engineers."

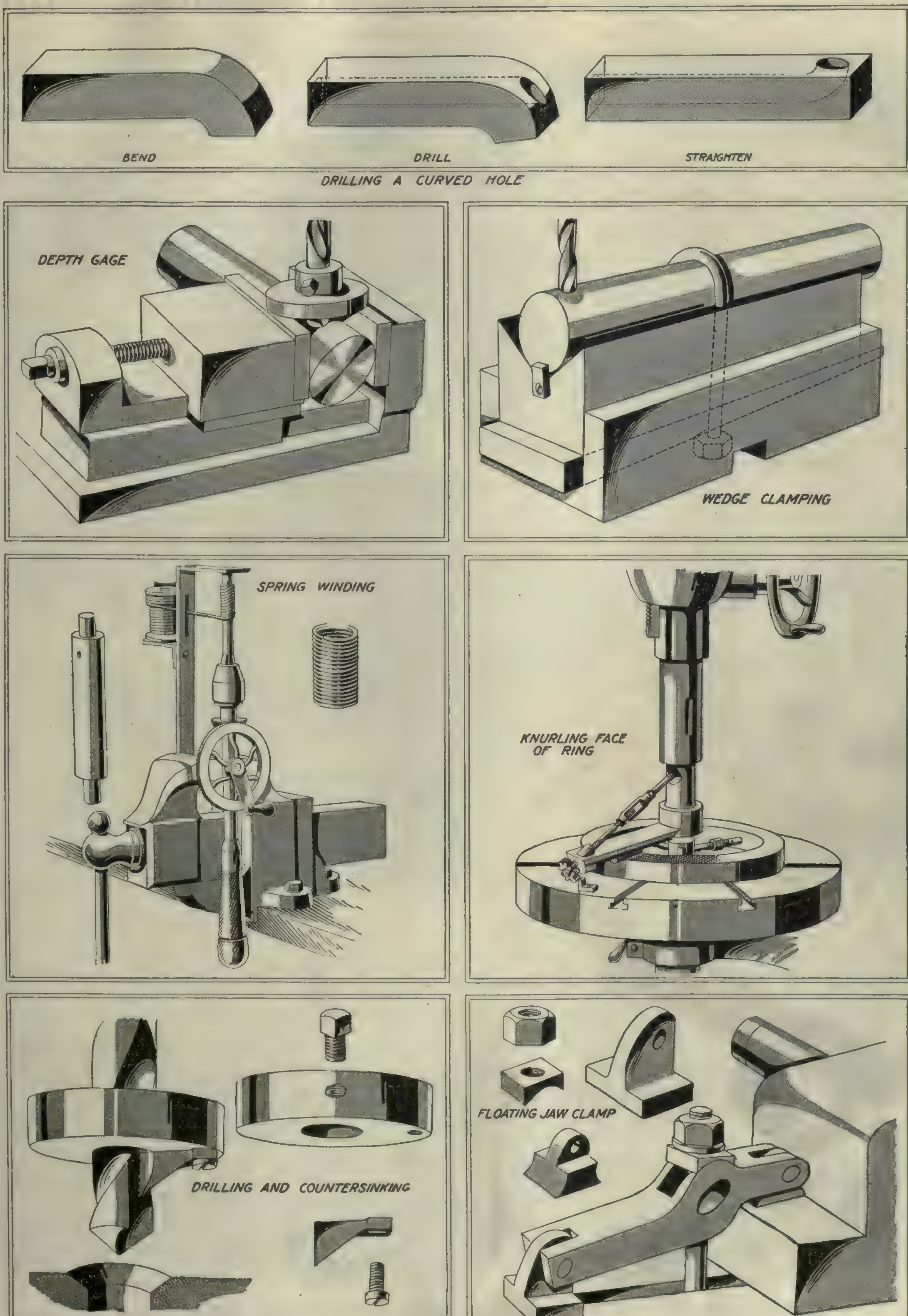
It would seem that here is a field wherein technical schools can do a little missionary work. No doubt there are some lists of books and courses of home study now prepared, but unless they are available to the mass of workers they are not doing all the good they might do. It may even be practicable for manufacturers to procure or have prepared such lists, to be used by their employees. In this case the course for each shop would include such subjects as bear more directly on the product of that shop. A little work along this line would be appreciated by many boys who are now blundering around unable to decide what they want to study.

From a Small-Shop Notebook

By John H. Van Deventer



MAKING THE DRILLING MACHINE EARN DIVIDENDS



BENCH AND VISE KINKS OF SHOP VALUE

Testing Trucks for the United States Army

FIGS. 1 TO 6. TESTING UNITED STATES ARMY-TRUCK EQUIPMENT

Fig. 1—Clintonville four-wheel drive truck with 2600 lb. of ammunition. Fig. 2—Clintonville truck with 9-in. howitzer and ammunition; weight, about 9000 lb. Fig. 3—Jeffery Quad fording stream with 3-in. gun (2520 lb.) and 2600 lb. of shells. Fig. 4—Clintonville in mud on river bank; pulled out unaided when unloaded. Fig. 5—Jeffery pulling out of mud by using winch at rear. Fig. 6—Clintonville hauling 6-in. howitzer and ammunition; weight, about 9000 lb.

How a Designer Designs

By Charles M. Horton

SYNOPSIS—Every design has its "heart." The designer searches for this at the outset. Once he finds it and understands it, the mechanical work of designing begins. The design of a pasting machine is traced through, step by step, until the finished machine is built and tried out—and found to be a failure.

As a matter of fact, designers are as individual in their methods of working as they are individual in their looks—color of hair and eyes, and facial expression. No two machine designers look alike, and no two set about precisely in the same way to develop a machine. It is a matter of training and habits of thinking, and boiling this statement down, habits of thinking have most to do with it. Habits of thinking are the sum total of a man anyway. For instance: A certain intrepid father thrashed his son for being out late one night. After the whaling, the old man, in order to drive home the lesson more firmly, uttered speech. Said he: "When I was your age, my father wouldn't let *me* out after *dark!*" The boy answered: "Then you must have had a devil of a father." Whereupon the old man came back hotly: "I had a d——— sight better father than you have!"

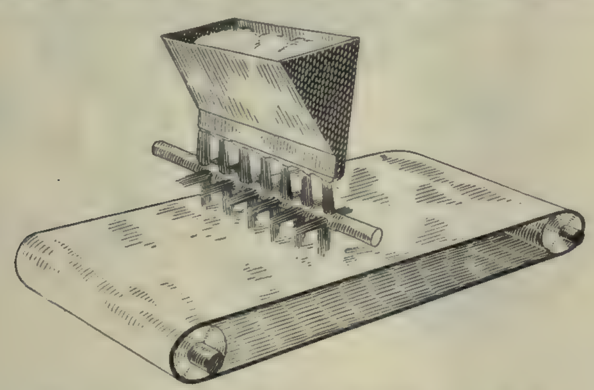


FIG. 1. THE "HEART" OF STEVE'S PROBLEM

It is all a habit—thinking.

But given an idea to work up—a machine to design—the experienced designer starts his thought in one direction. He gropes for the heart of the problem. By groping I mean groping—mentally, of course—because the heart of the thing at first usually lies very much in the dark, and the more intricate the machine the more difficult will the heart be to locate. And by heart I mean the particular piece of mechanism around which the other bits of mechanism center and from which these lesser mechanisms take, as it were, their cue—their more or less complicated motion.

Ordinarily this piece of mechanism lies as intimately close to the product that the machine is destined to handle as the designer's own vital organs are related to one another. Indeed, the corelation of unit movements in a good design are as compact as the human mechanism, proof of which may be found in the product of one branch of the machine industry alone—the universal miller.

Another general rule is that a machine usually takes its outlines from the shape of the material that it is destined to handle. This applies particularly to special machinery. Take a paper-perforating machine, for instance. This type of machine cannot but have the general lines of a sheet of paper, the size of the carrying table being governed and determined by the maximum size of sheet to be perforated. Then there will be the perforating needles, which of course will be held and operated in a vertical plane; and this constitutes, like the table, a problem by itself, and one to be taken care of individually. With these and other matters carefully considered and worked out, all are then tied together, and the whole machine steadily and rapidly simplifies itself.

A machine for the baling of tin cans, for another type, being more difficult, is something else yet again—as Abe Potash might say. Nevertheless, the principles are the same. As a machine, it will bear the general shape of a bale of tin cans as the latter will appear after having been pressed. Also, it will have its several pieces of individual mechanism, each to be considered separately. Being a contrivance for handling an initial loose product, it will consist at the top of some sort of hopper, in the middle of a series of rollers designed to crush the material into compact shape, and end with a device for holding this shape intact and another for throwing the bale out.

The Heart of the Problem Is Attacked First

And there you have, briefly, the cycle of thought—and in about as hazy a fashion at first—through which the designer forces his gray matter when given a special machine to design. He ponders on the larger factors, the largest or the heart first, and he does this a long time before putting pencil to paper. Having decided upon the general mechanical process, he then goes back to the heart of the thing and sets to work, grimly denying himself any thinking on all the other problems connected with the machine until this first and primary movement has been worked out to his satisfaction. Thus he designs the machine in sections. With the several sections completed, he then ties them all together, doing so with whatever methods in general practice happen to be most available.

Cast iron is the popular medium for this tying, because it readily lends itself to odd shapes, is, in a word, pliable—at least, under the designer's hands. Afterward and finally, the designer takes up the matter of drive—shafts and pulleys and the like. Then he passes over to the detailers the general "argument," as one negro porter I recall used to designate a general arrangement, owing no doubt to the numerous debates that he heard about these drawings. "One thing at a time" is made and must be the designer's creed.

Section-line paper readily lends itself to the designer's work. More and more this paper is coming into popular favor. With one unit part of the machine worked out on this paper, another sheet may be utilized in designing another unit section of the machine, and then a third, until the whole mechanism has been designed. After that, the several sheets may be pasted together, whereupon the drafting room has a complete assembly without detailing a man specially for this purpose. As a rule, however, this method does not work out well in the small drafting room. It keeps the designer himself

considerably worried about clearances, a worry that is fully obviated when the arrangement as a whole is worked out on a single large piece of drawing paper continually under his eye.

In large organizations, where there are a number of designers at work upon a single machine under one supervising designer, section-line paper is a decided economy, if for no other reason than that it affords considerable saving in time on the part of the designer, who is spared the use of a scale and frequently T-square and angles.

Steve Winthrop Starts a Design

And now let us design a machine—you and me. Let us design the machine with Steve Winthrop—I have already mentioned Steve. Let us suppose we are associated with a corps of systematizers at work, say, in the collar industry. These systematizers have their two staffs, one taking care of office routine, the other handling the subject of labor-saving devices, with each staff operating free and clear to do exactly what it wants to do. That is the way systematizers work anyway—a free rein or "nothin' doin'."

They go farther. Given the contract, they cause to be erected numerous boarded-up places in and around the plant, each inclosing a member or two of the staff and each bearing a large sign in painted letters. The sign reads, "Keep out—that means you!" It naturally impresses the management. "That gang of systematizers must be thinking," reflects the management, "or they wouldn't be so blamed exclusive!" They are thinking, all right, the systematizers, but not always on subjects of immediate concern to the organization. A funny old world, this!

"Steve," says the manager of the corps, one morning, "we want to get up a machine that will paste interlinings together. They are pasted together by hand now, out there in the factory—girls, at so much per dozen—and I've got a hunch we can do it by machinery. Suppose you run out and look at the thing. Money no object."

Steve—followed by you and me—goes out into the factory. He opens and closes one after another several doors and at last finds himself in the proper department and confronted by a million more or less beautiful girls—more or less a million, understand. The girls without exception are beautiful. Steve pauses a moment to attune himself to all this beauty, then proceeds cautiously to a table where some of the horde of beauty is doing something with its hands.

Close inspection reveals the fact that this something is a straight manual stunt of dipping a brush into a pot of paste, smearing with the paste one of a pair of interlinings cut for collars and then sticking the two pieces together in readiness for the outer pieces of linen, all of which are later sewed together on machines. Pasting these interlinings together helps considerably in the general manufacturing, and as a method it is almost as old as the collar industry—so opines and learns Steve. Also, he observes that there are a million—more or less—girls doing this work and that, on the face of it, as a method, it is out of tune with those of the modern systematizers, whereupon he forgets the bevy of beauty surrounding him and settles himself to a consideration of the problem. So do you and I.

Because it is of necessity slow and laborious, the work therefore is uneconomical; and to do the thing by machinery seems to Steve to be the right thing to do. Also, as he regards each operation wisely, he thinks it can be done by machinery. So he gets down closer. He analyzes each movement through which a girl goes to paste together one set. Then he notes the movements necessary to paste together a dozen sets, the rate upon which is based the operator's remuneration. Also, as he studies these different movements, he gropes in his mind for a similar movement among the thousand or more movements in mechanics which will perform the same work. Separating these in his thought, he makes notes and goes on to another operator, where he again observes with owl-like wisdom the motions of hand and arm necessary to complete one of the sets. He does this for a day or two, then returns to the drafting room, notebook in hand, and begins work. So do we—you and I—only we do not work. We always did hate work.

Steve takes up his problems in something like this fashion: The pot of paste, in the machine, becomes a large pot capable of holding a great quantity of paste.

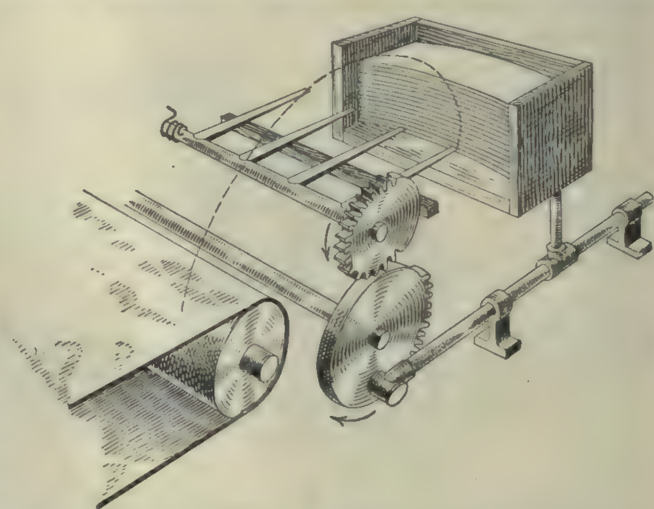


FIG. 2. ANOTHER UNIT SECTION OF THE PROBLEM

Recognizing the laws of gravity, he perceives that the pot must be suspended above the machine, in order that the paste will flow downward upon the things to be pasted. So far, so good. Now, then. To make the process continuous, which is the aim of all designers of labor-saving machinery, there must be a method devised by which the interlinings are carried underneath the paste. Almost immediately a belt conveyor suggests itself. Good. A pot of paste suspended in air and a belt to carry the product under it, that surely is good.

But what is this? The interlinings will of course come through under the paste at intervals—at regular intervals, to be sure, but at intervals—not a continuous feed in the sense that water flows underneath a bridge. There must be small intervals between from the very nature of the things. Therefore, the paste must be made to feed only at intervals. How shall we do that—let us see! Why, with some sort of rotary motion, sure—something that will permit the feeding of the paste at intervals equal to that with which the interlinings will pass under the pot. Nozzles—nozzles that rotate, gathering in paste on their upward arc from the paste pot and distributing it upon the interlinings while traveling through the lower half of the circle. Hurrah! That is fine, too! And now what else?

Well, the interlinings must be placed upon the belt conveyor by machinery, or the whole contrivance is not worth powder. Right! Well, then, what is the matter with the feed device on an ordinary printing press—one that prints street-car advertisements and the like? Nothing. The fingers will slip in under each set of interlinings, which have been placed in stacks of ninety-six in a tiny box for this purpose, and carry each set forward through a vertical plane and onto the belt conveyor. Enough—we have got it! You and I and Steve.

Mechanical Work of Designing Begins

Now, what? Well, Steve covers his board with a nice clean piece of drawing paper, sharpens up three or four hard and soft pencils and wriggles up onto his stool and wings to it. The nozzle business, because it is the heart

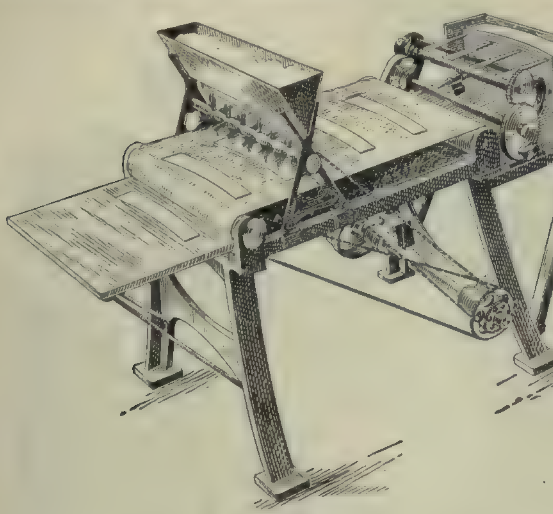


FIG. 3. THE FINISHED DESIGN

of the problem, first engages his attention. He draws a picture of a small tank to hold the paste, schemes out the type of nozzle that will best serve the purpose, dopes out approximately the distance between which the interlinings will ride forward on the conveyor and so determines through what arc his nozzles must revolve in order to meet each set of interlinings. This establishes also the number of nozzles that he may use. Then he places them on a shaft, which he knows will be operated, in the first and experimental machine, by some sort of chain and sprocket drive. After that he takes up the matter of the belt.

This he places on wooden rolls, one at each end of his table. As in the case of the nozzle shaft the belt will be operated by a chain and sprocket. Then he goes after the rates of speed of all these sprockets, calculating the size of his sprockets until his ratios are right. He now has the paste pot established, the nozzles roughly in operation, together with their number and circular sweep, and the belt conveyor correctly set below the pot and nozzles. There remains yet some means to work out by which the paste will remain in suspension between gathering moments of the nozzles, but that appears possible—a rubber lip on the pot, which will easily give way under pressure from the nozzle itself.

So far the whole thing works out fairly well, and Steve—and you and I—eat heartily these days at luncheon, while the birds sing in the elm tops and the sun shines on all seven sides of the street. Even the subject of asking for a raise occurs to us, but we wisely refrain until the machine is actually running.

Steve—and you and I—takes up other and more minor problems. He draws in a couple or four cheap cast-iron legs to support the table. Then he considers the box and the printing-press feed device for distributing the interlinings upon the canvas belt conveyor. He finally decides on a spring bottom to the box, which will continuously force the stack of interlinings to the top of the box, where one piece will readily be picked up by the sliding fingers and be swept over upon the belt conveyor. Indeed, he draws up such a box, with a flat spring in the bottom, and then goes after the finger device. This he makes up of flat steel pieces riveted upon a small shaft, and he has the shaft operated by a gear. Now he makes a discovery. Instead of the fingers sliding forward to the edge of the holding box, he perceives that the better construction from a mechanical point of view would be to have the box and its contents slide backward on the tips of the fingers.

That *is* good—a victory, in a way—one of those things that give a designer a little thrill whenever it so happens. A truly creative thing—sent to man from the Great Outside. As a successful interpreter his reward is the thrill that follows, which often, as in the case of inventors, is the only reward that will come to him.

Well, as they said in Shakespeare's time: The thing is done. It passes through the hands of the detailers, is sent into the shop to be made, and Steve, together with you and me, awaits with ill-disguised impatience and eagerness its appearance for a test. Then one fine day the foreman of the shop sends up the fatal word.

We go down—all hands. We are escorted into a neatly boarded-up inclosure, with the omnipresent sign, "Keep out," over the door. The proper authorities produce the proper set of keys, and the door swings open.

The Finished Machine—and Its Trial

There it is—gad! A table on four legs; a belt conveyor operating on wooden rollers at each end of the table; a pot of paste suspended halfway over the canvas belt; and the shaft and nozzles all in readiness for the big and official test. Sure, the machine has been turned over a good many times by the erecting man; but this is final—this is the thing. Underneath the table Steve sees shaft and sprockets and chains all crisscrossing one another—the chains understand—and there is a belt running back to a tiny motor on the floor. Above the motor, on the wall, is a starting box. The paste pot already is gooey with paste, and the tips of the nozzles, look as if they had been in use also. While out from the end of the table, suspended on a plane with the conveyor, sits in seeming dignity the box containing the stack of interlinings, waiting to be fed over upon the canvas.

The machinist starts her up. The fingers flop over toward the box, the box glides forward underneath the fingers, and the fingers rise in air—but without carrying any interlinings! You don't say! Yes; it's a fact! Something has failed of its duty; and the grin on the face of the machinist, together with the look of painful solemnity on the countenance of the shop foreman, seems to hint at his previous knowledge.

Steve himself, the author of this failure, looks a little troubled. Without regard for cost of material or the

unwritten rules of machine-shop procedure, he skillfully cuts out the feeding device by twisting the chain drive off one sprocket with a hammer handle. Steve is sore, you know. He is sore to the point where he takes things in his own hands. He feeds the interlinings upon the belt himself, and this and the pasting mechanism work beautifully. The fingers revolve as he expected them to revolve; the interlinings move forward in even distribution under his hands and are smoothly pasted. The whole machine, with that single exception of the feeding mechanism, works in strict concordance with instructions. It is fine —or a shame—whichever feature lies uppermost in your mind.

Cloth Cannot Be Fed Like Paper

Well, anyway, after an hour or two of discussion, Steve and you and I make our way painfully back to the drafting room. The birds have ceased to shine; the sun to sing; a raise in pay is very, very far distant. We all go to it—you and I, too—we are a little "het" up and inclined to bull things to perfection. We get out several things designed to make that feeding device work properly—from rubber-tipped fingers to a puff of air. But none of them work. Nor do any other ideas work. Nor do any ideas, those put out by others in the organization, ever work. It is discovered—and decided—that the thing cannot be done.

Cloth cannot be handled like paper. There is a "come-back" to a sheet of paper, a positive resistance, which is no part of a layer of cloth. Turn back a sheet of paper lightly halfway, and it will return. Turn back a "sheet" of cloth similarly, and it will remain. In this little difference lay Steve's—and your and my—defeat. Altogether it proves a hopeless attempt at labor saving.

It is too bad, of course. Steve feels it; I feel it; you, no doubt, feel it. So does the scrap heap. Still, you have had the fun of designing a special machine, even if it did not work; and that is what we went after. But more than all else, you have had a taste of the defeat that usually accompanies victory. Designers have their big as well as their little troubles. And even though they work behind closed doors, or because they work behind closed doors, or maybe in *spite* of the fact that they work behind closed doors, they breathe at first hand the air of the outside world of industry and know the feel of the greatest and most glorious thrill that comes to mankind, one that will bear repeating over and over again—the joy that comes of creative work. Also, knowing this thrill, this joy, they know also—and get this—that life runs about even in victory and defeat—sixty-sixty—if you will pardon my Yankee desire innocently to exaggerate.

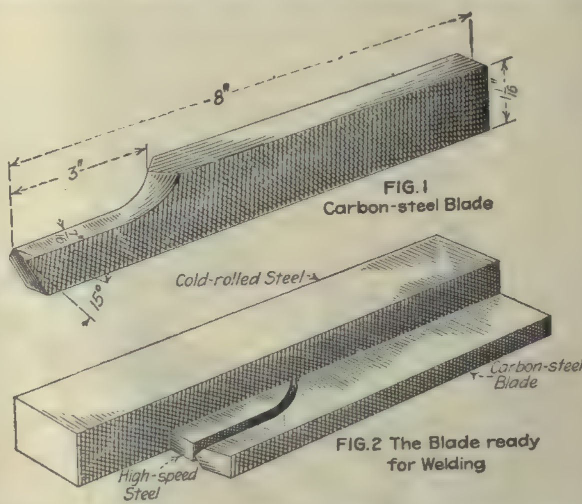
Reducing the Cost of Tools

By Charles Shaeff

Owing to the price of high-speed steel and to the short life of the average blade, we decided to weld high-speed tips on carbon steel, with the oxyacetylene flame.

A piece of carbon steel was roughed down to $^{17}/_{64}$ x $1^{1}/_{64}$ x 8 in., as shown in Fig. 1. A number of these blades were clamped together and then shaped $\frac{1}{4}$ in. deep and 3 in. back from one end. The undercut edges of these blades were ground on an angle of 15 deg. to permit the flame to reach the center of the blade without affecting the life of the high-speed steel tip. The high-speed steel tip was $\frac{5}{16}$ in. square by 3 in., with a $\frac{5}{16}$-in. radius on one end.

The high-speed steel tip was placed against a piece of 1-in. square by 10-in. cold-rolled steel to prevent burning the top edges. The carbon steel was then brought against the high-speed steel tip, as shown in Fig. 2. The flame was played on the carbon steel about $\frac{1}{2}$ in. back of the groove until the steel was a cherry red. The weld was then made, care being taken that the high-speed steel was welded on the under side (from the cutting edges).



FIGS. 1 AND 2. SHANK AND BLADE IN POSITION FOR WELDING

Soft machine steel was used as a filler, with $66\frac{2}{3}$ per cent. table salt and $33\frac{1}{3}$ per cent. borax as a flux.

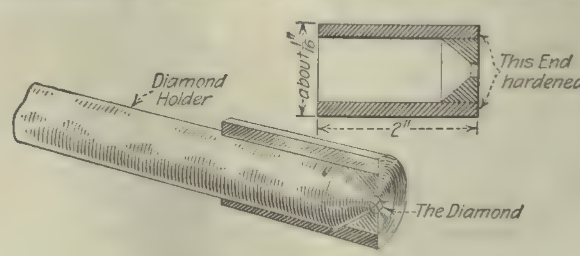
The flame was played on the blade around the tip until it colored a light lemon. The blade was then dipped into fish oil. The time of these two operations was about the same as the usual time taken to harden solid blades of high-speed steel in a gas furnace.

The hardened blades were ground to finished sizes on the surface grinder. Actual tests showed the life of these blades to be three times that of a solid high-speed steel blade, as they were used until ground back within $\frac{1}{4}$ in. of the length of the tip.

Diamond-Holder Safety Bushing

By Charles M. Valdes

The illustration shows a bushing with the end hardened. It is made from drill rod and is a sliding fit on the diamond holder. With this bushing fitted over the holder, either plain or saucer types may be trued without danger



THE BUSHING

of loosening the diamond, as it is supported by the bushing. The hardened end of the bushing also prevents the holder from being ground. Thus the diamond bearing is not weakened.

Heat-Treating Plant of the New Process Gear Corporation—III

By E. A. Suverkrop

SYNOPSIS—This final installment takes up the cleansing, refrigeration and distribution of the quenching oil, inspection of hardness and shape before sand blasting, sand blasting and ultimate inspection of hardness, shape and quality before the running test which precedes assembly.

The next operation on the gears is a thorough inspection and test of the hardness, but before passing to this it would be well to describe the handling of the quenching oil in the largest and best-equipped system the writer has ever seen. Altogether there are 32 quenching tanks approximately cubical in shape and measuring about 4 ft. on the side. Into these the oil is kept flowing in a steady stream at an initial temperature of 70 deg. F. As the oil in these tanks is never permitted to reach a temperature higher than 90 deg. F., the cooling of it presents a problem in refrigeration of no mean proportions.

In the basement of the hardening building there are two oil-storage tanks of 10,000- and one of 15,000-gal. capacity. Four pumps draw this quenching oil from the storage tanks and deliver it to the hardening room on the fourth floor, where it is distributed in constant streams to the various quenching tanks, according to their needs. The oil is let into the tanks from the bottom; and as, heated by the work, it rises to the top, it drains over the lip of the tank and passes into a pipe leading down to the straining and filtering machine on the floors below.

In passing through the quenching tanks the oil picks up small particles of scale, waste and other dirt, which are individually insignificant, but which in the aggregate amount to quite a lot of foreign matter. As all this has to pass through a complex refrigerating and piping system, it is obviously better to head off trouble by removing that which may cause costly delays later on.

An idea of what is meant by a "complex system of piping" may be had from Fig. 13. Here are fuel-oil, quenching-oil, air, water and other pipes in the most complex and yet the neatest arrangement of piping that the writer has ever seen. The pipes seen leading through the ceiling go to the hardening rooms just described. The illustration is merely shown to give the reader a vague idea of the intricacy of this installation. I have no desire, even if I were able, to give a description of this feature of the plant.

FIG. 13. PIPE ARRANGEMENT ON THE CEILING OF THE THIRD FLOOR

In Fig. 14 is shown one of the filters. The oil enters through the pipe *A* and passes first through a copper strainer with holes about $\frac{1}{32}$ in. in diameter, which are shown clearly in the illustration of the filter in the refrigerating room, Fig. 15. In these two illustrations, wherever possible, similar reference letters are used. These copper strainers, located in the casing *D*, arrest all the larger particles of foreign matter and are cleaned every three days. From them the oil passes to the filters *E*, Fig. 15. These are burlap bags about 24 in. in circumference and 12 ft. long, supported on wire netting, as shown. They present large filtering area to the oil, catch

the smaller particles and are removed and cleaned once every week.

Referring back to Fig. 14, the cast-iron casing *G* receives the burlap filters. The bolt holes in the head *H* are large enough for the nuts to pass through them. When the head *H* is to be removed, the nuts are merely slackened back; the D-shaped washers, which are permanently attached to the eye-bolt *I*, by the chains shown, are slipped out of the way, and the head is raised. This method of attaching the D-washers is worthy of note.

Having passed through the filters, the oil goes through the pipe *B* to the refrigerating system. In Fig. 15 the wall *F* forms one side of the oil refrigerator house, a front view of which is given in Fig. 16. Here *A* is the refrigerator house, with a door *B* giving access to the coils inside. To the right, at *C*, can be seen the ammonia coils. The refrigerating machine itself is on the ground floor. In Fig. 17 is presented a view inside the refrigerator house through the door *B*, in Fig. 16. The oil, after passing the filter, is forced up through pipes to the top of the coils, flows along gutters above them and, overflowing the edges of the gutters, falls in a thin film over the cold pipes *A* of the coils in the refrigerator, Fig. 17. From here the oil is carried by gravity to the storage tanks in the basement, whence it is again pumped to the quenching tanks on the top floor.

From the hardening department the work is transported on trucks, by the men who have hardened it, to the hardness inspection room, which is on the same floor, and in the case of bevel ring gears each gang transports its own work, but before turning it over to the inspector examines it for flatness. A thin film of burnt oil from the hardening operations remains on the surface of the work. This is removed from the backs of the gears with an ordinary scraper. A straight-edge is then laid across the cleaned surface and the flatness tested with feelers 0.003 in. thick. Those gears that do not pass are reported to the chief hardener.

In Fig. 18 may be observed a part of the inspection room. At *A* is one of the ordinary trucks for transporting the work from the hardening department. At *B* is a similar truck with a number of pinions wired together and disposed in wire baskets similar to those used for drawing and for washing in the soda tanks.

In this plant, gears are tested with two instruments—the scleroscope and a file. In spite of all that has been said about the scleroscope alone measuring hardness, it will not show the hardness of case-hardened work. It will show density, but there is some difference between density and hardness. The case can be glass hard to the file; but if it is as thin as 0.01 in. or less, the scleroscope cannot be depended on to give a reliable reading. In other words, a similar piece of work similarly hard, but with a case three times the thickness, will invariably show much greater hardness on the scleroscope scale.

The gears are taken to the block *D* in the corner. This is merely a cubical block of wood with an iron plate on top of it for the gear ring to rest on. There are several rollers that act as stops, but permit the gear to be rotated easily. These are so small that they do not show in the illustration. They merely prevent the gear from sliding off the plate while under the pressure of the file. The inspector tests every other tooth, or in case of doubt each tooth, with a file.

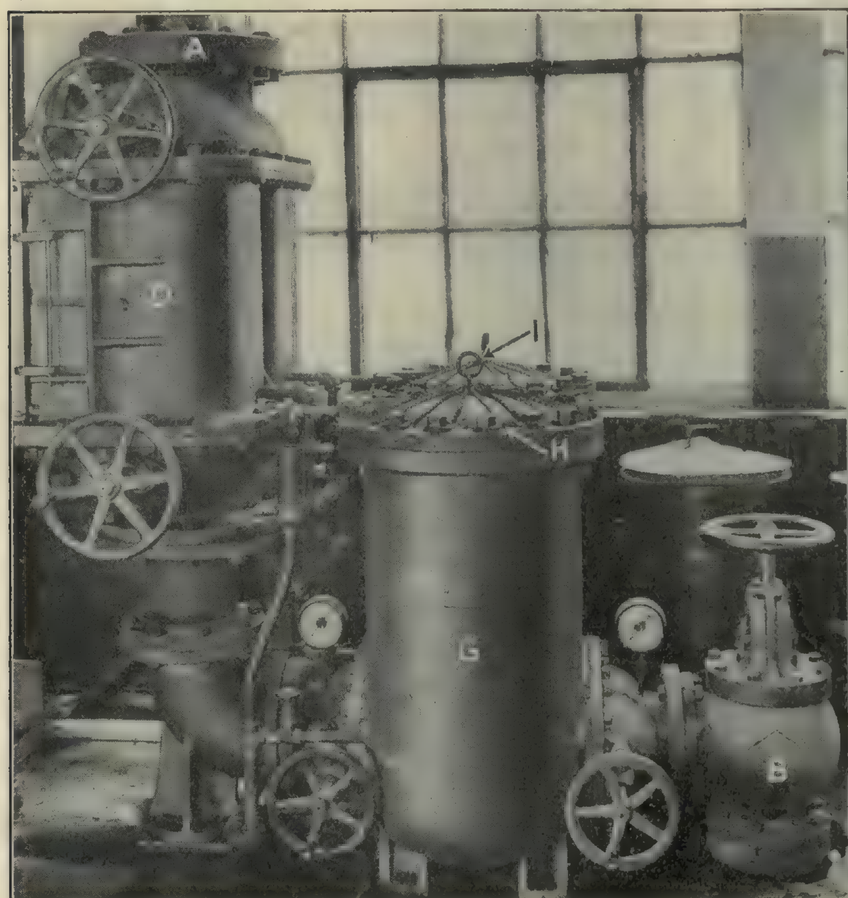


FIG. 14. ONE OF THE OIL FILTERS

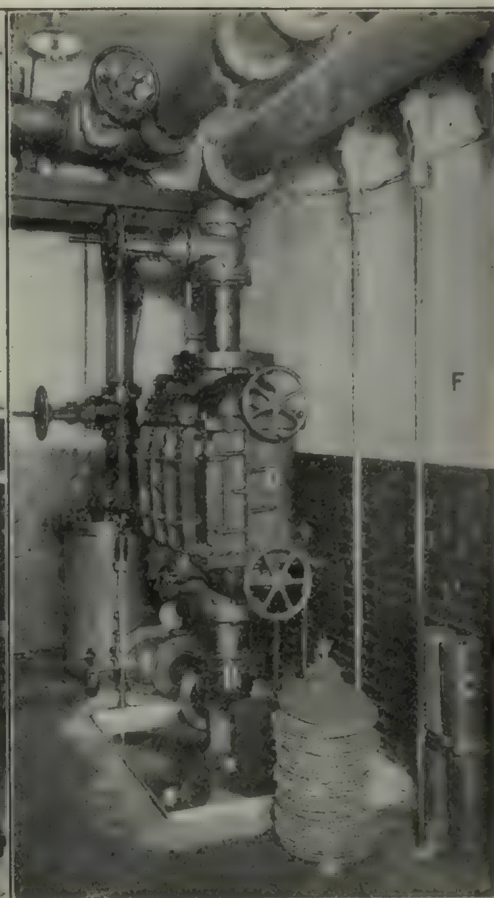


FIG. 15. STRAINERS AND FILTER BAG

To prepare the work for the scleroscope test it is taken to the disk grinder at C, and the faces of two or more teeth on opposite sides are ground. The work now goes to the scleroscope testing bench, a part of which is shown in Fig. 19. Small work is contained in the steel tote boxes A. The scleroscopes are not supported on the bases supplied with these instruments, but on special ones, the post B of which is secured to the bench. Mounted on this post is a vertically adjustable arm C, which can be set at any desired height on the post B. Beneath it is a collar that can be clamped to the post; and when so clamped, the arm C is free to swing on the post B in a circle in a horizontal plane. Hinged at D to this arm C is another arm E, which carries the scleroscope F. The work is held in the vise G or, as shown in the case of the gear I, it is laid on the anvil block H.

Considerable experience and special aptitude are required to inspect with any degree of certainty work of this character. There are so many conditions which give apparently conflicting results that it requires a faculty almost equal to instinct to determine just what really is the condition of the work, and neither the scleroscope by itself nor the file by itself can be depended upon as infallible in this connection. For instance, suppose a piece of work has been hardened at too high a temperature. If such a piece is broken, it will probably show a coarsely crystalline structure and, while under the file it will test hard, the scleroscope will indicate that it is soft. Obviously, a piece that the file will not grip is hard, whether the scleroscope says so or not. There must therefore be a reason why the scleroscope indicates that it is not.

When the drop of the scleroscope falls, the hard case of such work gives way under the impact, because it is poorly supported by the coarsely crystalline structure of the steel under it. A great part of the blow is thus absorbed with a consequent loss of resiliency, and the rebound of the drop will be less pronounced than with a similarly hard case well supported by a firm, close-grained core.

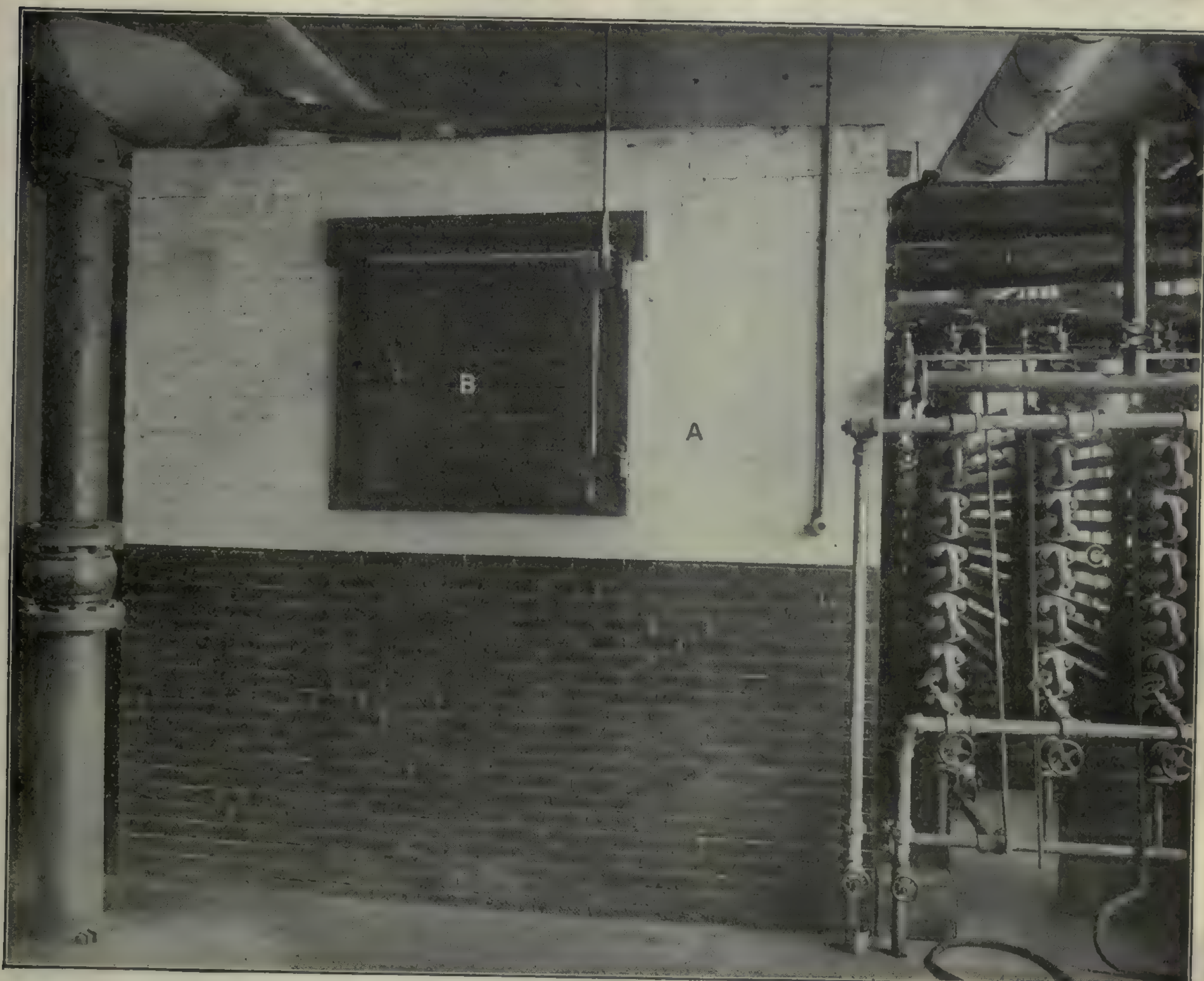


FIG. 16. REFRIGERATOR ROOM AND AMMONIA COILS

Another instance: If a piece is hardened just at or near the critical point, the scleroscope will often show that the piece is hard, in spite of the fact that it can be readily filed. A thin case will usually show soft under the scleroscope, no matter how hard it may show with the file. For this reason the scleroscope can be assumed to determine the density of the work rather than the hardness; and the file to show actual hardness irrespective of thickness or condition of core. When both agree as to the hardness of a piece of work, it is reasonable to assume that the case is hard and that it is properly supported by a core of sufficient density.

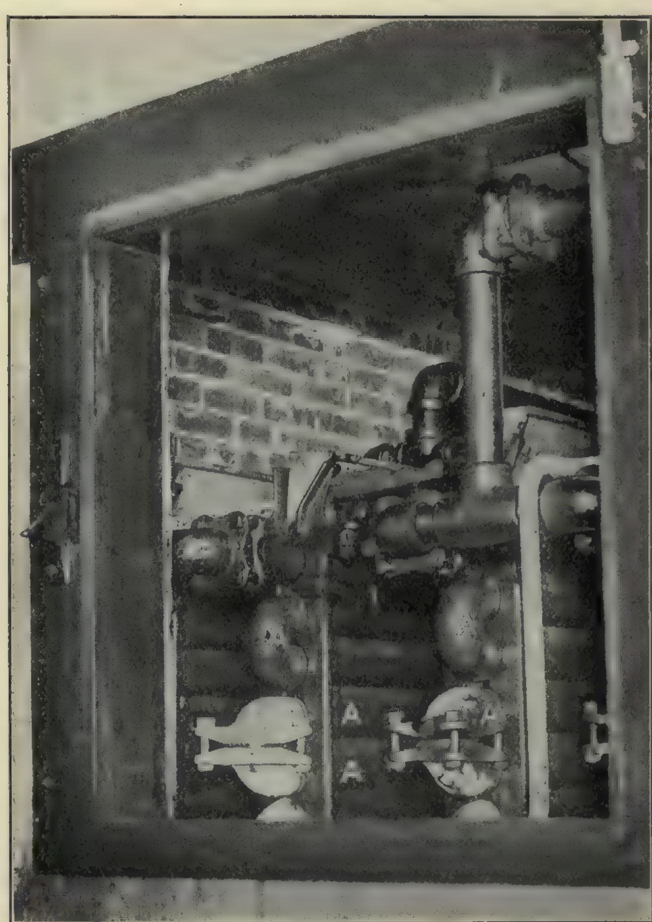


FIG. 17. VIEW INSIDE THE REFRIGERATOR

From the hardness-inspection department the gears go to the sand-blasting department on the ground floor of the hardening building. In Fig. 20 is shown one of the sand-blasting booths in this department. They are built of heavy sheet steel. Formerly they were sheathed on the inside with wood, but this wore out rapidly. The wood has now been replaced by steel sheets, which not only withstand the erosion of the sand blast better, but are so arranged that they can be replaced more readily than the wood. Each booth accommodates four operators. Each operator has a window A, so that he can view the work, and two arm holes B protected by canvas. The air-hose opening is shown at C.

Moderately fine silica sand is used. It is contained in hoppers on the floor above. The work is laid on gratings or supported in the hand of the operator, while with the other he directs the nozzle of the sand blast.

The spent sand falls to the floor of the booth, whence it is elevated to the floor above. Here it is directed first into a separator, where the fine dust is removed and the still serviceable sand is diverted to the large storage hoppers previously referred to. These are immediately over the booths. Except for the wastage of the dust the sand is used over and over.

The piles of gears shown in Fig. 20 were not specially posed for the illustration, but are just as they happened to be in the course of the day's work. The darker gears are those that have just come from the inspection department, while the white ones in the large tote box are gears that have just been sanded. In the sand-blast department, after being sanded and before going to the running test and assembling departments, the gears are subjected to a critical visual inspection.

Patterns for Single Castings

By F. W. Brady

In the jobbing shop the ingenuity of the pattern maker is frequently taxed to the limit in order to produce at low cost the molding devices for some single odd casting. However, the conscientious pattern maker gets a great deal of satisfaction from seeing his creations approved and hustled off to the foundry. There is an additional satisfaction when he learns subsequently that the production cost has come within the estimate and that the firm has made a profit. It is for these reasons that pattern making is a trade with much more of the human-interest element than can be claimed for many others.

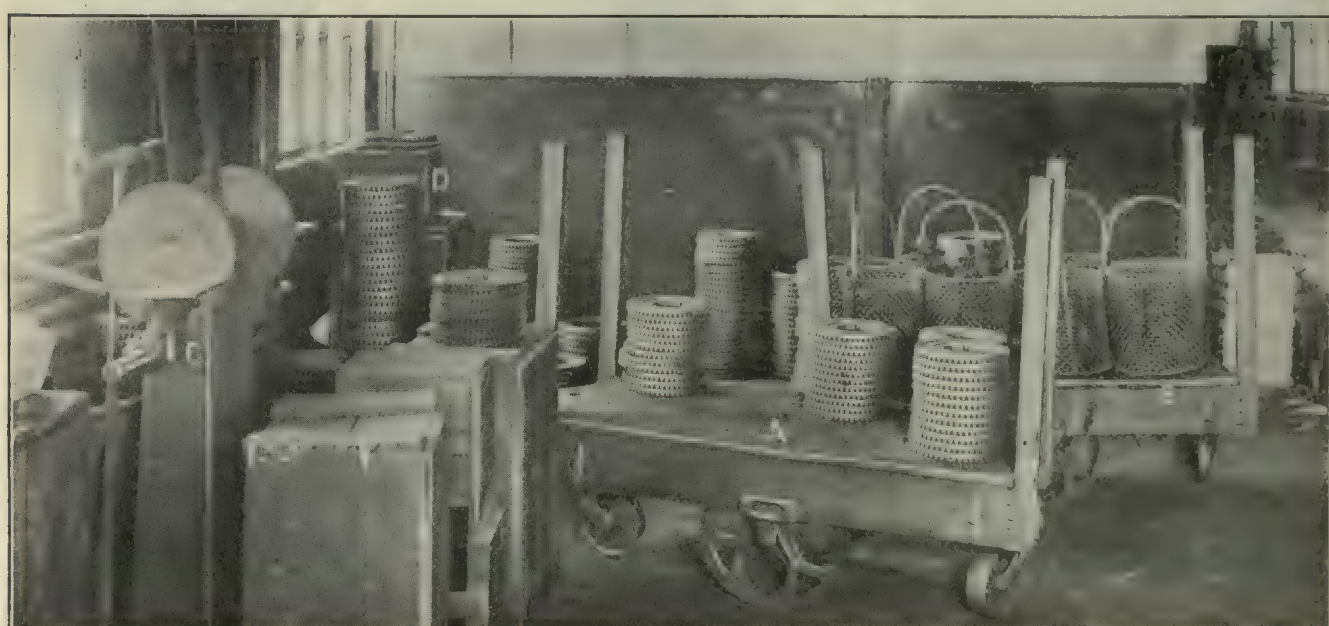


FIG. 18. CORNER IN THE INSPECTION DEPARTMENT

As an example of rapid-fire pattern making, Fig. 1 shows the skeleton and the core frame constructed for making a single 6-in. pipe bend with standard flanges. The method of making the molding devices was left entirely to the judgment of the pattern maker, with the requirements that there be quick service and a low cost of production of a single casting.

The skeleton method was adopted and the work expedited by sawing out the parts in multiple. Thus, the

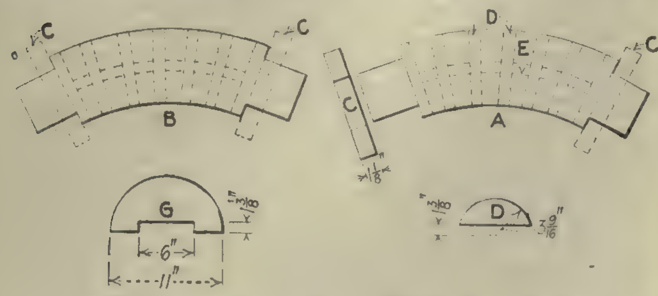


FIG. 1. PATTERN FOR A SINGLE CASTING

two main parts A and B, Fig. 1, which must be $7\frac{1}{8}$ in. wide, were sawed after being doweled together, using $1\frac{1}{8}$-in. stock. In the same manner the flanges C were sawed together and to go on the bases without requiring any extra fitting. The two sets of ribs D and E completed the parts.

The flanges were made 11 in. diameter and with a notch in the straight side 6 in. wide and $1\frac{1}{8}$ in. deep to fit over the core prints. The semicircular ribs D were made of 1-in. stock, and they were laid off with an allowance of $1\frac{1}{8}$ in. for the thickness of the base, requiring a radius of $3\frac{9}{16}$ in. The stiffening ribs E were also made of 1-in. stock and sawed out in multiple. Numerous nails were driven into the ribs to hold the sand.

For making the core of a frame F, Fig. 2, was made of two arcs having the curvature of the pipe united at the ends by half-circle disks cut with a radius of 3 in. The sweep G, Fig. 1, has the usual form. Making the pattern and core frame by multiple sawing, using cheap lumber, the lack of all extra finishing and the use of fillets, etc., favored the low cost of production.

The molder built up the sand pattern by filling between the ribs and slicking off; then he applied parting sand and rammed up the half-patterns in the drag and cope. The half-core was swept up on the drying plate, and the two parts were pasted together after drying.

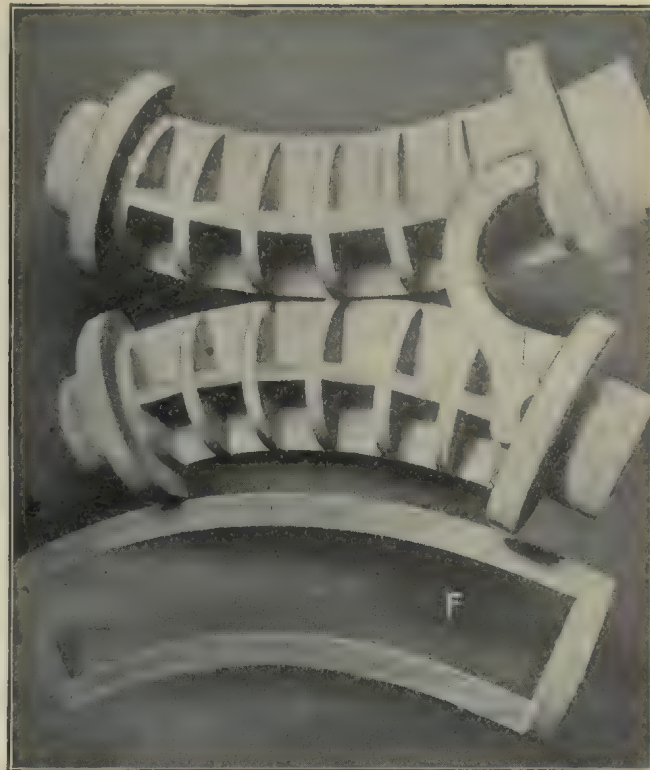


FIG. 2. PATTERN PARTS FOR A SINGLE PIPE BEND

Sammy's Shop—Increasing the Force by Advertising for Men

By W. Osborne

"The cornsheller business is so good that we are getting behind. I have just closed a large order and have promised delivery. That will be in addition to our regular requirements. Sammy, we will have to increase our force. We will need a man on every machine right away, and besides that we must keep a setting-up gang going. I have put an advertisement in several of the papers, and

FIG. 19. SCLEROSCOPE TESTING BENCH

FIG. 20. SAND-BLASTING DEPARTMENT

we must be ready to take care of the men as fast as they answer."

Mr. Brown had sprung into action, and Sammy was being informed of it.

The shop was not so very large, even if the action that Mr. Brown set up sometimes was.

"Shall we run a night force?" asked Sammy.

"Not at the present time. Even if we had enough business for that, we do not have stock enough on hand, but fill full up on everything that we can work."

Planning for New Men

Sammy found that it might be possible to work nine more men. Two of these should be good machinists who were used to doing a variety of work. They could fill in anywhere that they might be needed. Four of the others should have had some shop experience so as to be able to do plain turning or drilling-machine or shaper work. The others could be young men without experience, but with intelligence enough to be able to handle stock and help the mechanics.

Once before, when the country was booming, they had needed men and Mr. Brown had advertised for them. The results had not been good. The men who came were evidently men who did not fit anywhere. Those who were good workmen were intemperate. The ones who were willing to stay seemed to feel that their mere presence was a blessing. They were not looking for work, but for a paymaster. The entire number that had applied was not great, so Sammy did not have to do much selecting.

Now the case was different. As it was the time of business depression before the beginning of the war, many men were looking for jobs. In two days every place was filled, but the stream of answers had just begun. Applications were received for positions from general manager to shop sweeper. Wages were the only thing that some of the applicants seemed interested in, while others were so anxious to learn the cornsheller business that they were willing to leave the financial question to the future.

There was one thing that seemed to stand out very clearly in most of the answers that had anything clear in them, and that was that the side of the shop was not given much consideration. In very few cases was anything said that would enable the recipient to form a judgment of the qualifications of the writer.

Sammy Changes His Ideas

It has been said by contributors to the *American Machinist* that each answer to an advertisement is entitled to a courteous reply. Sammy had thought the same way himself. Now he began to have some different ideas on the subject. If Mr. Brown had been rather broad in wording his advertisement, he had at least made it clear that the help was wanted to work in a shop making cornshellers. Why should a man who had been a preacher and who knew nothing about a machine shop answer it? Why should he feel ill used if he did not get a reply to his answer? And there was the case of the young man who could play baseball and make a hand in the band, and the one of the man who had worked hard on the farm so long that he wanted a job where he could rest up.

As a means of shedding light on the real reasons that some men have for changing jobs, some of the letters were valuable. One of the common reasons given by men from out of town was that some relative of the family lived in the town and desired them to come; another one was the desire to earn more money, or rather it was the desire to get more pay for the work done. One man wished to change locations because he had a neighbor who had a wife who judged men by their ability to bring home a large pay envelope and who continually and forcibly expressed her judgment to his wife, and she in turn transmitted it to him. A restless feeling was produced. Apparently, it was easier to move than it was to compete successfully with the pay envelope of the neighbor and with the tongue of the neighbor's wife.

One thing was apparent as time went on, and that was that very few of those who were hired as the result of Mr. Brown's advertisements became permanent employees. Many of those hired under Sammy's system of getting additional help did stay as long as there was work for them. You may be surprised to know that Sammy had a system, and also be surprised that Mr. Brown had not taken advantage of it. Both of these things are easy to explain to anyone who understands the conditions that have to be met in a machine shop.

Every shop has a lot of little things about its ways of doing things that make it different from any other shop. The sum of these make the "atmosphere" of the shop. This atmosphere is made up of a great many things, such as the way the foremen treat the men, the attitude of the company toward a man who makes a mistake in his work, the chances a man has of being changed from a job that he does not like to one that he does, the way a man is given instruction, the way merit is recognized and a lot of such things that are mostly unclassified and which go entirely unrecognized by anyone not a part of the shop itself.

Sammy's System of Hiring Men

This system of Sammy's had never been classified as a system, even by Sammy. It was just one of the little ways that he had of doing one of the things that he frequently had to do, and he had never thought of it as a thing worth speaking about. It was a part of the shop atmosphere that Mr. Brown did not know anything about.

If Sammy wanted a boy for a small drilling machine, he would ask a boy who was running one if he knew of a boy who would like such a job and whom he could recommend; Sammy would lay stress on the "recommend" part of it. Or he might go to a reliable family man and ask if he knew of a good boy in his neighborhood who wanted a job, or he might tell a coming young man that his work was so good on the drilling machine that he would be moved over to a lathe as soon as a suitable person could be found to take his place at the present job. It sometimes took several days to get the right kind of hand, but it was very seldom that a poor one was recommended. When labor conditions were such that Sammy's force could not be increased by such means, desirable men could not be obtained by newspaper advertising.

There is no intention of holding such methods up as suitable for other shops and other situations and surroundings. Some companies may prefer to advertise and then classify and select by tabulating the visible physical characteristics of the applicants and the aptitude they may show in placing pieces of wood in holes. It takes time to develop a real science of anything.

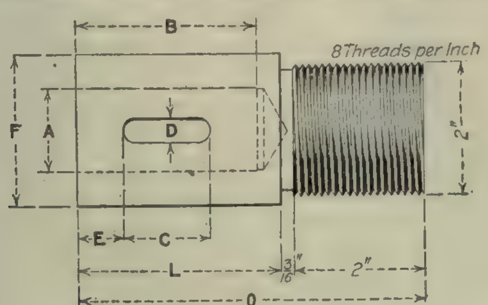
Broaches—Their Design and Manufacture*

By W. G. Groocock

SYNOPSIS—This article introduces a series on broaching written from the standpoint of a practical shop man whose actual experience with broaches extends over a number of years, and in consequence represents a maximum of practice with a minimum amount of theory.

Broaching is not a new operation, though it is only during a comparatively recent period that it has been recognized as one of the machine operations necessarily associated with successful manufacture. Like several other of our latter day processes, being in a more or less embryonic state it has infinite possibilities for further developments. These developments naturally depend on the tools used and therefore we must look for more efficient and cheaper broaches. A good deal has been written about broaches and in this article, perhaps, some of the ground already gone over may be re-traversed. If so, no apology will be needed, as the repetition will serve to emphasize the importance of particular points to be considered in broach design.

There are two ways of broaching—pushing and pulling. I will confine myself to the tension system. In this system the broaches vary in length from 18 in. to 5 or 6 ft.



A, in.	B, in.	C, in.	D, in.	E, in.	F, in.	L, in.	O, in.
5/8	2 1/2	1	5/32	11/16	2	3	5 3/16
3/4	2 1/4	1 1/4	7/32	11/16	2	3 1/8	5 5/16
7/8	2 1/4	1 1/4	7/32	11/16	2	3 1/8	5 5/16
15/16	2 3/4	1 1/4	1/4	11/16	2	3 1/8	5 5/16
1	2 3/4	1 1/4	1/4	11/16	2	3 1/8	5 5/16
1 1/8	2 3/4	1 1/4	11/32	11/16	2 5/16	3 1/8	5 5/16
1 3/16	2 3/4	1 5/16	3/8	11/16	2 5/16	3 1/8	5 5/16
1 1/4	2 3/4	1 5/16	3/8	11/16	2 5/16	3 1/8	5 5/16
1 3/8	2 7/8	1 5/8	13/32	11/16	2 1/2	3 1/8	5 5/16
1 7/16	3 1/4	1 5/8	7/16	3/4	2 5/8	3 1/2	5 11/16
1 1/2	3 1/4	1 5/8	7/16	3/4	2 5/8	3 1/2	5 11/16
1 5/8	3 1/4	1 5/8	7/16	3/4	2 3/4	3 1/2	5 11/16
1 3/4	..	..	..	..	...	..	...
1 7/8	..	..	..	..	...	..	...
2	3 5/8	1 3/4	17/32	1	3 1/4	4 1/4	6 7/16

DIMENSIONS OF BROACH HOLDERS

The great drawback to the very long broaches—apart from the difficulty of making them accurate—is that with the ordinary toolroom equipment they cannot be kept sharp, and a broach that cannot be sharpened readily is a constant source of trouble.

When purchasing broaches, therefore, it must always be borne in mind that they will have to be kept sharp (the same reason obtains if they are made in the factory toolroom); consequently, the plant where they are to be sharpened must be taken into consideration. The ideal length for a broach is about 3 ft. long over all.

The question of the material from which to make the broaches is an important one. They are made from high-speed steel, high-carbon steel, and from low-carbon steel casehardened; but the best in practice seem to be those made from low-carbon casehardened steel. From the point of view of cost of material, those made from high-speed steel are, of course, the most expensive; while if we add the carbonizing cost to the material charge, there is still a balance considerably in favor of those made from the low-carbon steel.

In the actual production of the broaches, up to the heat-treatment stage, there is little difference in cost, what difference there is being in favor of those made from casehardening material. When, however, the hardening of the broaches is considered, those made from low-carbon steel are found to be the lowest in cost. The extreme difficulty of straightening either high-speed or high-carbon steel broaches as compared with the easy way in which the casehardened broaches may be manipulated is worth considering. As to the length of life, there is not much to choose between broaches made from these types of material if the conclusions are based on a good clean hole that may only vary from its original size by a very small amount. To get the clean work required in modern manufacture the broaches must—as I have stated before—be constantly sharpened, and it is a curious fact that high-speed steel broaches need more sharpening than either of the other materials mentioned, to obtain these conditions.

Again, high-speed steel and high-carbon steel broaches are more liable to shed their teeth under any unusual load. As a matter of fact, while many mishaps have occurred in both making and using broaches of high-speed and high-carbon steels, I have only one failure to record out of some hundreds of broaches made from casehardening material, and that one was due to carelessness. Altogether, everything is in favor of broaches made from casehardening material and one may look to the steel makers to give a still better material of this type, one that will carry a heavy case—when necessary—which can be hard without being brittle, and at the same time give a tough core with the proper heat treatment.

As maximum life is desired for the broach, the holes originally must be as large as possible. The size obtained from a square broach of a given size being somewhat problematical, it is best to have them slightly large and rub them down with an oil-stone.

The Machinery Required

The machinery required for the production of broaches is not at all elaborate, and good broaches of all sorts may be made in any toolroom that is equipped with the usual toolroom machinery—namely, lathe, milling machine, cutter grinder, universal grinder and small surface grinder. Broaches may, of course, be made successfully without grinding, but to get the best results either from the point of view of cutting or of finishing, it is desirable that they should be ground all over. Aside from the foregoing considerations, grinding is the cheapest method of producing them within the necessary limits, and when the broaches are designed with this end in view—that is, so that they may be ground by existing plant—then there is never any fear of the result and

failures should be rare exceptions. It follows from this that the drawing of the broaches must embody all the particulars to assure success.

Having once adopted a method for the manufacture of the broaches, and a length that is suitable for their production and upkeep in an existing plant, then the only variables that we shall have will be the shape of the broach, its size, the number of its teeth and their pitch, and the number of broaches required to a set.

It will readily be apparent from what has just been said that we may get out standard (blank) broach blueprints that only need to be filled in with the necessary particulars, and if this is done the design for a set of broaches may be got out quickly.

Use of Standard-Size Sheets

As an aid to thus rapidly filling in these sheets another standard sheet should be filled out showing all the adaptors with which the machine is supplied; and as others are made their particulars should be, of course, added to the standard sheet. If this is done, there will be no need to walk around to the tool store and measure up a lot of adaptors every time a set of broaches has to be put in hand. This sheet should contain all the necessary information required either to design a set of broaches or to make a new adaptor should the necessity arise.

Such a sheet is shown in the illustration, and the holder has been found to be successful in service.

It has been stated that in designing broaches the factors that must be borne in mind continually are the load per tooth and the number of teeth in contact at any one time. But there are other equally important factors. It is possible to design a set of broaches for machining a 1⅝ in. square hole, from a 1⅝ in. round hole, with seventy-two teeth that will do good clean work on cast iron, or malleable-iron castings that are as long as 4 in. through the hole. Yet these broaches will do indifferent work on steel, and on the high class steel alloys used for gears in the automobile industry they may fail utterly, or drag badly, on a hole only 2 in. long.

General Design

Therefore, the question of the material that has to be broached has an important bearing on the design of the broach; so much so, that when the holes have to be broached in various materials the broach must be designed so that the load per tooth is suitable for the best (worst from a broaching point of view) material. This means that if we are broaching square holes, say in both malleable iron and steel, with the same set of broaches, we shall be losing time when broaching the malleable-iron articles. For this reason it is worth while considering the installation of two sets of broaches for each size and type—one set designed so that the load per tooth is suitable for material of low tensile strength and one set designed for the higher class materials. This may mean an increase of as much as 50 per cent. in output on the low tensile material, but the extra set would soon pay for itself where broaching methods are largely used. Apart from this, the extra set could be used to keep things going for a short time should anything happen to the other set.

Having adopted a length—that is, the maximum length that can economically be produced and kept in good order—it follows that for any given conditions the number of broaches in the set must be altered. This number, then, will depend on the length of the hole and the material to be broached. But generalizing will not produce successful broaching, and the type of broach must be studied in conjunction with the two variables mentioned before.

The types of broach in common use are: Keyway broaches, either single or double; spline broaches, which may have from three to twenty or more splines; square broaches, with which may be classed hexagonal broaches, either for finishing rough drilled holes or for broaching direct from a cored hole.

It is in this order that the subject will be treated, and each type will be dealt with so as to show a few of the many problems that confront the tool designer when he turns from his regular line of work and tackles the subject of broach design.

Why Preparedness?

By Lucien I. Yeomans

It must seem to the non-technical reader of the non-technical press that the *American Machinist* and other technical papers are making a "great to do about nothing" in their discussions of ways and means of manufacturing munitions. Can it be that there is any difficulty in connection with the manufacture of munitions? Surely not; for we may pick up any newspaper and learn that Henry Ford has offered the Secretary of the Navy his factories for the production of a thousand submarines a day, and in all seriousness and without a smile on his face the Secretary of the Navy has formally accepted the tender. We may likewise learn that John Willys, probably under the impression that there is not much difference between the famous Overland "75" and the even more famous French "75," has solemnly offered his manufacturing facilities, which have been duly accepted. The cold fact that the Pillsbury flour mills would be about as useful for making munitions as either of the others does not affect the situation any, and we draw a sigh of relief and say to ourselves, "Truly we are prepared—Why worry."

It is to be expected that in case of dire necessity we will learn that the Tiffany shops may be depended on to cease making jewelry and commence turning out 16-in. naval guns.

We find that even the kids are in on it too, and a recent news item says: "War with Germany will see the manual training schools of Washington turned into munition factories. The McKinley Manual Training School alone could turn out from 3000 to 4000 shrapnel shells daily," etc.

A highly esteemed periodical prints a story which says, among other things: "This group of financiers went into the market and bought factories as hucksters buy apples. An uncomplicated change in the automatic—and they were ready to make shells. A slight readjustment here and there and they were making bayonets."

So why should there be talk of "preparedness" when we can so readily see that the day of miracles has not passed and that with a slight "readjustment" of the coffee mill and an "uncomplicated change" in the furnace grate every grocery store can cast steel ingots and complete them into ammunition.

Special Attachments for Making Typewriter Parts

Editorial Correspondence

SYNOPSIS—One of the machines shown is used for grinding small rubber rolls for feeding the paper, and here an automatic screw machine has been adapted for the purpose by fitting it up with a grinding wheel and suitable spindles. The work is fed directly toward the center of the wheel and sized without being traversed past the face of the grinding wheel. The other machine illustrated is a plain miller fitted with a positive cam feed for continuous operation of the tables where desired, as in cutting off small pieces of stock that are supported under the saw by special holding features.

In addition to the large number of special tools in the way of jigs, fixtures, punches, dies and the like, required by every large manufacturing establishment in conducting its work on an uptodate basis it is usually found necessary in such places to devise a certain number of special machines or to modify standard machine tools by adding special equipment to adapt them to the maximum rate of production on some specific parts. That is, where one machine is to be kept a good part of the time on one line of work, it is generally possible to make some change in certain features whereby a considerable gain in output is possible over the normal rate of production obtainable with the conventional machine.

In the plant of the Noiseless Typewriter Co., Middletown, Conn., there are many machines that have been set up for one specific job and are kept in operation on that work continuously. In a number of cases special machining attachments in addition to the holding fixtures for the work have been applied.

The paper-feed rolls on the Noiseless typewriter are about ½ in. in diameter by 1 in. in length. There are eight of them on the machine, four at the back and four at the front of the large rubber cylinder over which the paper feeds in passing up over the flat steel printing platen at the front. These feed rolls are of course made in large quantities and are finished to size by grinding in the machine illustrated in Fig. 1. As will be seen, this is a Hartford automatic screw machine that has been stripped of its regular turret, turret slide and headstock. On the cross-slide, instead of the usual form-tool holders and cutting-off tool holders, there are mounted a headstock carrying a high-speed spindle and a footstock for supporting the work in convenient position. At the back is a wheel spindle driven by the flat belt at the left, as shown.

The grinding operation consists in placing the roll between the head and tail spindles, after which the cross-slide is automatically fed forward by the cam on the drumshaft below until the work has been fed into the proper position to bring its periphery against the wheel. No lateral feeding is used, the work being analogous to form-grinding in that the feed is directly toward the center of the wheel. As the work approaches its true diameter, the dwell on the operating cam below is reached and merely holds the roll in position until it is finished.

These rolls are of soft rubber mounted on a small spindle with flanges at each end of the roll, as clearly shown. The large knurled knob at the right of the cross-slide, mounted on a screw passing through a nut in the

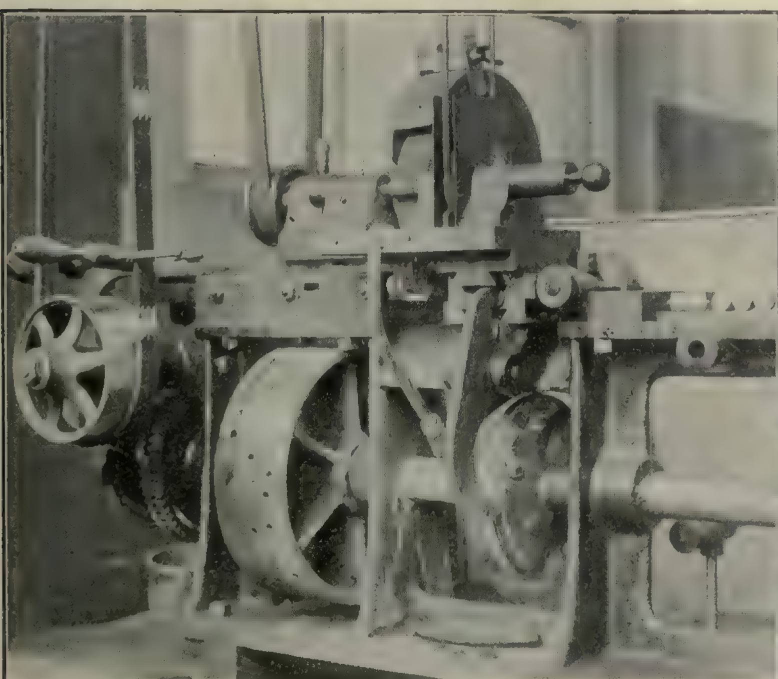


FIG. 1. GRINDING PAPER FEED ROLLS ON AN AUTOMATIC SCREW MACHINE

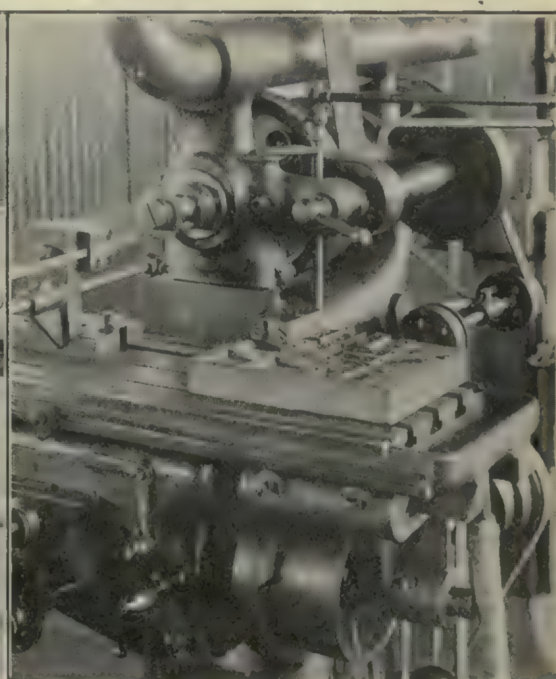


FIG. 2. MILLER WITH CAM-OPERATED TABLE FOR CUTTING-OFF WORK

bracket at the rear end, is used to adjust the cross-slide with the work to bring the latter to the proper position so that the cam movement will size it accurately. Micrometer adjustment is provided through graduations on the collar. It is a simple matter to make changes at this point so that if the wheel wears, or wear occurs at the ends of the lever or upon the working surface of the cam, compensation is easily made. This feature is also a great convenience in setting up a job at the outset, after the wheel has been trued up and consequently reduced in diameter.

The method of running the work between spindles and driving it is indicated in Fig. 3. Here it will be noticed that the work is mounted on its own spindle, or journals, between the head and tail spindles. The small diameter fits nicely into each one of these spindles, and the roll is driven by means of a sharp-toothed cup into which the end of the collar on the roll fits. The face is pressed

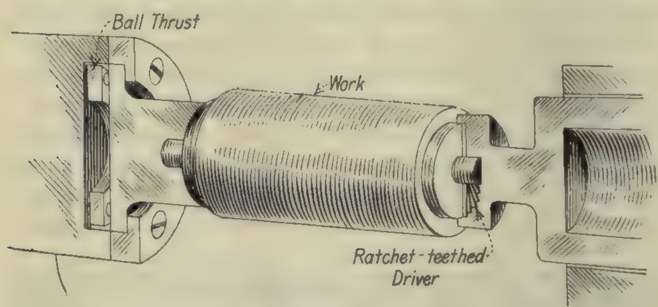


FIG. 3. METHOD OF SUPPORTING THE WORK

against the sharp teeth by spring action operating upon the driving end of the apparatus. The work is removed by pulling out the knob shown at the right-hand end of the head spindle, Fig. 1. When this is released, the spring is sufficient to cause the shaft driving teeth to act positively upon the end of the steel collar at the side of the roll. The pressure of the work due to the spring action is taken by the ball thrust collar shown on the spindle at the left side of the work, Fig. 3.

The grinding wheel used is about 12 in. in diameter by 2-in. face. This is a Crystolon combination, wheel 36 and 48 L grade. The wheel is run at a speed of 5000 ft. per min., and the work runs 500 r.p.m., giving it a velocity of approximately 70 ft. per min. About six rolls per minute are ground right along with this process.

Miller with Automatic Table

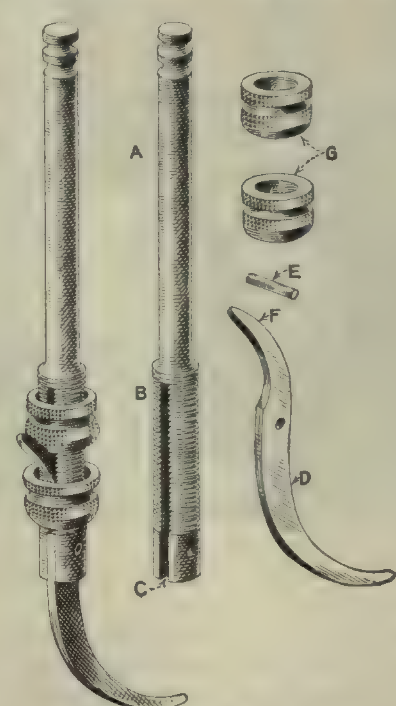
The miller in Fig. 2 is used a good share of the time for cutting-off operations on small parts, similar to the job shown set up. The output is increased by the use of a cam motion for feeding the table back and forth automatically. The work shown is a bar of stock to be sawed off to a certain length by the cutter on the arbor. The work is held on the upright fixture in the block, which is made to various sizes and depths to suit the section of stock. A set of these holding blocks is shown in the wood case on the right-hand end of the table. It is obvious from the number of holders here illustrated that a considerable amount of work is done on this particular miller. It is a plain machine, and the modification in construction consists principally in the addition of the drum cam below the table and the use of a substantial bracket clamped to the under side of the table guide, as indicated. This bracket carries a hardened ground roll to come in contact with the cam face and operate the table accordingly.

This machine has been in use for ten years or more at this factory. It is operated by a boy who feeds the stock against the stop, the supporting rod of which passes backward through the fixture and extends out to the end bar of the stock itself. The limit of length which the work will cut depends only upon the length of the bar itself. If the bar is so long as to be unhandy, the outer end is supported upon a suitable guide. The cam, it will be noticed, works on the inner surface of the roll. Therefore, the return motion is derived from a compression spring under the table. The camshaft is of course driven from the belts and pulleys at the rear, and the cam is laid out to give a suitable rate of feed. By means of the dogs on the table the machine can be set up to stop on the return stroke; or if desired, the process of operation may be continuous, the operator simply sliding the stock forward upon the conclusion of each cycle of movements.

A Fine Adjustment for Use on Beam Calipers

By Frank P. Johnson

The illustration shows an arrangement for a fine adjustment of the caliper leg for a beam trammel set. It consists of a stem *A* with a threaded portion *B* and a sawed slot *C*. The blade *D* is hinged in the slot by the



ADJUSTMENT FOR BEAM CALIPERS

hollow rivet *E* and has a tail portion *F*, which is acted on by the knurled nuts *G*, thereby getting the desired adjustment.

When the adjustment has been made by turning one nut against the blade, the other nut is tightened, thus locking the blade firmly in position.

United States Munitions*

The Springfield Model 1913 Service Rifle

Guard—III; Sear, Trigger and Floor Plate—I†

SYNOPSIS—This completes the guard, carries the sear and trigger through all its operations and begins the machining of the floor plate.

OPERATION 30. MILLING EDGE OF TANGS

Transformation—Fig. 1247. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—On pin; clamped with vise jaws, Fig. 1248. Tool-Holding Devices—Standard arbor. Cutting Tools—Two milling cutters, 2.75 in. diam., 0.5 in. wide, one plain, one with 0.15 R on one corner. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—2,500 pieces. Gages—None. Production—20 per hr.

OPERATION 31. MILLING LEFT SIDE OF TANGS

Transformation—See Fig. 1247. Machine Used—Same as operation 30, except reversed in fixture. Number of Machines per Operator—Four. Work-Holding Devices—On pin; clamped with vise jaws, same as Fig. 1248. Tool-Holding Devices—Standard arbor. Cutting Tools—Same as operation 30, except reversed in fixture. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—None. Production—20 per hr.

OPERATION 32. MILLING BEVEL ON OUTSIDE OF RIGHT WALL OF MAGAZINE

Transformation—Fig. 1249. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—On pin; clamped, with vise jaws similar to Fig. 1248, but has block in magazine opening to prevent springing of sides. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1250. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—Same as Fig. 1251, except for right hand. Production—25 per hr. Note—Block placed in hole.

OPERATION 33. MILLING BEVEL ON OUTSIDE OF LEFT WALL OF MAGAZINE

Transformation—See Fig. 1249. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Same as operation 32, only work is reversed in fixture (see Fig. 1248). Tool-Holding Devices—Standard arbor. Cutting Tools—Same as Fig. 1250. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1251; stand gages with fingers AA, which rest on block B; pin C locates the guard endwise. Production—20 per hr. Note—Block placed in hole to keep from closing in on clamping.

OPERATION 33½. COUNTERBORING GUARD-SCREW HOLES TO FINISH AND REAMING FLOOR-PLATE CATCH-PIN HOLE

Transformation—Same as Figs. 1177 and 1180. Machine Used—Speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Held in hand against counterbore, practically a burring operation. Cutting Tools—Counterbore shown in Fig. 1252. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Gages—None. Production—80 per hr.

FIG. 1247

OPERATION 30 & 31

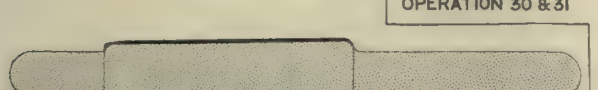


FIG. 1249

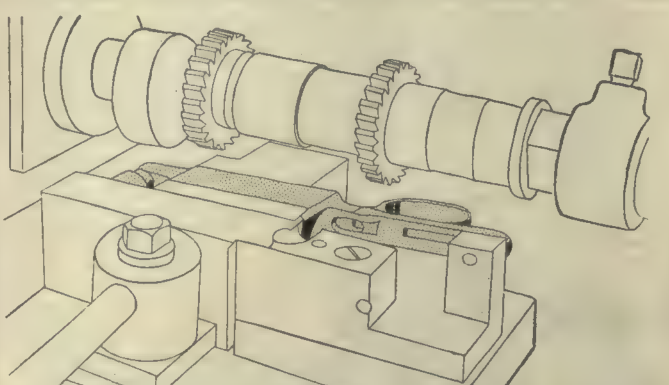


FIG. 1248

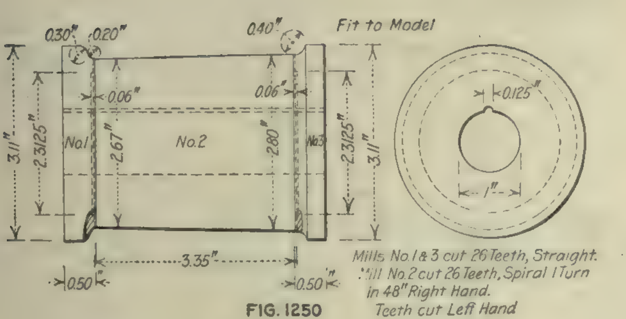


FIG. 1250

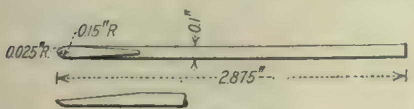


FIG. 1252

OPERATION 32

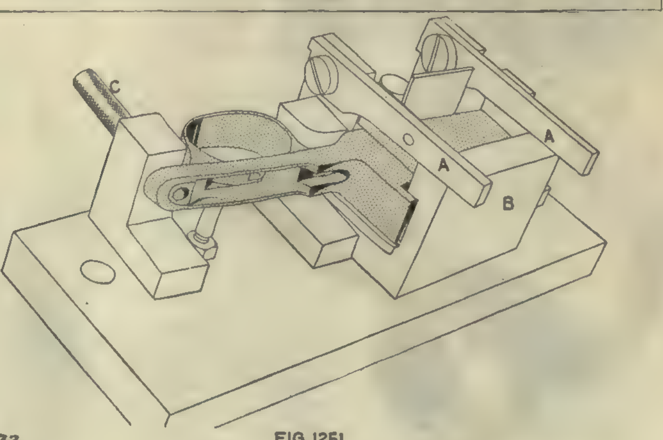


FIG. 1251

OPERATION 34. FILING, GENERAL

Number of Operators—One. Description of Operation—General filing and brushing up. Apparatus and Equipment Used—File. Production—10 per hr.

OPERATION 35. POLISHING

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Polishing jack and wheel. Production—18 per hr.

OPERATION 36. FILING AND CORNERING

Number of Operators—One. Description of Operation—Filing and cornering. Apparatus and Equipment Used—File. Production—50 per hr.

OPERATION 37. BLUING

Number of Operators—One. Description of Operation—Same as sleeve and other bluing operations.

†This installment should have preceded that published in the issue of Mar. 8, 1917.

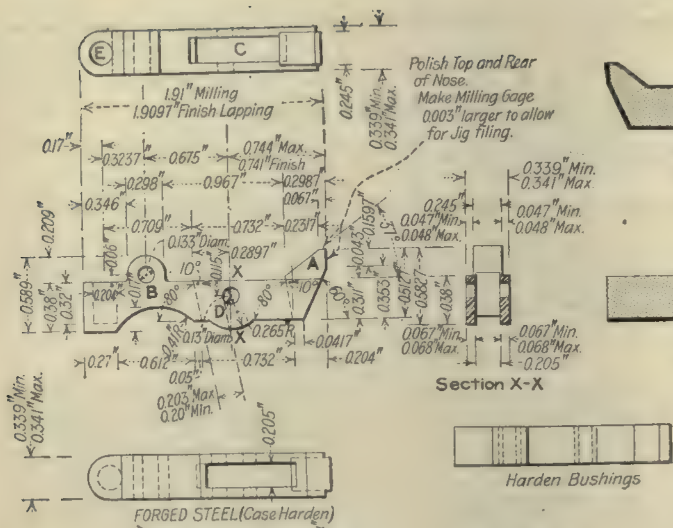


FIG. 1253


FIG. 1254 OPERATION A

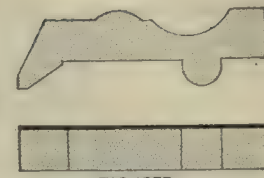
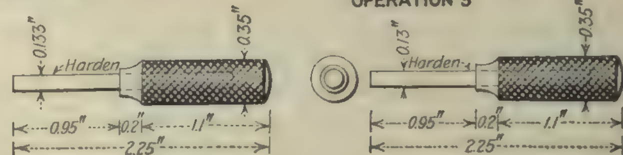


FIG. 1255 OPERATION 1


FIG. 1256 OPERATION 2


FIG. 1257 OPERATION 3



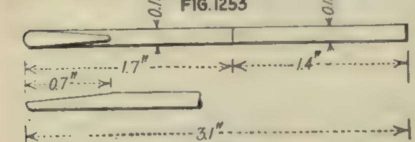


FIG. 1258

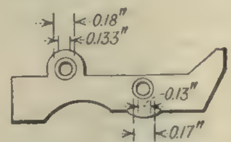

OPERATION 4


FIG. 1259


Longitudinal Section

The Sear

The sear, shown in detail in Fig. 1253, which in connection with the trigger releases the cocking piece and fires the rifle, is a drop forging made from Class D steel, 0.047 in. round. The principal parts are the sear nose *A*, the joint pin hole *B*, the trigger slot *C*, the trigger-pin hole *D* and the sear-spring seat *E*. The sear is finished by casehardening.

OPERATIONS ON THE SEAR

Operation	
A	Forging from bar
B	Annealing
B–1	Pickling
C	Trimming
1	Grinding right side
2	Grinding left side
3	Drilling trigger-pin and joint holes
4	Reaming trigger-pin and joint holes
AA	Reaming burrs from trigger and joint-pin holes
5	Milling top edge
BB	Removing burrs left by operation 9
6	Milling bottom edge
CC	Removing burrs left by operation 6
7	Straddle-milling poin., or nose
DD	Removing burrs left by operation 7
8	Drilling for trigger and spring hole
9	Hand-milling front end
10 and 10½	Hand-milling trigger slot (two cuts)
11 and 11½	Shaving slot (two cuts)
FF	Removing burrs from trigger-pin holes
12	Hand-milling joint, undercuts
15	Countersinking joint-pin and spring holes
16	Shaving joint
17	Filing, general cornering
17½	Grinding nose
14	Casehardening
18	Finishing, honing nose

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1254. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer; drop-forge dies. Production—125 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal, heated to 850 deg. C. (1,562 deg. F.); left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnaces; Rockwell oil-burning furnace and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets, then in the pickling solution, consisting of 1 part sulphuric acid and 9 parts water, and left from

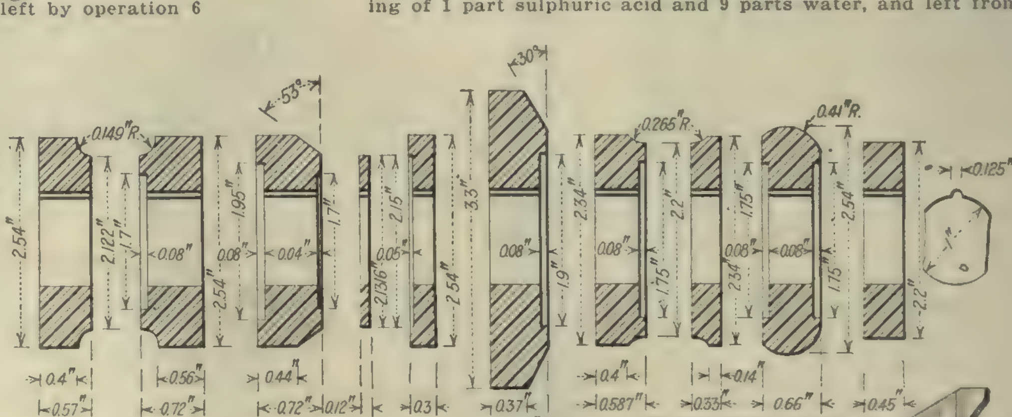


FIG. 1262

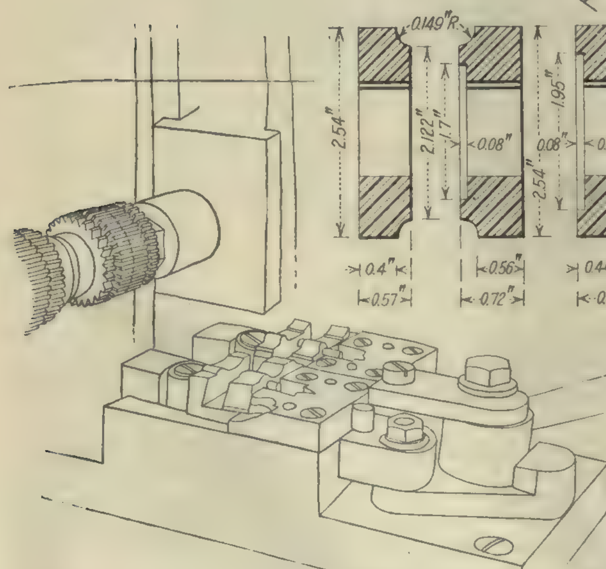


FIG. 1261

OPERATION 5 & 6

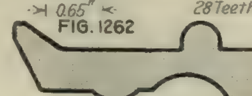


FIG. 1260

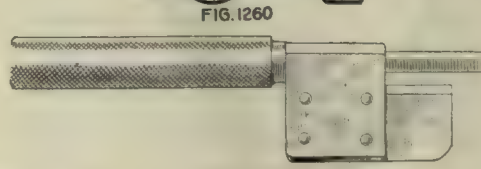


FIG. 1263


FIG. 1264

FIG 1265

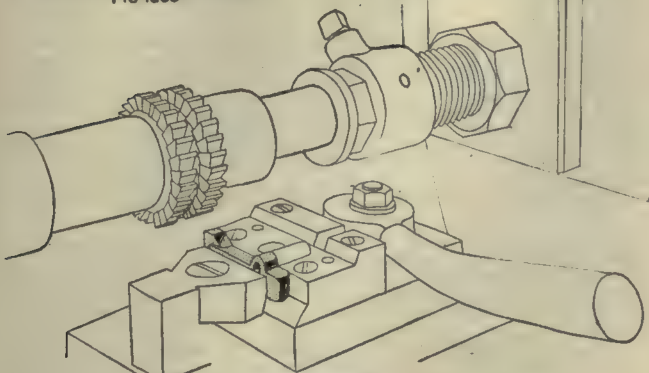
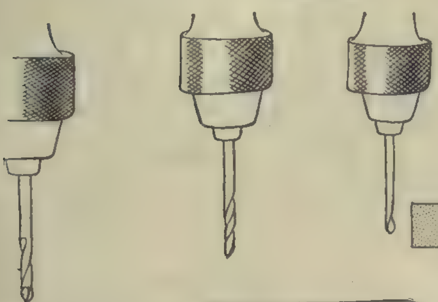


FIG 1266
OPERATION 7



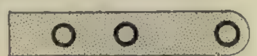


FIG.1267

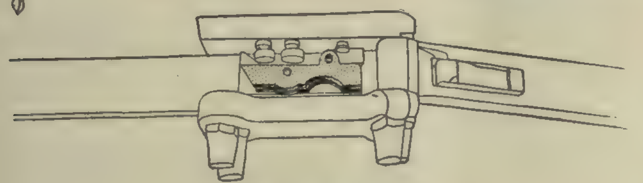


FIG. 1268
OPERATION 8

10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hoist.

OPERATION C. TRIMMING

Machine Used—Bliss press, 2-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Production—500 per hr.

OPERATION 1. GRINDING RIGHT SIDE

Transformation—Fig. 1253. Machine Used—Pratt & Whitney vertical grinder, 14-in. wheel, 30-in. magnetic chuck, same as extractor collar. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck with rods between. Cutting Tools—14-in. abrasive wheel. Cut Data—1,500 r.p.m. Coolant—Water. Gages—Snap for thickness Production—425 per hr.

OPERATION 2. GRINDING LEFT SIDE

Transformation—Fig. 1256. Machine Used—Pratt & Whitney vertical grinder, 14-in. wheel, 30-in. magnetic chuck, same as extractor collar. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck. Cutting Tools—14-in. wheel. Cut Data—1,500 r.p.m. Gages—Similar to above. Production—425 per hr.

OPERATION 3. DRILLING TRIGGER-PIN AND JOINT HOLES

Transformation—Fig. 1257. Machine Used—Pratt & Whitney four-spindle 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, with cover. Tool-Holding Devices—Drill chuck. Cutting Tools—Two drills. Number of Cuts—Two. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—None. Production—60 per hr.

OPERATION 4. REAMING TRIGGER-PIN AND JOINT HOLES

Transformation—See Fig. 1257. Machine Used—Either drilling machine or speed lathe of any make. Number of Operators per Machine—One. Work-Holding Devices—In jig or rest on speed lathe. Tool-Holding Devices—Reamer held in drill chuck. Cutting Tools—Reamer, Fig. 1258. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1259. Production—350 per hr.

OPERATION AA. REAMING BURRS FROM TRIGGER AND JOINT-PIN HOLES

Number of Operators—One. Description of Operation—Removing burrs from trigger and joint-pin hole. Apparatus and Equipment Used—Hand reamer. Production—500 per hr.

OPERATIONS 5 AND 6. MILLING TOP AND BOTTOM EDGE

Transformation—Fig. 1260. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—By vise jaws; located on pins in the trigger and joint holes, Fig. 1261. Tool-Holding Devices—Held on standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1262. Number of Cuts—One. Cut Data—60 r.p.m; ⅝-in. feed. Coolant—Compound, two ⅛-in. streams. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1263, radius over joint hole; Fig. 1264, contour. Production—35 per hr. Note—Work-holding points, trigger-pin and joint holes; also gaging points.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 9

Number of Operators—One. Description of Operation—Removing burrs thrown up by several operations. Apparatus and Equipment Used—File. Production—Grouped with operations 5, 6, 7, CC and DD.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 6. Apparatus and Equipment Used—File. Gages—Grouped with operations 5, 6, 7, CC and DD.

OPERATION 7. STRADDLE-MILLING POINT OR NOSE

Transformation—Fig. 1265. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Three. Work-Holding Devices—On pins; clamped by vise

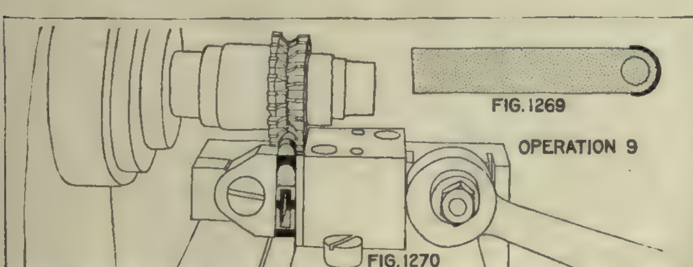


FIG. 1269
OPERATION 9
FIG. 1270

FIG. 1271 OPERATION 10 & 10½ FIG. 1272

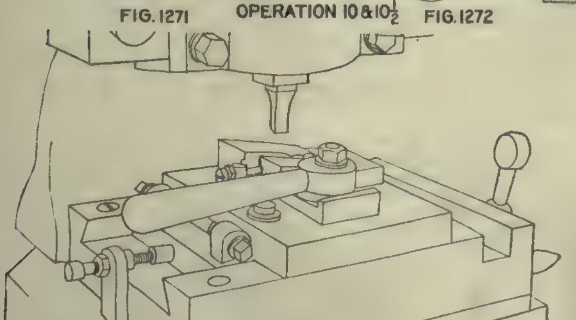


FIG. 1273

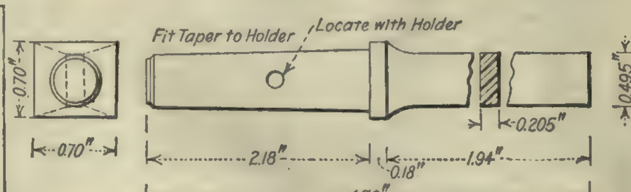
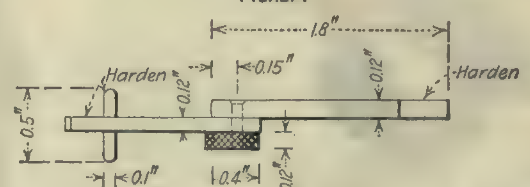


FIG. 1274



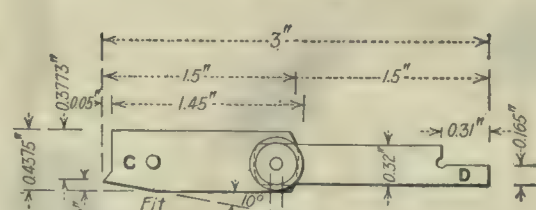


FIG. 1275

OPERATION 11 & 11½

jaws, Fig. 1266. Tool-Holding Devices—Standard arbor. Cutting Tools—Two side-milling cutters, 2.5 in. diameter, 0.375 in. wide. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Snap. Production—35 per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7.

OPERATION 8. DRILLING FOR TRIGGER AND SPRING HOLE

Transformation—Fig. 1267. Machine Used—Pratt & Whitney 16-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1268. Tool-Holding Devices—Drill chuck. Cutting Tools—Drill. Number of Cuts—Three. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—150 pieces. Gages—Plug or pin. Production—40 per hr.

OPERATION 9. HAND-MILLING FRONT END

Transformation—Fig. 1269. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pins; clamped with vise jaws, Fig. 1270. Tool-Holding Devices—Standard arbor. Cutting Tools—Interlocking milling cutters, 2.25 in. diameter, 0.68 in. wide; half circle groove in face, 0.17 in. radius. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—

OPERATION FF. REMOVING BURRS FROM TRIGGER-PIN HOLES

Number of Operators—One. Description of Operation—Removing burrs from trigger hole. Apparatus and Equipment Used—Bench lathe and reamer. Production—Grouped with operation 12.

OPERATION 12. HAND-MILLING JOINT, UNDERCUTS

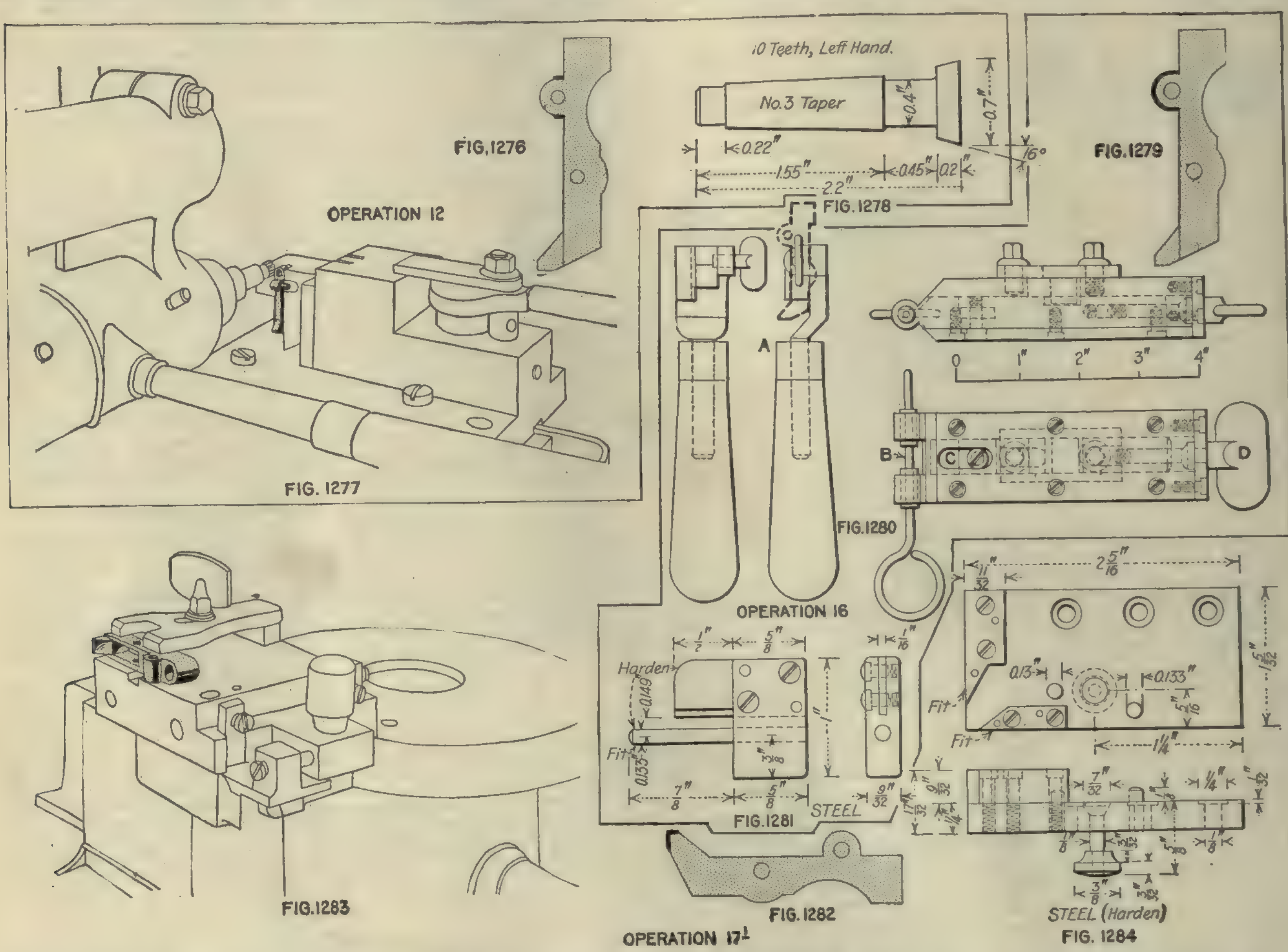
Transformation—Fig. 1276. Machine Used—Whitney No. 6 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pins; held by finger clamps, Fig. 1277. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1278. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1,000 pieces. Production—300 per hr.

OPERATION 15. COUNTERSINKING JOINT-PIN AND SPRING HOLES

Number of Operators—One. Description of Operation—Countersinking and removing sharp corners. Apparatus and Equipment Used—Speed lathe and countersink; this is 0.246 in. beam and has six left-hand flutes; a finish reamer, 0.133 in. diameter with half-round point, finishes hole. Production—450 per hr.

OPERATION 16. SHAVING JOINT

Transformation—Fig. 1279. Number of Operators—One. Description of Operation—Shaving radius on joint; this is done by clamping sear in the handle A, Fig. 1280, as shown;



Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—1,500 pieces. Gages—Form. Production—300 per hr.

OPERATIONS 10 AND 10½. HAND-MILLING TRIGGER SLOT (TWO CUTS)

Transformation—Fig. 1271. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located by pins; clamped with vise jaws. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Compound, ⅛-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—None. Production—80 per hr.

OPERATIONS 11 AND 11½. SHAVING SLOT (TWO CUTS)

Transformation—Fig. 1272. Machine Used—Perkins press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank; work held in vise jaws, Fig. 1273; located by pin; work swung to two positions; punch shown in Fig. 1274. Stripping Mechanism—None. Average Life of Punches—400 pieces. Lubricant—Cutting oil, put on with brush. Gages—Fig. 1275; thickness of wall; length of slot at C and width at D. Production—80 per hr. Note—Fixture moves crosswise by handle at right of machine.

the shaving tool at the right is clamped in the vise: the sear joint is placed between the ears shown, and the pin B run through the joint hole; then the sear is rotated on the pin by the handle A, while the cutter C is fed against the sear by the thumb-screw D, shaving the radius. Apparatus and Equipment Used—Vise shaving fixture; hand holder for rotating sear. Gages—Fig. 1281, radius. Production—125 per hr.

OPERATION 17. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing and cornering. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATION 17½. GRINDING NOSE

Transformation—Fig. 1282. Machine Used—Machine built at Hill shop. Number of Operators per Machine—One. Work-Holding Devices—In an indexing fixture, Fig. 1283. Tool-Holding Devices—On spindle. Cutting Tools—8-, 6-, 2½- and 1¼-in., grain 46, grade G, tested 4,300, ½-in. rim, ½-in. back, Norton alundum wheels. Number of Cuts—Two. Cut Data—1,500 r.p.m.; hand feed. Coolant—None. Gages—Form, Fig. 1284. Production—125 per hr.

OPERATION 18. FINISHING, HONING NOSE

Number of Operators—One. Description of Operation—Honing top of nose. Apparatus and Equipment Used—Oilstone. Production—350 per hr.

OPERATION 14. CASEHARDENING

Number of Operators—One. Description of Operation—Packed in ¾ bone, ¼ leather; heated to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quenched in oil. Apparatus and Equipment Used—Same equipment as for all other casehardening.

The Trigger

The trigger shown in detail in Fig. 1285, which is hinged in the sear and pulls the sear down so as to release the cocking piece, is now made of a steel punching instead of being drop forged as formerly. It is made from Class D steel, is finished by milling and is casehardened

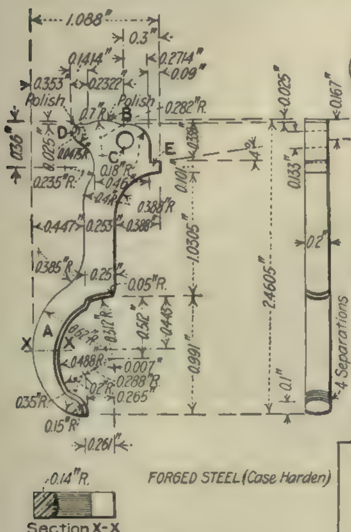


FIG. 1285


FIG. 1286
OPERATION A

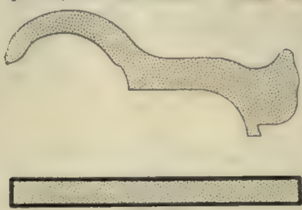


FIG. 1287
OPERATION 1


FIG. 1288

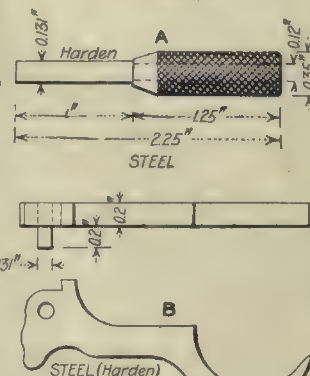


FIG. 1290

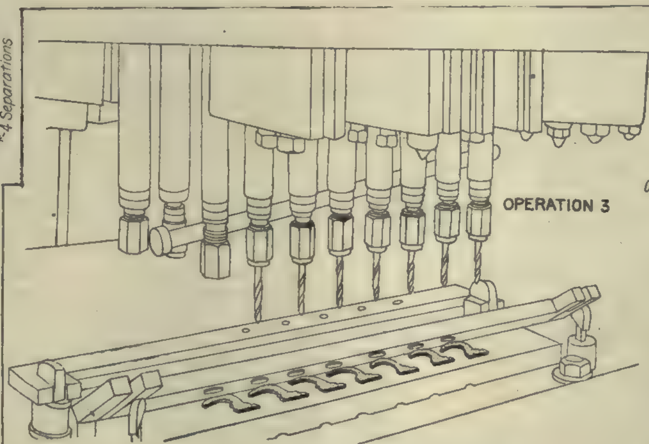


FIG. 1289


FIG. 1291

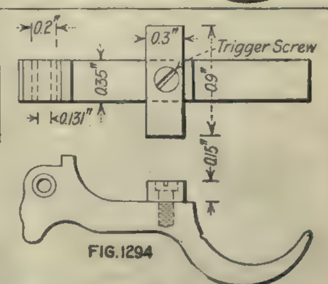


FIG. 1294

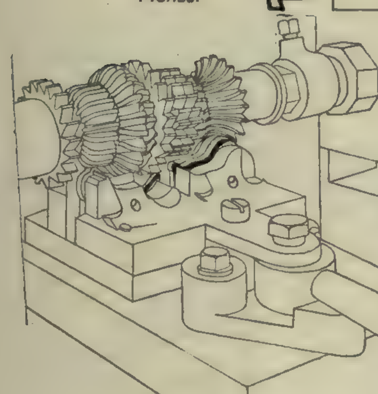


FIG. 1292

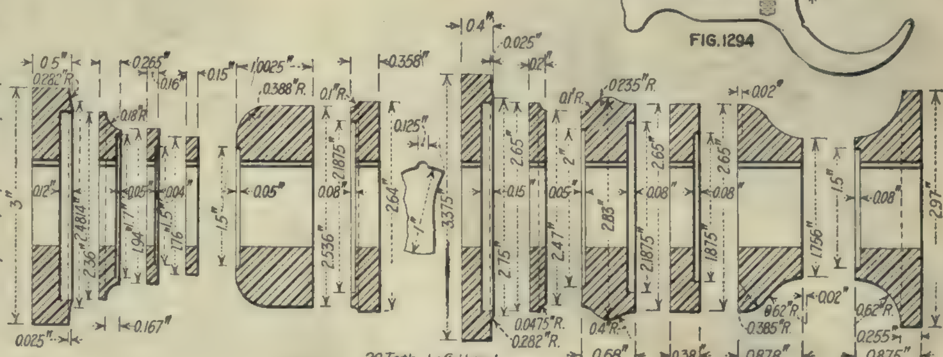


FIG. 1293
OPERATION 5 & 6

in the usual manner. The main parts of the trigger are the finger piece *A*, which is knurled to prevent the slipping of the fingers; the bearing point *B*, which comes in contact with the under side of the receiver; the trigger-pin hole *C*; the heel *D* and the stop *E*.

OPERATIONS ON THE TRIGGER

Operation	
A	Blanking
B	Pressing
B-1	Pickling
1	Grinding to finish thickness
3	Drilling pin hole
5 and 6	Milling edges (combination fixture)
AA	Removing burrs left by operation 5
BB	Removing burrs left by operation 6
6½	Milling upper surface
7	Profiling finger piece
CC	Removing burrs left by operation 7
7½	Checking finger piece
13	Reaming and counterboring trigger-pin hole
8	Polishing side, edges and finger piece
9	Filing and general cornering
10	Casehardening
8½	Polishing top
11	Assembling with sear and trigger pin

OPERATION A. BLANKING

Transformation—Fig. 1286. Machine Used—Perkins back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Die held in shoe by setscrew. Stripping Mechanism—Stripping plate. Lubricant—Stock is oiled with cutting oil. Production—550 per hr. Note—Size of stock, 0.235x2¾ in., 132 lb. to 1,000 pieces.

OPERATION B. PRESSING

Machine Used—Bliss back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Flat plate, round shank. Dies and Die Holders—Flat plate. Stripping Mechanism—None. Production—700 per hr. Note—Simply flattens the punchings for future operations.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water; left in this solution 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hoist.

OPERATION 1. GRINDING TO FINISH THICKNESS

Transformation—Fig. 1287. Machine Used—Pratt & Whitney vertical grinder. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck, located between strips of steel. Tool-Holding Devices—Vertical spindle. Cutting Tools—14-in. wheel, same as sear. Cut Data—1,500 r.p.m.; 15-in. feed. Coolant—Water. Gages—Thickness. Production—350 per hr.

OPERATION 3. DRILLING PIN HOLE

Transformation—Fig. 1288. Machine Used—National automatic 16-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Held in fixture in lots of eight; triggers are held in and positioned by the plate, Fig. 1289; this is enough thinner than the trigger so that the bar clamps them and also guides the

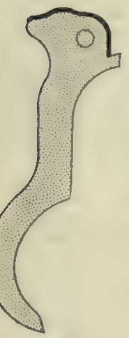


FIG. 1295

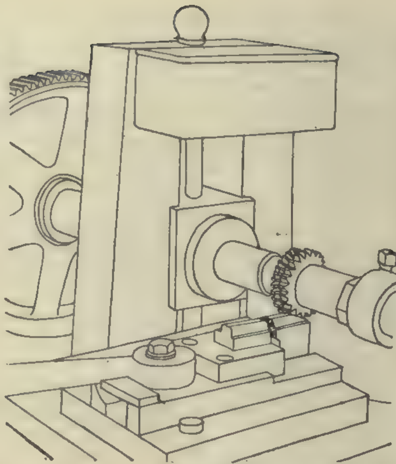


FIG. 1296

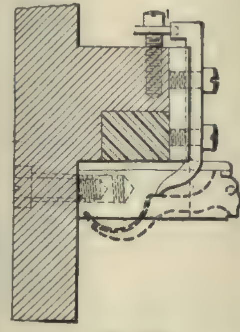


FIG. 1297

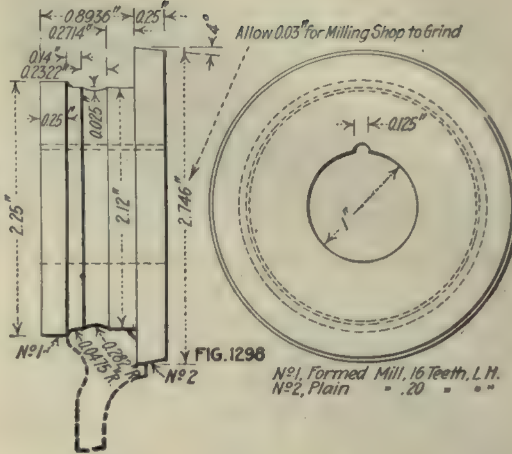


FIG. 1298

OPERATION 6½

eight drills. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Number of Cuts—One. Cut Data—900 r.p.m.; $\frac{1}{16}$-in. feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1290; A, plug; B, form. Production—125 per hr.

OPERATIONS 5 AND 6. MILLING EDGES

Transformation—Fig. 1291. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—On pin and stop; clamped by vise jaws, Fig. 1292. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang milling cutter, Fig. 1293; the cutters for the finger pull are shown. Number of Cuts—One. Cut Data—60 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—Fig. 1294; the pin locates the trigger on form gage; the stop positions it and enables the outline to be compared. Production—35 per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operations 5 and 6. Note—This is rough-burring.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 6. Apparatus and Equipment Used—File. Production—Grouped with operations 5 and 6. Note—This is finish-burring.

OPERATION 6½. MILLING UPPER SURFACE

Transformation—Fig. 1295. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Trigger located by pin; clamped by cam, Fig. 1296; details in Fig. 1297. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1298. Number of Cuts—One. Cut Data—60 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—See Fig. 1294. Production—30 per hr.

OPERATION 7. PROFILING FINGER PIECE

Transformation—Fig. 1299. Machine Used—Pratt & Whitney No. 1 profiler, Fig. 1300. Number of Operators per Machine—One. Work-Holding Devices—Work held on pin A against stop B by clamp C, operated by cam D. Tool-Holding Devices—Taper shank. Cutting Tools—Formed profile cutter to round edge. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—350 pieces. Gages—Fig. 1301; the trigger pivots on pin X and stops against pin Y to show correct form; form of finger pull. Production—70 per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7½.

OPERATION 7½. CHECKING FINGER PIECE

Transformation—Fig. 1302. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pin; clamped by vise jaws, Fig. 1303; the work projects as at A; the cutter B is guided in its proper path by form C bolted to the table, which controls movement of the guide roller D, as in former operations. Tool-Holding Devices—Special taper shank; arbor with roller. Cutting Tools—Milling cutter for corrugating. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—3,500 pieces. Gages—None. Production—475 per hr.

OPERATION 13. REAMING AND COUNTERBORING TRIGGER-PIN HOLE

Number of Operators—One. Description of Operation—Reaming pin hole to finish. Apparatus and Equipment Used—Reamer, 0.133 in. diameter, with half-round point; and bench lathe. Gages—Plug. Production—500 per hr.

OPERATION 8. POLISHING SIDE, EDGES AND FINGER PIECE

Number of Operators—One. Description of Operation—Polishing sides and finger piece. Apparatus and Equipment Used—Polishing jack and wheel. Production—125 per hr.

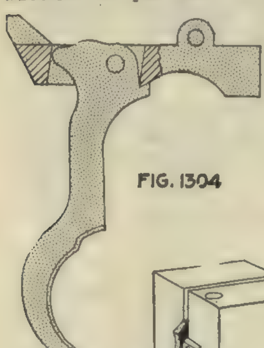


FIG. 1304

FIG. 1302

FIG. 1299

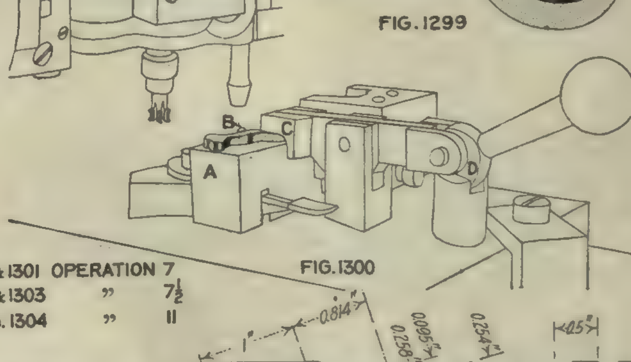


FIG. 1300

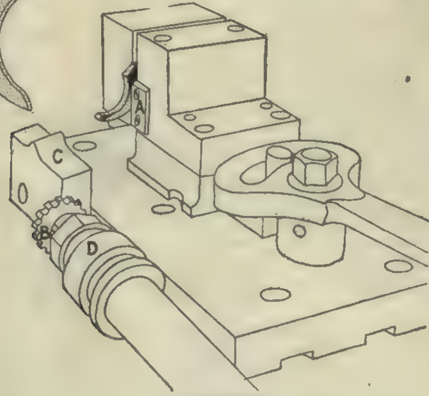
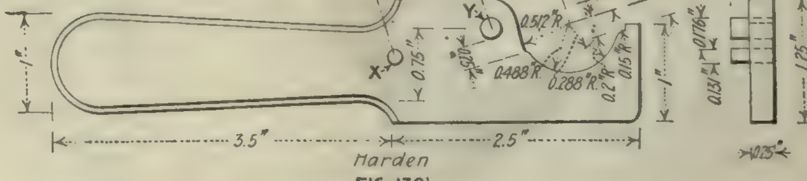


FIG. 1303

NOTE: FIG. 1299, 1300 & 1301 OPERATION 7
FIG. 1302 & 1303 " 7½
FIG. 1304 " 11



Harden
FIG. 1301

OPERATION 9. FILING AND GENERAL CORNERING

Number of Operators—One. Description of Operation—General filing and cornering. Apparatus and Equipment Used—File. Production—125 per hr.

OPERATION 10. CASEHARDENING

Number of Operators—One. Description of Operation—Same as performed on the sear.

OPERATION 8½. POLISHING TOP

Number of Operators—One. Description of Operation—Polishing top surface of trigger after hardening. Apparatus and Equipment Used—Wheel and polishing jack. Production—600 pieces per hr.

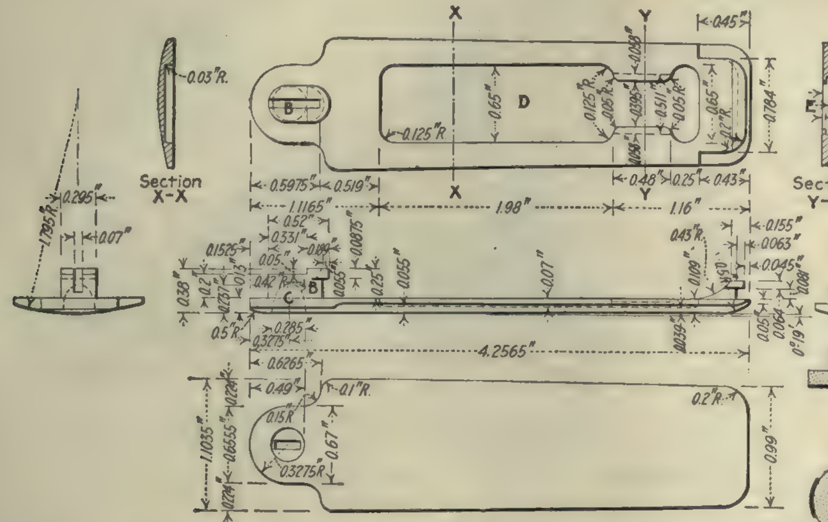
OPERATION 11. ASSEMBLING WITH SEAR AND TRIGGER PIN

Transformation—Fig. 1304. Number of Operators—One. Description of Operation—Assembling sear and trigger. Apparatus and Equipment Used—Hammer and block on bench. Production—350 per hr.

securely in place at the bottom of the magazine. The lug B is slotted to receive the floor-plate catch and has at its front end a tenon that fits into a slot in the magazine. The cavity C, through which the floor-plate catch is released by the end of a bullet, the magazine-spring recess D and the magazine-spring seat E complete the major operations on this piece.

OPERATIONS ON FLOOR PLATE

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
D	Cold dropping
1	Milling edge and bottom and both ends



FORGED STEEL
FIG. 1305

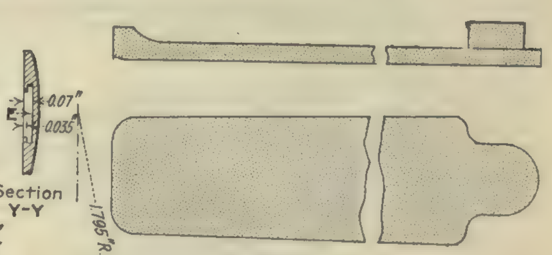


FIG. 1306

OPERATION A

FIG. 1307

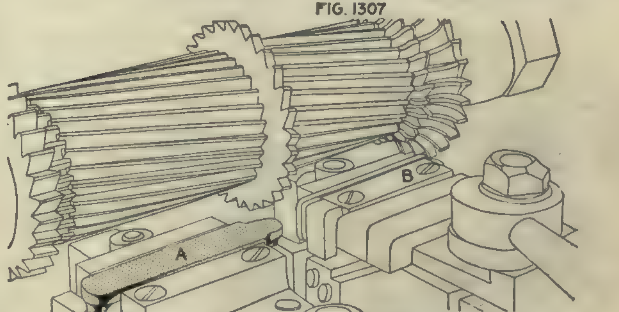


FIG. 1308

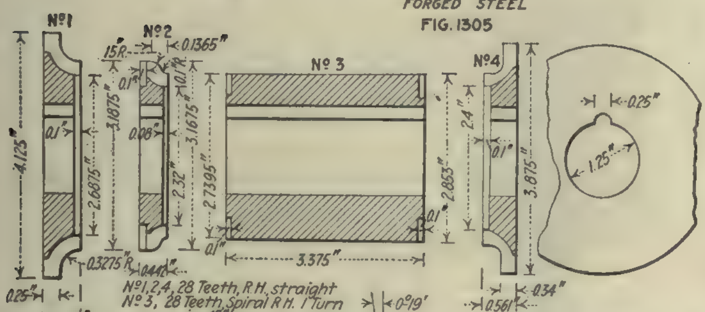


FIG. 1309

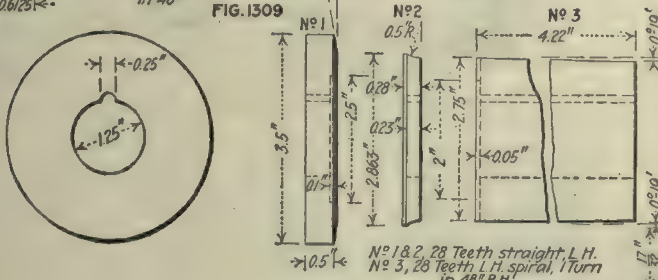


FIG. 1310

OPERATION 1

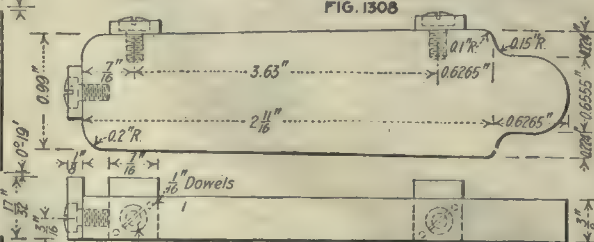


FIG. 1311

Magazine Mechanism

The magazine mechanism, shown in Fig. 2, p. 636, Vol. 45, as a unit, consists of the floor plate, floor-plate catch, pin and spindle. There are also the follower, magazine spring, cutoff and cutoff spindle, shown in detail in their regular order. Then there are the minor details, such as the cutoff screw, spring and plunger, the dimensions of which are shown.

The floor plate, Fig. 1305, has a tenon that fits into a groove at the front end of the magazine and, with the assistance of the floor-plate catch, holds the floor plate

4	Milling top crosswise
4½	Burring operation
6	Drilling and reaming disassembling hole
7	Hand-milling straddle cut lengthwise on lug
7½	Straightening
8	Profiling lug and tenon
8½	Burring operation 8
9	Profiling undercuts on lug and tenon
9½	Filing lugs to match profiling and milling cuts
10	Hand-milling for front end of magazine-spring recess
10½	Hand-milling for rear end of magazine-spring recess
11	Profiling magazine-spring recess to form and depth
11½	Burring operation 11
12	Profiling undercuts for magazine-spring seat
13	Milling bottom lengthwise
13½	Burring operation 13
14	Hand-milling floor-plate catch slot in rear lug
14½	Finish straightening
20	Filing, general
21	Polishing
22	Filing, cornering
23	Bluing

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1306. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 1,000-lb. drop hammer. Production—120 per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal; heated to 850 deg. C. (1,562 deg. F.); left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnaces; oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then put in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water; left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

FIG. 1312

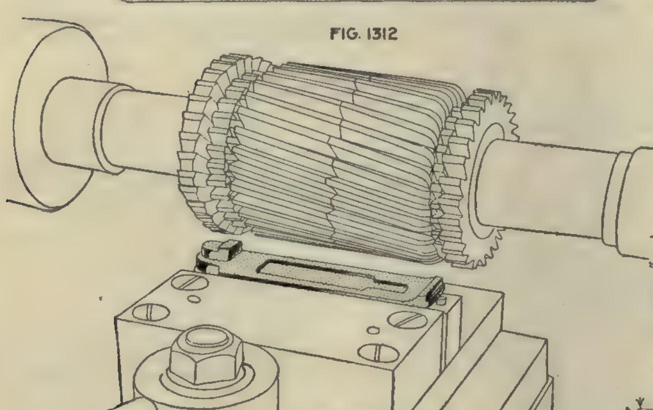
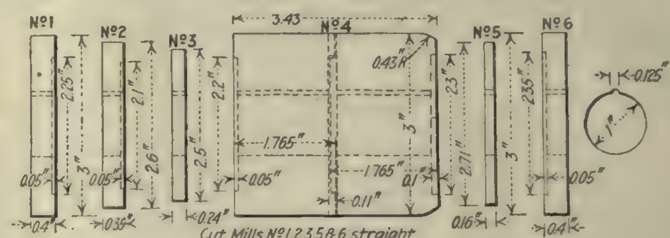
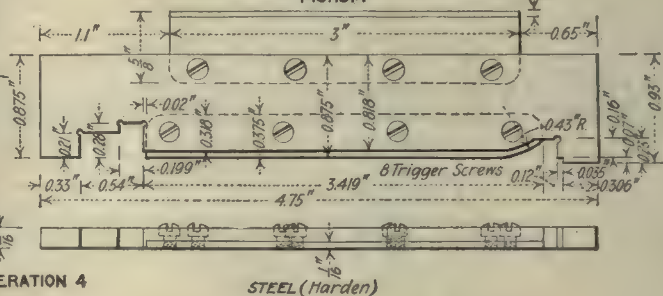


FIG. 1313



Cut Mills Nº1,2,3,5 & 6 straight, 26 Teeth, L.H.
Cut Mill Nº4, spiral R.H. 1 Turn in 48", L.H.

FIG. 1314



OPERATION 4

FIG. 1315

OPERATION C. TRIMMING

Machine Used—Bliss back-geared press, 2-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Average Life of Punches and Dies—15,000 pieces. Production—500 per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—400-lb. Billings & Spencer drop hammer. Production—500 per hr.

OPERATION 1. MILLING EDGE AND BOTTOM AND BOTH ENDS

Transformation—Fig. 1307. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Held in vise jaws two at a time; one is shown in place at A in Fig. 1308; the other jaws B are empty; these mill two plates on the edge. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1309, for the edges; Fig. 1310, for the bottom. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1311; contour of outside by form gage with side and end stops; contour of back. Production—20 per hr. Note—Mill bottom, one plate; mill edge, two plates.

OPERATION 4. MILLING TOP CROSSWISE

Transformation—Fig. 1312. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws; work pushed to stop, Fig. 1313. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1314. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1315, contour of top, also height of lug. Production—20 per hr.

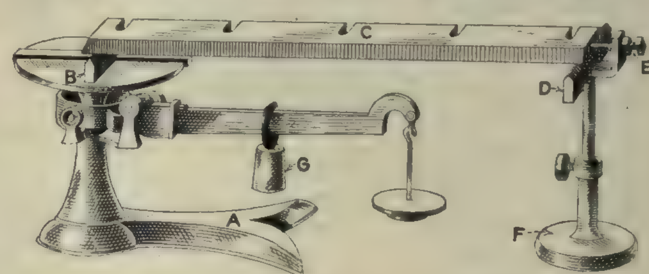
OPERATION 4½. BURRING OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—400 per hr.

Center-of-Gravity Scale

By S. W. Hartley

Grinding a nick out of one end of a planer knife makes that end lighter. When revolved in the cylinder with other knives at a high rate of speed, a violent jarring and knocking may occur. It is essential that all the knives be not only of the same weight, but that the center of gravity of each be midway of its length. This may be accomplished by weighing first one end and then the other and grinding down the heavy end. A scale *A* should be provided with a sharp-edged bearing *B* on the platform, as shown in the illustration. As it is necessary that the knife should occupy exactly the same position when reversed, a rest *F* should be furnished with an adjustable stop *E* against which the end of knife should always bear. The bearing *D* should be adjusted to the same height as the one on the scale. Lay the knife *C* on the scale with these bearings as near the ends as possible. Move the poise *G* along on the beam until the scale balances and note the amount indicated on the beam. Reverse the knife,



SCALE WITH PIECE IN POSITION

and if it balances as before the ends are alike. If the poise needs to be moved, note the second reading; the difference between the two will be twice the error. Set the poise halfway between these amounts and grind off the heavy end of the knife until a balance is obtained.

Threading Copper Tubing

By H. R. Selby

My first experience in trying to cut threads on copper tubing of small diameter showed that the die would force the metal toward the center of the tube before the thread would take its hold. This was remedied by procuring a piece of wire that would slip rather loosely into the tubing and long enough to extend down below the depth to which the thread was to be cut, so that the vise jaws could press the shell against the wire. Small elbows made from the same material were filled with solder, which was removed with a blow torch after threading.

Letters from Practical Men

Tool Holder Setscrews

The company for which I work purchased a new 30-in. boring mill with a tool holder like Fig. 1. The three bottom setscrews were so near together that I had diffi-

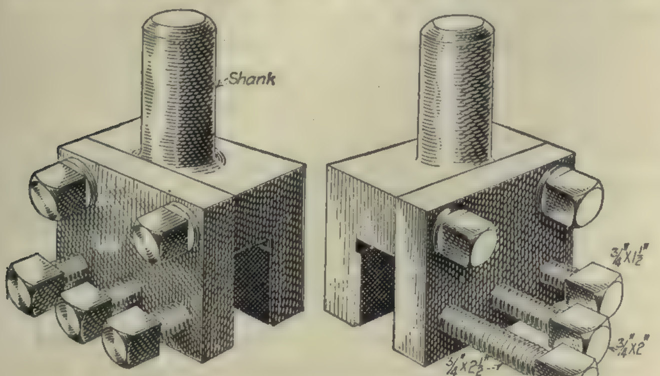


FIG. I FIG. 2

FIGS. 1 AND 2. TWO SETSCREW ARRANGEMENTS

culty in getting a wrench in to tighten them. I could not use a socket wrench, as the screws were so close to the turret.

The setscrews were originally $\frac{3}{4}$ x $1\frac{1}{2}$ in. I took out two of them and put in two more, one $\frac{3}{4}$ x 2 in. and one $\frac{3}{4}$ x $2\frac{1}{2}$ in. From above, the arrangement looked like Fig. 2, and I had no further trouble in the wrench slipping. I have seen many boring mills where the screws were close together, especially in the smaller sizes. As this is my first experience in running a mill, I hit upon this simple kink. E. HARTMAN.

Toledo, Ohio.

Beveled Work Holder for Use on Magnetic Chuck

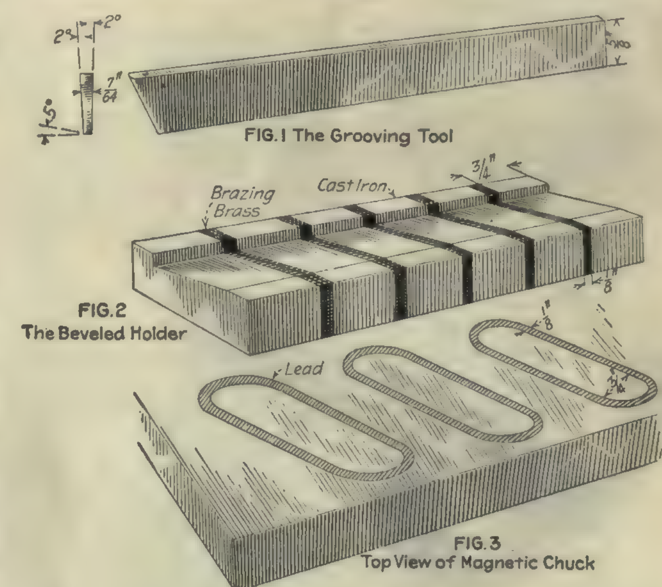
The tapered grooving tool shown in Fig. 1 is made from a standard $\frac{1}{8}$-in. thick cutting-off tool, such as is made in this shape for use in patented lathe tool holders. It is used to turn grooves about $\frac{3}{8}$ in. deep and $^{7}/_{64}$ in. plus or minus 0.002 or 0.003 in. wide. It had been necessary to grind the tool by hand from the standard $\frac{1}{8}$ in. stock, which is sometimes $\frac{1}{32}$ in. oversize. It usually took about 5 min. to grind the tool from the rough, and after about two grinds, lack of skill in grinding and wear on the side cutting edges made it necessary to cut the end off and start over again. It was highly desirable to surface grind the sides to width, with the clearance angle of 2 deg. on each side, as shown. The method finally adopted may not be new, but I never saw it tried or heard of it being used.

A Pratt & Whitney vertical spindle surface grinder with a magnetic chuck was available for the job, and I made the holder, Fig. 2, to use on the chuck.

This holder is made of cast-iron pieces spaced to match the pole pieces on top of the chuck, Fig. 3, and brazed solidly together with the proper thickness of brass to match the insulating lead. This latter was accomplished by first machining the cast-iron blocks, then holding them for brazing on a parallel by clamping the two end pieces, flat to the parallel, with pieces of $\frac{1}{8}$ x $\frac{5}{8}$-in. rolled brass between the blocks. The top half of the brass strips was then melted out and brazing brass run in, by means of an oxyacetylene welding outfit. When one side was finished, it was taken off the parallel and the other side melted out and brazed. It was necessary to do it in this way because the only $\frac{1}{8}$-in. thick brass to be found was of a composition unsuitable for brazing. It was finished by surface grinding, and the bevel was milled with a milling cutter ground on a 4-deg. angle. It took about 3 hours to make.

When in use this holder must be placed so that the lines of brass are directly over the lead spaces, and then blocked securely in all directions by broad flat strips of cast iron or steel, taking care to keep pieces of brass between it and all blocking pieces. The reason for such care in blocking is that since the lines of magnetic force are diverted up through the individual cast-iron pieces for holding the high-speed steel blade, the holder itself is not held very tightly. On the contrary, it will, if possible, move sideways until the magnetic force is shortened through the parallel itself. Then it would hold nothing on top of it.

By using a suitable grinding wheel, no trouble was experienced in warping of the blades. From 15 to 20 blades



FIGS. 1 TO 3. THE TOOL AND THE ATTACHMENTS FOR GRINDING IT TO SHAPE

Fig. 1—The grooving tool. Fig. 2—The beveled holder. Fig. 3—Top view of magnetic chuck

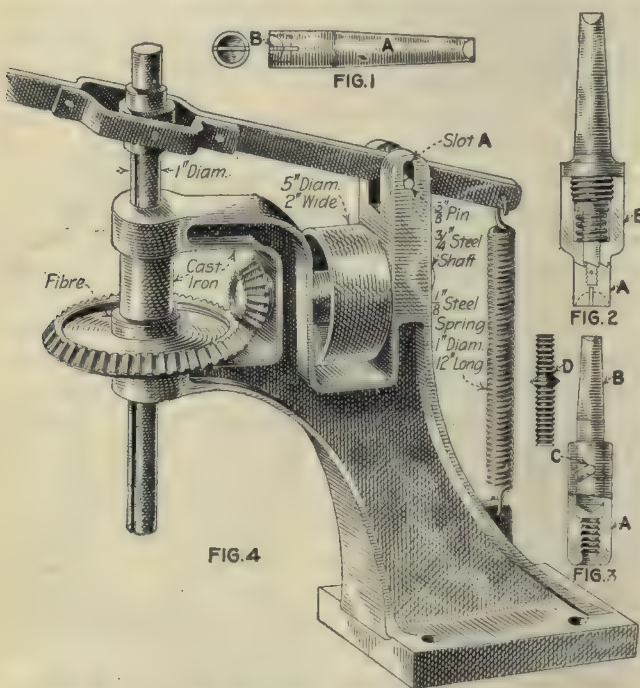
can be ground in one hour, and the labor of keeping these tools sharp now amounts to but little. The dull end is cut off on a rubber wheel, on the proper clearance angle, and the radius ground. It takes about 1 min. per tool, in lots of a dozen or more. EARL L. LIDDELL.

Highland Park, Mich.

Power Screwdriving

After having seen a pattern maker spoil his reputation and many good oak cases by hammering woodscrews into holes in the cases, it occurred to me that a short article on power screwdriving might be of interest.

Driving quantities of screws, as in electric-supply and similar factories, is a problem usually solved by means of expensive patent screwdrivers. An effective and inexpensive unpatented one is shown in the illustrations.



FIGS. 1 TO 4. SCREWDRIVING MACHINE AND BITS

The bit seen in Fig. 1 consists of a shank A, sunk in at the end and slotted to take a thin steel plate B. This kind of bit in a drilling machine will drive screws very rapidly. The screws are entered and started a few turns in the work by hand. The screw is centered in the driver, and there is no tendency for it to slip out. When the driver wears slightly on the driving edges, it is an advantage, as it permits it to jump out of the slot when the screw is home.

For driving screws through porcelain blocks, it is advisable to have a friction drive for the bit, to prevent breakage when the screw is home. One of these friction drivers is shown in Fig. 2. The bit A is driven by a ratchet that acts as a friction when driving, but is positive when taking the screws out.

The bit illustrated in Fig. 3 is used to drive the rolled studs, shown at D. The bit A is tapped to take the stud. It is bell-mouthed, and the thread is very loose. The body is connected to the shank B by means of a through pin C, which is a tight fit in the shank. The pin is a loose fit in the spiral slot on each side. In driving, the point of the shank B is forced down by the cross-pin and spiral slots, and presses on top of the stud, thus holding and driving it. When the drilling machine is reversed, the pin C goes up the spiral slots, the stud is released, and the bit readily unscrews, owing to its slackness on the stud.

In Fig. 4 is a simple power screwdriver. The only point to be explained is the slot A, in which the fulcrum of the lever rests. By having this pin in a slot instead of a round hole, the bit can jump up when the screw is home, and the rattling will call the attention of the operator.

JAN SPAANDER.

Brooklyn, N. Y.

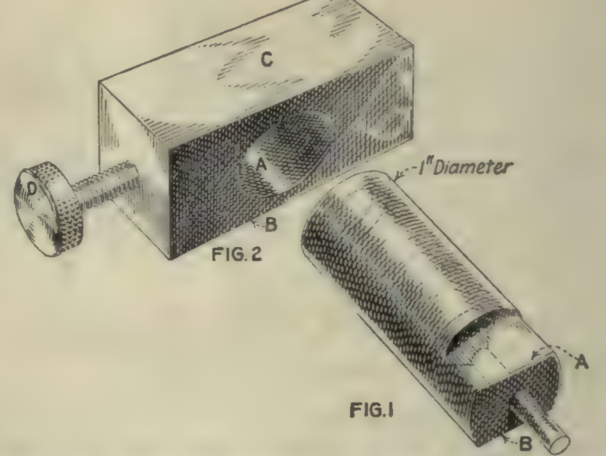
Grinding a Limit Gage

The views herewith illustrate the easy method by which the limit gage, Fig. 1, was ground to the desired size. The center pin is hardened and driven into the body of the gage. The surface A must be 0.170 in. from the center of the pin and the surface B 0.168 in., making a limit of 0.002 in.

In order that a gage of this kind be accurate, it is necessary that it be ground in such a way that the surfaces A and B are perfectly parallel to each other and also to the center pin.

Unlike the miller, the surface grinder is not provided with a dividing head and, consequently, whenever a job of this kind comes along some special device must be made up that will assure accuracy. Of course, if there were but one gage to be made it could probably be set up in the vise with the use of the surface indicator; but when there are a dozen or more gages to the order, it is obvious that some time-saving device would be preferable.

The fixture employed, Fig. 2, was a piece of steel 1 x 1 x 3 in., with the hole A bored a close fit to the body of the gage. The surfaces B and C were then



FIGS. 1 AND 2. THE METHOD FOR GRINDING THE GAGE

ground parallel to each other and also to the hole. The screw D was inserted in the end to clamp the gage.

The gages were inserted in the holder so that the surfaces A and B of the gage projected just far enough to allow for grinding. About 0.010 in. was left on each surface for grinding, so that the gage could be set in the holder by placing a 6-in. scale on the surface and sighting it to read parallel with the base of the holder. With the gage in the holder, it was then placed on the magnetic chuck of the surface grinder and the surface A trued up. Then a flat piece of ground steel was clamped on this surface, projecting sufficiently to allow a 1-in. micrometer to be used for measuring the distance across the center pin. In this way it was known how much was to be taken off the surface A to bring it to the dimension. After the surface A had been ground to size, the holder was reversed and the surface C presented to the magnetic

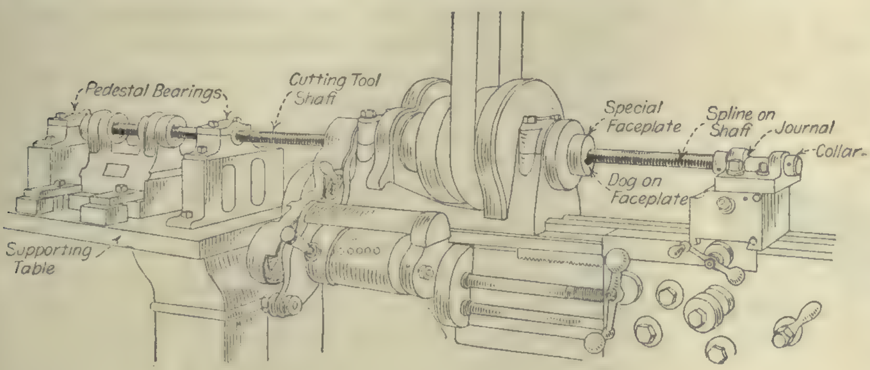
chuck and ground, so that the distance from the surface A to B could be measured with the micrometer.

The holder was easily made, and it did the work with accuracy and at a great saving in time

Philadelphia, Penn. CHARLES SEHL.

Boring Attachment

The illustration shows a simple attachment for the engine lathe, whereby the work usually done on a horizontal boring machine can be performed. It consists of a cast-iron table set at the left of the headstock. This



LATHE WITH BORING ATTACHMENT

table carries two boring-bar guides, in line with the spindle of the lathe. The work is blocked up to the required height, set to position and held by clamps.

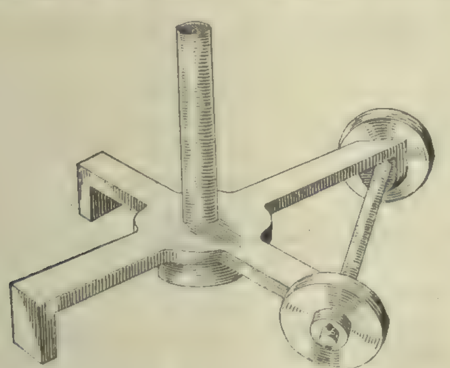
The boring bar is splined and driven by a key in the driver screwed to the nose of the lathe. The feed of the bar is from the carriage, as shown. The range of feeds is the same as that of the lathe, and internal threads can be cut in the work in the attachment, provided the threading tool is withdrawn on the return.

While this attachment takes up a little more room than the lathe alone, it is much more easily connected or disconnected than the type of boring attachment that is bolted to the wings of the carriage.

Yonkers, N. Y. JOSEPH J. EATON.

Stock Stand for Machine Shops

The stock stand shown in the illustration is provided with wheels that permit the filled stand being easily moved from place to place. The stand is of a conven-



THE ASSEMBLED STOCK STAND

tional type, with provision made for mounting a pair of cast-iron wheels, which run on a bar or pipe for an axle.

Peru, Ind. K. F. RAUSCH.

Cutting a Perfect Gear with a Broken Cutter

Emil Daiber's letter on page 254 prompts me to tell my experience in cutting a perfect gear with a broken cutter on a Fellows gear shaper.

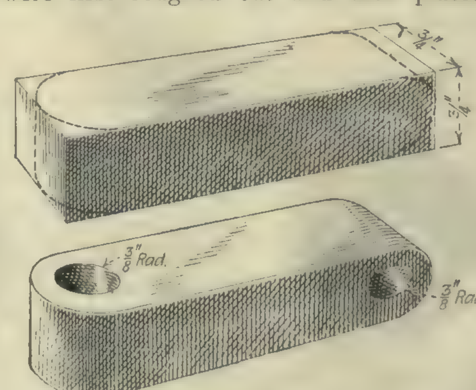
The blank had 93 teeth, three pitch, and the cutter had 12 teeth, one of which was broken entirely out. Therefore, it will be seen that every twelfth tooth would be entirely uncut. Dividing 93 by 12 gives 7 revolutions of the cutter and 9 teeth more to get around to where we started, because 12 is not contained in 93 an even number of times. The tooth that is broken out in the cutter will come in the place of the tooth that has already been cut, and a good tooth on the cutter will come in the place that has been left uncut. As we use two settings for cutting the depth of a three-pitch tooth, it will be seen that it is necessary for us to pass around the blank four times, or double the number that we would if the cutter was not broken. We fear that Mr. Daiber does not understand that we make an extra cut around the blank at the same depth for the purpose of cutting the material out of the unmilled space left by the broken tooth; but as we feed by hand over the teeth already cut, the second time around does not take long.

We wish to say that we know by experience that we have obtained perfect gears with a broken cutter.

Joliet, Ill. E. A. CLARK.

Rounding Ends with the Toolpost Grinder

Several pieces of square cold-rolled steel with holes as shown in the sketch were required to have their ends rounded. In order to complete the work more quickly and accurately than was possible by hand, the pieces were first roughed out and then placed on an



WORK BEFORE AND AFTER FINISHING

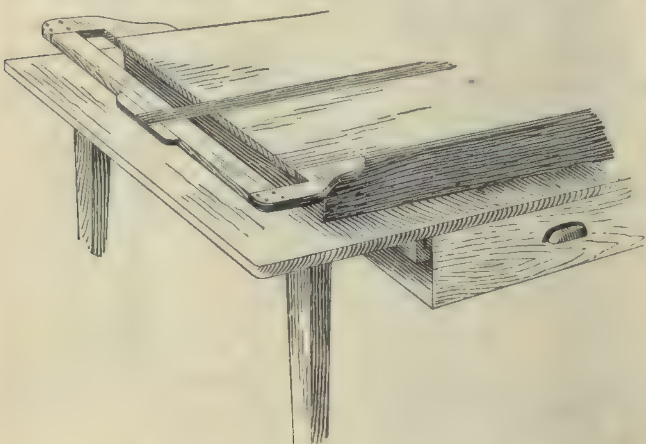
arbor secured between lathe centers, where the ends were quickly rounded by means of a toolpost grinding wheel. The work was turned by hand, with the aid of a dog placed upon the arbor. It was necessary to have the arbor clamped rather tightly between centers to prevent the work being forced into the grinding wheel.

Oakland, Calif. H. H. PARKER.

Discussion of Previous Question

Arrangement of Drawing Board for Handling Large Drawings

Referring to the arrangement shown by M. Favor on page 887, Vol. 45, we recently had a big job in hand the drawings of which were supplied to us and had to be traced. Being 65 in. long and 34 in. deep, they were



THE ATTACHMENT IN USE

far too large for any ordinary size drawing board, so the arrangement shown in the illustration was made.

While it is the same in principle as the one that has already appeared, the scheme herewith suggested is an improvement, inasmuch as it will accommodate drawing paper of any length fully the whole depth of the drawing board. As the arrangement is fixed to the top and bottom of the board, it preserves the edge of the board intact and so prevents the possibility of distortion on this important part, which acts as a guide to the T-square when doing ordinary work. A. R. PARSONS.

Linwood, Scotland.

Training Young Mechanics

For the last 20 years I have been engaged in training young mechanics in three well-equipped engineering works where the boys are offered a very general opportunity. I indorse all Mr. Williams says, on page 935, Vol. 45, about the boy having a poor chance of becoming an accomplished mechanic. That is the fault of the management, not of the boy. There are some works here very much on the same lines, while a few take a real interest in the welfare and efficient training of their apprentices.

My own experience is that, if a boy is worth keeping, he must be taught how to work efficiently and quickly; and the best way to accomplish that is to make him interested not only in his work at the present time, but in its development in the future, and to lead him to study what others have accomplished and what he can expect to accomplish. I find that six months is long enough to keep a boy on one machine, and if he is a sharp boy, a shorter period will suffice. I always bear in mind that the more the boy is taught the more efficient he will become and the greater profit he will be to his employer.

I always try to show the boy the quickest way to start his work and to grind his tools; at the same time I touch upon one or two other subjects of current interest—for instance, anything I may have read in the latest issue of the *American Machinist* or any other publication. Lastly, I usually arrange a visit or two a year to some works of importance in the neighborhood.

The last paragraph of Mr. Williams' letter touches upon the most important and vital part of a boy's career, in these words, "There are of course a few boys who ultimately make good—usually after a few shifts from one firm to another."

The shifting is the fatal step in a boy's career, if he is not an apprentice. If he is taught to be efficient, he will invariably shift in the hope to gain more knowledge. If he is not taught, he dares not shift, for fear he could not do the new work. Therefore, I always insist upon the boy's being a bound apprentice, so that the officials have a free hand to make the boy as efficient as possible and in as short a time as is convenient, some boys learning much more quickly than others. H. MAPLETHORPE.

West Bromwich, England.

Shrinking Steel Pinions Too Large in the Hole

On page 31, H. J. Reuping tells how to shrink steel pinions too large in the hole. Another way to accomplish the same results by heating only once is to heat the steel pinion to a red heat, close each end with a small block of wood held firmly with the tongs and cool quickly in water. I have used this method on collars of various sizes and lengths with good results.

It will be readily seen that, in sudden quenching, the outer surface of the collar cools first and the contraction causes the inner surface to upset while still hot.

Janesville, Wis. J. A. RAUGHT.

Metric Conversion Chart

On page 1133, Vol. 45, William Roberts illustrates a metric conversion chart that is handy for one who is constantly using the metric and United States systems

LINEAR METRIC CONVERSION CHART

of linear measurement. The accompanying illustration is of a chart that is much easier and quicker to make. It can be pasted on a thin piece of wood and carried in the pocket. It compares centimeters and inches.

Cincinnati, Ohio. RALPH C. FLOHR.

Editorials

Money Cannot Settle This Account

The man who does things is never a dyspeptic pessimist—the two qualities do not mix. And because the dyspeptic pessimist has never done anything worth while, he is a poor judge of human accomplishments.

There is also the ignorant egotist, equally innocent of achievement, who dismisses with a wave of his hand the obstacles confronting some other man's superhuman task.

Both these men belittle accomplishment—the egotist before, and the pessimist after, the fact. And both of them have been terribly busy since the war started.

The ignorant egotist said, in various languages: "Paris in two weeks!"—"The Dardanelles in three months"—"A million volunteers overnight." And in the industrial field he was equally positive. Said he, "Not skill and thought, but money makes munitions. Rub the golden lamp and the slave of Crœsus will immediately bring rifles and fuses and motor trucks and victory!"

If machine tools were built in the quantities that shells have been—and if machine tools involved as few and as simple operations as do most munitions—the builder of machine tools could turn unskilled men into producers within a few days. As it is, the training of a tool-building mechanic is a matter of years. And it is not a question alone of mechanical skill, for those who know the machine-tool business from the shop end know that an engine builder or a motor-car builder, no matter how skillful at his own trade, is a square peg in a round hole when in the machine-tool shop. There is no other business like it. Prior to the war, 50 lathes or 25 millers or 10 planers going through the shop simultaneously constituted a large lot. Combine this small-quantity production with the complexity of the machines, with the necessity for accuracy, with the variety of types of tools and the range of sizes in any one type, and you have the reason why the machine-tool building machinist is the result of evolution and not of creation.

The munitions shops have demonstrated that machine operators can be created. The formula is as follows: Pick a farmhand who has never seen the inside of a shop, one endowed with strength from the neck down and a fair degree of imitative ability; give him three days' training in the half-dozen motions that will comprise his world of action for all time to come; pay him from five to ten times as much as he ever received before—and call the job finished. Compared with the task of training a machine-tool building mechanic, the making of a munition worker is a kindergarten accomplishment!

And yet, in America and in England, it took two years to get really going on munitions.

When you overload a motor, the fuse will blow out; if you attempt to start a trolley car too rapidly, the circuit-breaker will operate; crowd a belt beyond its pulling power, and it will slip; make unreasonable demands on industry, and trouble ensues. It takes an infinitely great amount of energy to accelerate even a small body in an infinitely short time. Increase the time allowed, and you decrease the effort. Nature's laws apply equally to industry, to the individual and to the inanimate.

Coincident with the insistent demand for shells came the demand from abroad for American machine tools on which to make them. Upon the shoulders of American machine-tool builders was placed the gigantic burden of responding with an unheard of expansion in their industry in an incredibly short period. Orders were veritably forced upon them—delegations from abroad combed the United States in a search not only for existing machine-tool builders, but for shops that could be persuaded to build machine tools. Price was apparently no object when weighed against the need of these machines. Orders were taken, in many cases for early delivery.

Just as an order, entering the shop, is split into its components, and orders for these parts are sent to foundry, stockroom and manufacturing departments, so this tidal wave of foreign demand for machinery, flooding the shops in which machinery is built, spread to the sources of supply of raw materials, overwhelming them also. A hundred manufacturers, having promised quick delivery in response to urgent pleadings, rushed to the steel mill and the iron furnace to find that the multiplication of demands had divided the quantities available to fill them. And even the steel mills and iron furnaces passed along the demand, and with it the delay—back to the coke oven and the mine. Transportation facilities, as necessary for raw materials as for finished product, were overtaxed to the extent that food became scarce in crowded centers dependent on rail supply. Labor, even the most unskilled and crude, was in demand at unheard-of wages.

This labor shortage, and the terrific expansion of output of the machine-tool factories, resulted indubitably in a dilution of skill that reached the danger point. To meet the demands of those across the water in dire need of their products, the machine-tool builders were compelled to double and triple their working forces in the face of an unprecedented labor shortage. They were forced to devote multiplied energy toward securing supplies, in the face of an unparalleled material shortage. Through absolute lack of physical-plant capacity, many were forced to sublet work to shops sometimes hundreds of miles distant. Confronted by such conditions, the wonder is not that deliveries were delayed and occasional lapses in standards occurred, but that it was possible to maintain deliveries and standards at all.

In the face of these difficulties, what did American machine and tool builders accomplish? Take, for example, gages, micrometers and measuring devices of all kinds, without which standardization of product and quantity manufacture are impossible. London *Engineering,* of

Feb. 2, 1917, quoting from a paper delivered by Arthur Brooker before the Liverpool Engineering Society, said: "Of the measuring equipment now used in the average British workshop about 90 per cent. is of American make."

Nine-tenths of the fundamental means of making munitions—the measuring devices used in British shops—came from America! Laying aside for a moment the consideration of all other tools, the fact that nine shells out of every ten produced in British shops owe their accuracy to American measuring instruments chalks up a heavy score for American tool builders in the matter of Service. What would have happened if this 90 per cent. had been lacking? And not alone in the matter of measuring instruments, but with the machine tools that are essential to the existence of munitions and other equally necessary material, American tool builders have responded with efforts that have made their mark in Europe. At Havre, for example, the Belgian Government munition factory with its 12,000 workers has close to 90 per cent. of its machine-tool equipment "made in America."

And after the accomplishment comes the dyspeptic pessismist, belittling, casting slurs on motives, forgetting that real service cannot be entirely paid for in coin or exchange. An Englishman—*but not an English tool builder*—writes as follows:

"I can imagine you all . . . attending the Manufacturers' Club, making patriotic speeches with regard to independence, liberty and all the other fine virtues, talking about Lincoln, waving the Stars and Stripes . . . and then each one going back to raise prices 15 to 20 per cent. and demand cash against placing the order in your works.

". . . It is my deliberate opinion that, after the war is over, you will find, especially those of you who have courage enough to face the trip across here, that you are more than up against it. The day of the American representative coming across and talking hot air is over. . . .

"The day will arrive when you will have to take in one another's washing, and I think you will find in that day that it will be more tolerable for an Englishman, Frenchman or Russian to trade with his today implacable enemies than to trade with his most sympathetic friends across the herring-pond.

"When they come and drop bombs on us at Leigh, we admire them for their courage, for it takes a very considerable amount of courage to go up in a Zeppelin. . . . It is a different kind of courage that is needed to protest your sympathy, all the while having your tongue in your cheek."

If this were the attitude of the man who knows—the man who understands and appreciates—we might well consider two years of tremendous effort wasted.

Thank God that the men who know—the men who actually build machine tools in England and who have brought them from America—understand and appreciate. Alfred Herbert is a name familiar not only in the industrial world of Great Britain, but wherever machine tools are built and used. At the sixth annual meeting of the Machine Tool and Engineering Association, Ltd., held in London on Feb. 14, Alfred Herbert himself acknowledged in direct and handsome terms the advantages that have come through the importation of American machine tools.

The men who understand—the men in England who know that machine tools are the red corpuscles in England's life blood—the men who are big enough and broad enough to judge by final results, forgetting the petty delays and annoyances that arise unavoidably in the accomplishment of a superhuman task—it is to these men that the machine-tool builders of America look for settlement of their accounts. For though the bills may be paid, the accounts are not settled unless Appreciation comes in exchange for Service.

Moving Embargo Freight

The embargo on freight, which has been declared at various times, affects not only foodstuffs, which naturally obtain the most prominence, but also the shipment of machinery of all kinds. This situation makes any information in regard to the movement of freight of particular interest to machine builders at this time, and it is pleasing to note that the Pennsylvania R.R. has established a joint embargo committee with headquarters at Pittsburgh. Its purpose is to modify embargoes where transportation conditions and the ability of consignees promptly to remove freight from the cars permit such exceptions to be made. As a result of the committee's efforts there were moved during the last week of February more than 3100 carloads of freight of all kinds through the Pittsburgh and Buffalo gateways. These cars were under embargo and could not have been handled with equal promptness, if at all, except by special arrangements effected by this committee. Of this freight approximately 2000 cars were eastbound and 1100 westbound. It is hoped to increase this movement and so relieve congestion to an even greater extent.

This committee virtually constitutes a clearing house for handling all requests for special movement of freight affected by embargoes between the eastern and western lines of the Pennsylvania system, practically uniting the transportation facilities of the two branches. It is intended to simplify the work of arranging shipments and to assist shippers of all kinds, although foodstuffs and other necessities for domestic consumption must receive first attention. Shippers and consignees should keep in touch with this committee.

A New Fire Danger

The National Board of Underwriters is pointing out a new form of fire danger that we should heed more as individuals than as shop men—the danger from small electric devices such as pressing irons, plate warmers and hair curlers. These are credited with over 30,000 fires in 1916—all preventable. The danger comes from not turning the current off when leaving the instrument.

About the only device of this nature in use in the shop is the electric soldering iron (the hair curler has not yet become a shop fixture). While not mentioned in the list, a soldering iron might easily cause trouble if left lying on a wooden bench or against a piece of waste. The safe way is to turn off the current when you leave a device of this kind. Forgetting to do so is what causes the trouble.

The Commercial Outlook—National and International*

By O. P. Austin†

SYNOPSIS—In this article the statistician of the National City Bank of New York, who has made a profound study of the changes to be expected in industrial conditions after the war, arrives at a number of interesting conclusions.

The time has come when we of the United States must begin to think seriously of the future of our trade. True, we have prospered by the conditions of the past 2½ years, but we neither expect nor desire that these conditions will continue indefinitely.

The first question to be considered in looking to the future of trade is the probable condition in which the countries now at war will emerge from that great struggle and their prospective ability to resume their commercial relations with each other and with other parts of the world. The second question is our own prospective relation to world trade, both with the countries now at war and also with those sections in which we have been making material gains by reason of the inactivity of those accustomed to supply those fields.

Trade Currents Not Permanently Changed by the War

In my opinion international trade after the war will be quite similar to that before the war. The great trade currents that have been developed in the last century are the result of natural conditions which cannot be permanently interrupted by even this titanic struggle. Certain great sections of the world have become its chief producers and distributors of manufactures and must so continue for generations, while certain others have become and must continue to be the chief producers of foodstuffs and materials. Business is little influenced by sentiments.

The suggestion of the Paris conference that the war at arms should be continued commercially receives less and less of support on reflection. That the countries at war will, immediately upon its termination, begin to dump accumulations of manufactures upon the markets of the world; that these countries will be short of certain classes of manufactures and will call upon the United States for great supplies; that shortage of capital will prevent a resumption of their industries and export business and that lack of shipping facilities will prevent a return to customary trade movements appear likely to prove much less formidable than was anticipated.

The war between the two sections of our own country, in which the bitterness was great, was followed by a rapid resumption of trade between the sections. Trade relations were quickly resumed between France and Germany following the war of 1870-71, in which the bitterness was quite as great as that which now exists. The trade relations between the United States and Spain, following our own war with that country, were promptly resumed and quickly increased. Japan's exports to Russia, which were about $1,500,000 in the year prior to that war, averaged more than $3,000,000 per annum in the five years after her war with that country, an increase of over 100 per cent. in a five-year period.

Trade Relations of the Countries Now at War

No countries in the world are more keenly alive to the importance of commerce and to governmental coöperation therein than are those now at war, and it seems highly improbable that either their commercial or financial interests will enter upon or even permit a business war at the close of that now in existence. Great Britain alone sells in times of peace to the Central Powers about $400,000,000 worth a year of her products and buys from them another $400,000,000 of merchandise which she must have and which it is more convenient for her to purchase from that near-by territory than to bring at greater expense of transportation from other parts of the world.

France sold to the Central Powers in the year preceding the war about $200,000,000 worth of merchandise and bought from them $250,000,000 worth. Russia's exports to the Central Powers averaged $250,000,000 a year and her purchases from them $325,000,000 a year. Italy's sales to them amount to $125,000,000 a year and her purchases from them $175,000,000 a year. Belgium's imports from them amounted to $160,000,000 per annum and her sales to them $220,000,000. Germany's imports from the Allies and their colonies amount to over a billion dollars a year, and her exports to them a full billion; Austria-Hungary's imports from the Allies are $600,000,000 and her exports to them over $500,000,000, while the trade of Turkey with the Allies is about $150,000,000, making the recorded trade of the Central Powers with the Allies about three billion dollars a year, while the records of the Allies also show their trade with the Central Powers at about three billion dollars.

Can we believe that 10 of the most alert commercial countries of the world are going to throw away opportunities to sell three billion dollars' worth of merchandise a year or to buy that three billion dollars' worth of their requirements at less cost than they can bring them from more distant countries, merely as a result of conditions that have never before, in any part of the world, resulted in permanent interruption of trade relations?

Industrial Power of Belligerents After the War

There are some who assert that the belligerents will be greatly reduced as a result of the 4,500,000 killed or fatally wounded up to this time. But those making this assertion forget that the countries at war are constantly increasing their population, that there is in all cases except that of France a large excess of births over deaths and thus a net gain in population. The annual net increase in population in recent years has been in Russia, 2,900,000; Germany, 825,000; Austria-Hungary, 403,000; Great Britain, 393,000; Italy, 362,000; Belgium, 73,000; and France, 64,000, making the annual average of

*Extracts from an address delivered before the editorial conference of the New York Business Publishers Association, Mar. 20, 1917.

†Statistician of the National City Bank of New York.

net gain in population of the European countries now at war a little over 5,000,000 per annum. Of this number approximately one-half are males, and we may thus assume that the net increase in the number of male persons entering the industrial age and thus available for industrial pursuits in the countries in question is in the $2\frac{1}{2}$ years since the beginning of the war about 6,000,000, while the war losses by death and permanent disability, according to the latest computations, are but about 4,500,000. In addition to this the loss by emigration has been suspended, and many of their former emigrants have been called home. Then too, there have been large additions to the number of women employed in industrial pursuits. We may safely assume that the countries in question, when they emerge from the war, will find themselves with a materially larger industrial element than they had at the beginning of the war and machinery has been speeded up to a much greater producing power than it had before the war began.

Destruction of Shipping and Effect on World Trade

As to the destruction of vessels during the war and its effect upon future commerce, the latest estimate of vessels destroyed is about 5,000,000 tons, or about 10 per cent. of the world's total tonnage at the beginning of the war; but as it is asserted that the production of new ships meantime has been one-half as much as the tonnage destroyed, we may assume that the net loss thus far is not over 5 per cent. and that this loss, unless greatly increased, will be so evenly distributed in world trade as to be comparatively unimportant in the relative commercial power of the great trading nations.

Have we increased our share in world trade during the war period? The answer to that question is obvious, for our exports in 1916 were 160 per cent. greater than in 1913, the year before the war, and imports 33 per cent. greater than in 1913, while total world trade in 1916 was probably about 10 per cent. greater than in 1913. While it is true that much of this increase in our exports occurred with the nations at war and consisted chiefly of munitions for which the demands upon us will cease at the termination of hostilities, it is also true that there was a large gain in the sales to the neutral world; and this consists almost entirely of a class of material for which we must continue to find markets abroad.

It is to these neutral sections and the increased trade with them that we should now be giving special attention. Our exports to the neutral countries of Europe increased from \$242,000,000 in 1913 to \$402,000,000 in 1916; to South America, from \$147,000,000 in 1913 to \$220,000,000 in 1916; to Asia, from \$126,000,000 to \$205,000,000, exclusive of that going to Vladivostok for transmission to European Russia; to Africa, an increase from \$29,000,000 to \$54,000,000; to Oceania, from \$82,000,000 to \$106,000,000; and to North America, from \$601,000,000 to \$925,000,000. The total increase in exports to the neutral world was from \$1,226,000,000 in 1913 to \$1,911,000,000 in 1916, a gain of \$685,000,000, while in the three years ended with 1913 the gain was but \$416,000,000. The increase in exports to the neutral world in the three years ended with 1916 was 62 per cent. greater than that of the three years ended with 1913.

The gain which we have made in our exports to the neutral world, \$685,000,000, occurs in a class of merchandise that must be our chief hope in the future growth of our export trade. In the past, while we were making a phenomenal increase in exportation, the natural products—grains, meats and cotton—were the articles in which the chief growth occurred. But within recent years we have reached a stage in national development in which we have no more of foodstuffs to spare, and the share of our cotton that we require for local consumption is steadily increasing. As a result, we must expect that the chief gains in our exports in the future will occur in manufactures; and while we shall have a harder fight to develop an increased trade in manufactures than we ever had in selling the natural products, because of the sharp European competition that we shall encounter in manufactures, we must make that fight if we are to maintain our rank and prosperity as an exporting nation.

In all the neutral world—North and South America, Asia, Africa and Oceania—the demand for manufactures will continue and increase with the general revival of business and industrial development that will come with a return to world peace. And it is to that field that our manufacturers should give their special and earnest attention. And to do this successfully they must adopt the methods which have given our rivals success in that field—make the goods to suit local requirements and customs and sell them upon the accommodating terms to which the people of those countries have been accustomed for generations.

New Opportunities in the Tropics

There is a great section of the world yet undeveloped in its producing power and therefore its purchasing power, and it is a field that the experiences of the war have shown us a practical method of development. By this I mean the tropical world. Between the thirtieth parallel of north latitude and the thirtieth parallel of south latitude is half the land area of the world outside the polar regions, and one-half the world's population. Yet the commerce of this great tropical belt, with half the land area and half the world population, is but one-sixth that of the international commerce of the world, and it has but one-seventh of the world's railways. We ourselves brought into continental United States last year a billion dollars' worth of the products of the tropics; and other parts of the temperate zone are making similar demands upon that area, which fails to respond to these demands because of the lack of transportation facilities.

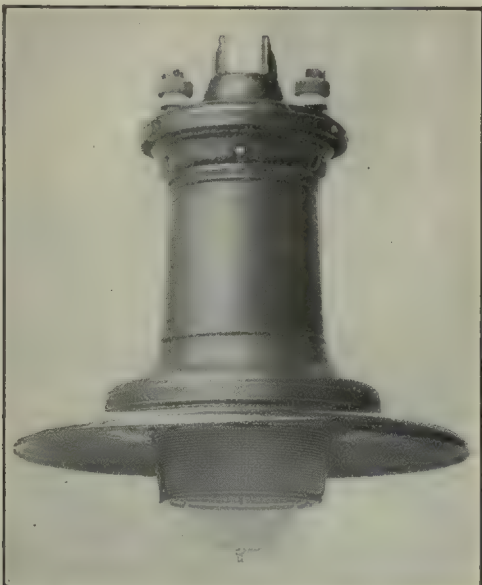
The Horseless Vehicle Will Conquer the Tropical World

It is with reference to this great area, whose products the world is now demanding, that the war has given us a lesson that may result in its conquest. The chief cause of its slow development has been the absence of any method by which the natural products could be transported from the place of production to the common carrier. The lessons of the war have proved, what we already suspected, that the horseless vehicle is capable of transporting men and merchandise over comparatively roadless areas and that the flying machine is capable of facilitating a close study of topographic conditions in any climate and under any circumstances; so by the lessons that the war has given us, men may have learned the art of conquering that now unconquered part of the world.

Shop Equipment News

Electric-Lighting Fixture

The fixture shown has been placed on the market by the General Electric Co., Schenectady, N. Y., and is suitable for lighting large open spaces in industrial plants.

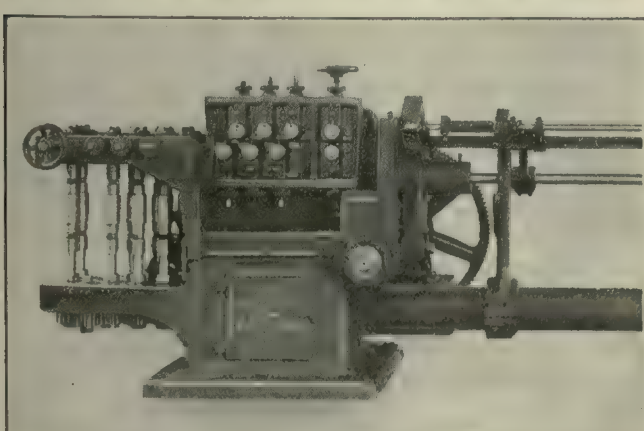


LIGHTING FIXTURE WITH REFLECTOR AND REFRACTOR

It is known as the form 6 Novalux pendent type fixture and is shown equipped with a 20-in. reflector and band refractor. The object of the refractor is to catch the rays of light, which are thrown upward and wasted, and direct them downward and outward. The fixture is intended for use with Mazda type C lamps.

Motor-Driven Straightener and Cutter

The F. B. Shuster Co., New Haven, Conn., has recently made an addition to its line of straightening and cutting machinery for bar and flat stock. The new machine is shown in the illustration and is for use on square and hexagon stock, being known as the No. A-3 geared roll straightener and cutter. On the bed is mounted a housing containing the six horizontal and six vertical straightening rolls and also two sets of feed rolls, one at the front and one at the rear, or entering, end. All gears are of steel and all bearings are bronze bushed. The roll shafts and roll gear shafts are connected through ball joints and sleeves that allow the roll gears to remain stationary, give independent adjustment to all rolls and make it possible to handle several sizes of material of one shape without changing rolls.

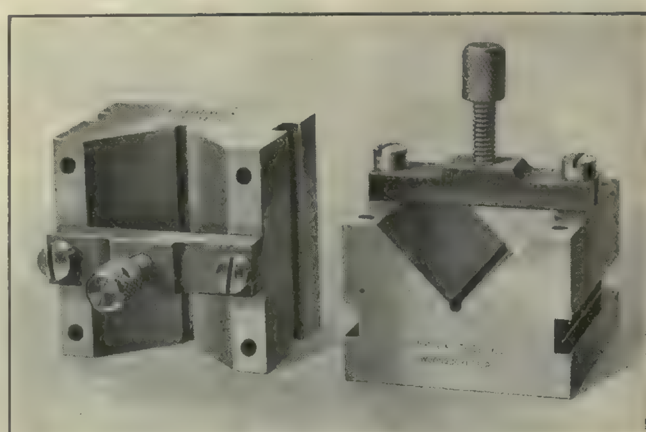


STRAIGHTENER AND CUTTER FOR BAR AND FLAT STOCK

The material is taken from the coil passing through guides into the rear feed rolls, which feed it through the straightening rolls and into the front feed rolls. These pass the stock through the stationary die and into the covered guide bar until it strikes a gage set for the desired length. This operates the clutch mechanism, which releases the feed and at the same time starts the mechanism that cuts the piece off and raises the cover of the guide bar, dropping the piece into the forked holders shown. On the return of the cutting-off mechanism the feed rolls are again set in motion, and the operation is repeated. The machine is arranged for motor drive and will handle stock $\frac{1}{2}$ in. square, hexagon stock down to $\frac{1}{4}$ in. and flat stock from $\frac{1}{8}$ x $\frac{3}{8}$ in. to $\frac{1}{4}$ x $\frac{3}{4}$ in.

Hardened-Steel V-Blocks

The Simplex Tool Co., Woonsocket, R. I., has placed on the market the V-blocks shown in the illustration. They are made of hardened steel and are ground all over.



SIMPLEX V-BLOCKS

The V is ground to a 90-deg. angle, is in alignment with the sides and base, at right angles to the ends and central with regard to the sides.

The design of the clamp is such that it will not interfere with the block being used on its side. Grooves are provided in the sides for clamping purposes, in order that the top of the block may be free from obstructions. The blocks measure $2\frac{1}{2}$ x $2\frac{1}{2}$ x $1\frac{3}{4}$ in. and are made in pairs to insure alignment, but may be purchased singly.

Floor-Type Boring, Milling and Drilling Machine

In Fig. 1 is shown a horizontal boring machine, of improved design, built by the Landis Tool Co., Waynesboro, Penn., especially to meet the requirements of shipyards, navy yards, turbine works, etc., for handling a wide range of heavy machine work. The drive is from a motor on the column, direct-connected to the mainshaft. The spindle drive is controlled by a pair of friction cone clutches accessibly placed at the back of the saddle. The spindle reverses for back facing and tapping. The driving pinion for the spindle meshes with a large gear cut directly on the faceplate, thus reducing spindle torsion and chatter when milling. The spindle slides, but does not rotate, in an adjustable bearing carried on the spindle sleeve. The bearing for the rotary motion of the spindle is on the spindle sleeve itself. The spindle is traversed by a long nut which engages a square thread cut directly on the spindle and which has a bearing on the sides only of the thread. The feed is applied between the main bearings. The nut and screw rotate together at the same rate of speed, except when the feed is engaged. The method of feeding permits continuous traverse of the spindle without resetting. Adjustment for wear is provided. The end thrust in either direction is taken on ball bearings.

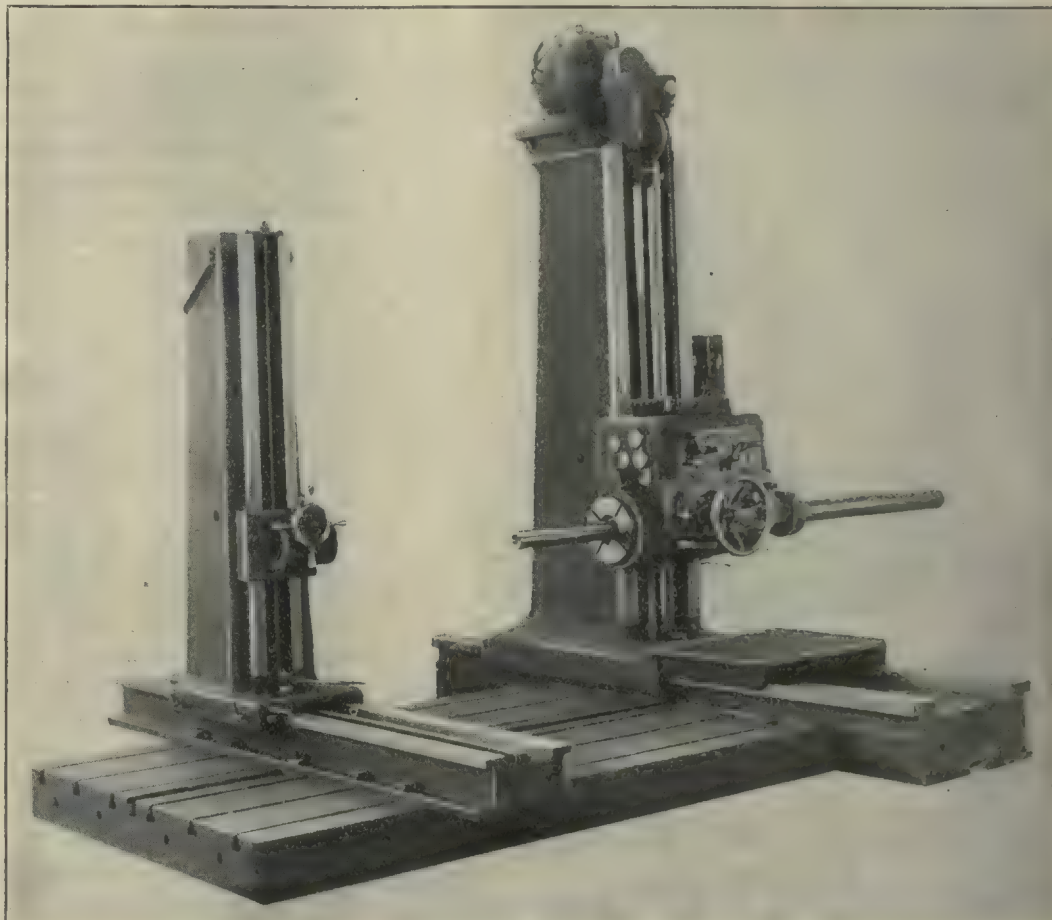


FIG. 1. HORIZONTAL BORING, MILLING AND DRILLING MACHINE
Spindle feed, 40 in.; minimum distance center of spindle to floor plate, 18 in.; maximum, 72 in.; maximum distance from faceplate to outer spindle, 88 in.

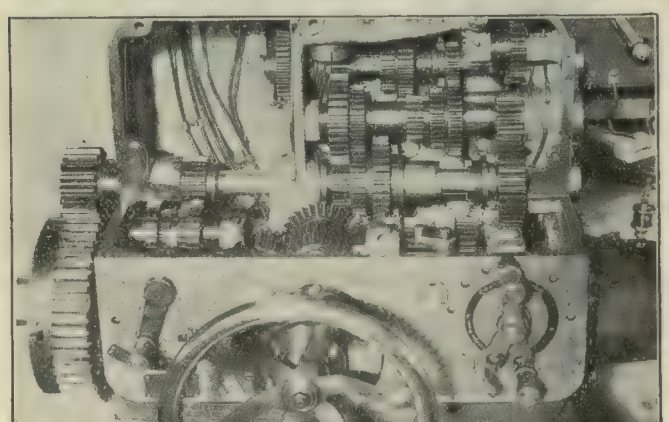


FIG. 2. FEED AND SPEED GEARS

In milling, the thrust of the spindle is taken directly on the main saddle casting, independently of the thrust provided for the spindle during boring. The feed and speed gear trains, shown in Fig. 2, are carried in the saddle as one unit.

Twelve gradations of spindle speeds are provided and 12 feed changes for each speed. The feeds are the same whether applied to spindle, saddle or column traverse, and no two of them can be engaged at the same time. Power rapid traverse, independent of the regular feeds, is provided for spindle, saddle and column in every direction. With one lever the machine can be instantly started and stopped, or reversed, independently of the main drive.

The gear shifts are all of the sliding-transmission type, inclosed. The saddle parts are oiled by a siphon system. All traversing gears are located between the ways and close to the guiding member. The counterweight for the saddle is inside the columns. The gears and shafts are made of chrome-nickel steel, heat-treated. The spindle is made of high-carbon hammered crucible steel.

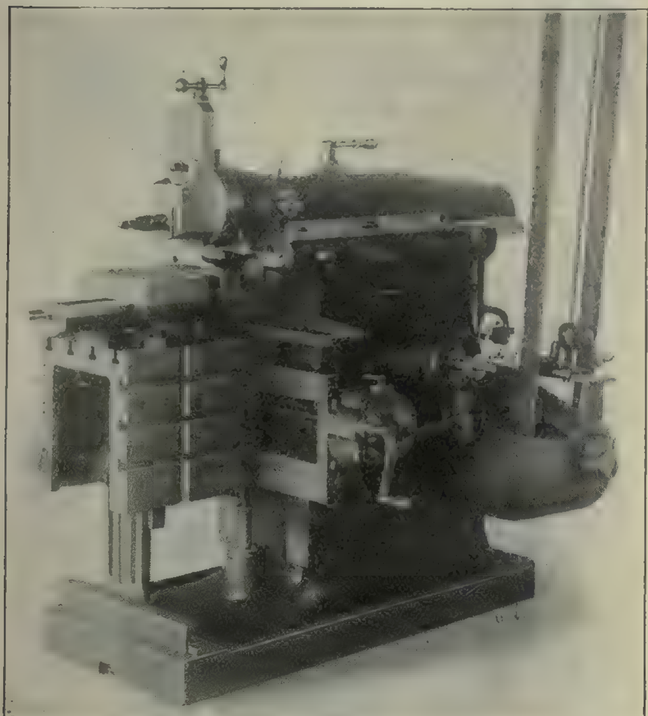
The machine will bore, mill, drill, tap, spline and cut oil grooves, or can be used for rotary planing, at one setting of the work. When the swivel table is used, two or more sides of the work may be finished at one setting.

Crank Shaper

The Hendey Machine Co., Torrington, Conn., has recently brought out a 20-in. crank shaper that is regularly equipped with a mechanical belt-shifting device.

The shifting arrangement consists of two shifters, one on the machine and the other on the countershaft, which are moved alternately by a set of cams operated by the handle seen just above the cone pulley at the right. The rod projecting upward above the handle is for the purpose of operating the upper shifter.

The frame and base of the machine are cast in one piece, and an oil pan on the inside catches any oil that may drip from the bearings. The hub for the bull gear



HENDEY 20-IN. CRANK SHAPER

Stroke, $20\frac{3}{4}$ in.; horizontal travel of table, $24\frac{1}{2}$ in.; vertical travel of table, 15 in.; minimum distance, ram to table, 4 in.; top of table, 16 x 20 in.; side of table, $16\frac{1}{4}$ x 15 in.; power cross-feed, 0.008 to 0.2 in. per stroke; travel of head slide, $7\frac{1}{2}$ in.; power feed of head slide, 0.005 to 0.06 in. per stroke; vise opens, 13 in.; size of vise jaws, 12 x $2\frac{7}{16}$ in.; keyseating capacity, $3\frac{1}{2}$ in.; toolpost opening, $\frac{7}{8}$ x $1\frac{3}{4}$ in.; strokes of ram, 8 to 115 per min.; floor space, 54 x 92 in.; weight, 4100 lb.; belt width, 3 in.

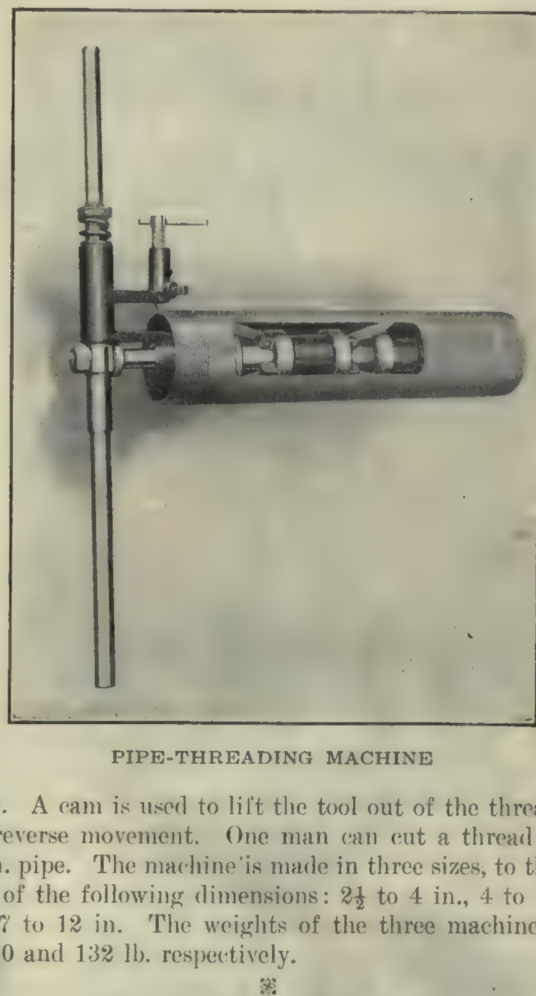
is also cast integral with the frame. The crankpin is hardened and ground and works in a cast-iron bushing in the steel crankpin block. Ways for the ram have an angle of 50 deg., and an adjustable gib is combined with the cap in one casting. The ram has a bearing surface in the frame of $11\frac{1}{4}$ x 34 in. and can be set either while stationary or in motion, the length of stroke being shown in the index. All adjustments for the crossfeed mechanism are at one end of the crossrail, and a dial with an indicator controls the amount of feed, which can be varied while the machine is in motion. The feed is stopped, started or reversed by means of the small ball lever shown. Power downfeed is optional; and when furnished, it is provided with a micrometer dial.

The elevating screw is telescopic, and the crossrail is clamped to the column with a square lock. The toolhead swivel is bound to the ram by a single screw. A four-step cone pulley is used, which together with back gears gives eight speeds. The shaft has an outward bearing in the casting, which forms a guard for the cone pulley. An adjustable bottom support for the table slides on a channel-shaped track on the base. Four bolts hold down the vise, which has a graduated base. An expanding friction clutch is incorporated.

Pipe-Threading Machine

One of a line of pipe-threading machines manufactured by the William T. Johnston Co., Cincinnati, Ohio, is shown in the illustration. They are known as the Lathe-cut pipe-threading machines. The wall of the pipe is cut away to show the expanding sleeve by means of which the machine is fastened to the section of pipe to be threaded. The threaded end of the sleeve may be seen just inside the end of the pipe. This thread is cut on a standard pipe-thread taper and serves as a feed screw. The arm that engages this thread also carries the cutting tool, which is a piece of $\frac{3}{8}$-in. square high-speed steel.

As the cut progresses, the arm recedes against the spiral spring on the propelling arm, thus giving the proper taper to the thread. The operation is repeated a number of times, the tool being advanced a little each time in a manner similar to that followed in cutting a thread on the



PIPE-THREADING MACHINE

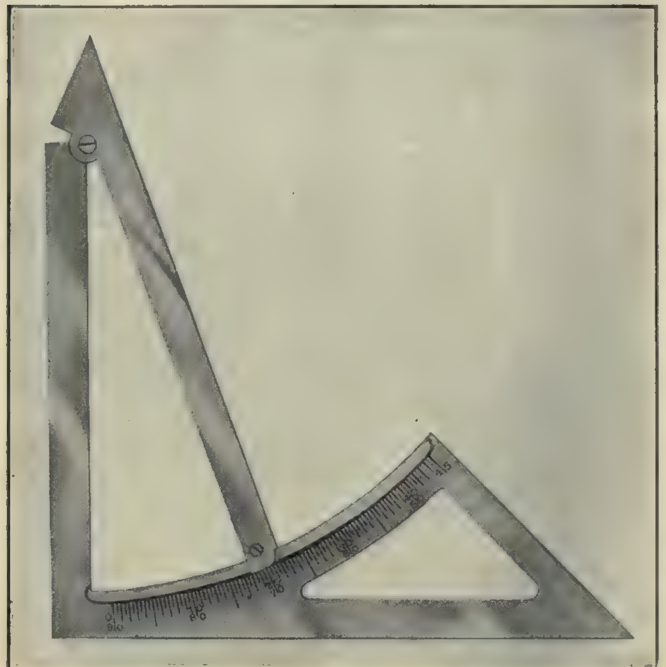
lathe. A cam is used to lift the tool out of the thread on the reverse movement. One man can cut a thread on a 12-in. pipe. The machine is made in three sizes, to thread pipe of the following dimensions: $2\frac{1}{2}$ to 4 in., 4 to 6 in., and 7 to 12 in. The weights of the three machines are 16, 30 and 132 lb. respectively.

Universal Triangle

The adjustable triangle shown has recently been brought out by Charles E. Baker, Indianapolis, Ind., and is known as the Hellman universal triangle. It is made of nickel-plated steel in 6-in. size and is $\frac{1}{8}$ in. thick. As may be seen, the instrument consists of a 45-deg. triangle, a part of the hypotenuse of which is hinged in such a manner that it may be adjusted to form any angle from 0 to 45 deg. with one side or an angle of from 90 to 45 deg. with the other side.

The loose end of the hinged section is provided with a groove that fits over a tongue milled at the proper

radius in the body of the triangle. Friction is relied upon to hold the hinged section in the proper position. The protractor is graduated to ½ deg. The whole device



UNIVERSAL TRIANGLE

is flat and can be used either side up, there being no projecting screws or nuts to interfere.

Cutter Drill and Tool Grinder

The machine illustrated in Fig. 1 is the product of the Grand Rapids Grinding Machine Co., Grand Rapids, Mich., and is known as its No. 2 universal cutter, drill

FIG. 1. UNIVERSAL GRINDER

Capacity of drill holder, ⅛- to 2½-in. drills. Capacity of cutter grinder: Diameter of swing between centers, 9½ in.; length of swing between centers, 20 in.; longitudinal movement, 15 in.; transverse movement, 7 in.; vertical movement, 6¾ in.; capacity for face mills, 12 in. in diameter; weight, 650 lb.

and tool grinder. This machine is adapted for all classes of tool grinding within its capacity. On account of the necessity for different spindle speeds for the cutter and tool-grinding wheels, a double-spindle construction is used. The two spindles have ring-oiled bronze bearings and may be adjusted for either radial wear or end play. The drive between the two spindles is by gears, that on the tool-grinding shaft being of cast iron, while the one on the cutter-grinding shaft is a Fabroil cloth pinion. The spindles are of crucible steel and are ground to size.

The drill holder accommodates all sizes of drills from ⅛ to 2½ in. in diameter and is so made that any desired angle of point or clearance may be obtained. The size or type of shank makes no difference, even though this may be considerably larger than the drill itself. A device is also included for truing the face of the wheel.

The machine will handle any cutter reamer or tool within its capacity, which is given in the specifications. The table will swivel through 360 deg. and two screws, one in front and one in back of the subtable, lock it in position as well as secure it to the subtable. A scale that is included for grinding tapers may be read as fine as $\frac{1}{16}$ in. per ft. An auxiliary lever is furnished, which may be quickly mounted on the handwheel for longitudinal

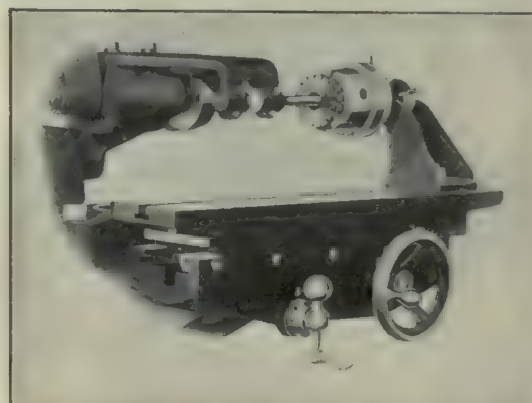


FIG. 2. ARRANGEMENT FOR INTERNAL GRINDING

movement, thus providing the lever action so convenient for some classes of grinding work.

Slots are so placed that the headstock may be mounted either in line with or across the table. The vise is also carried on the headstock, so that it may be mounted in either position; it has a swivel action, so that the work may be presented to the wheel in a horizontal, a vertical or an angular position. The vertical-feed and cross-feed screws operate in bronze nuts and have dials indicating in thousandths of an inch.

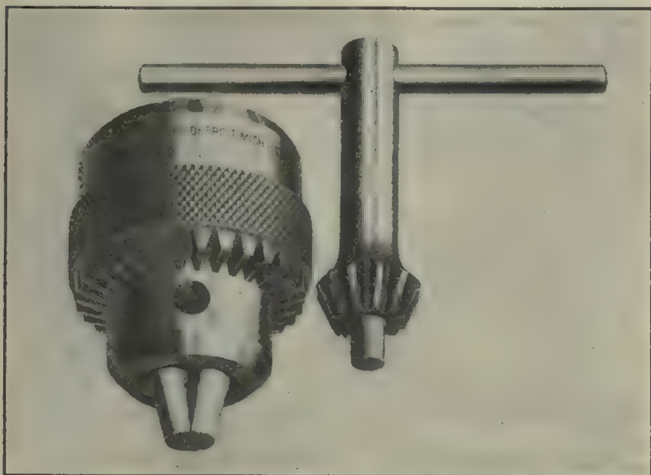
In Fig. 2 is illustrated the internal-grinding attachment. A belt pulley is placed on the cutter-wheel spindle and is used to drive the internal-grinding spindle, which has a speed of 12,500 r.p.m. Internal holes may be ground either straight or tapered from $\frac{9}{16}$ in. in diameter up, and to any depth to 3¼ inches.

Drill Chuck

The Parker Manufacturing Co., Detroit, Mich., is placing on the market a line of drill chucks, one of which is shown in the illustration. They are being made in six sizes for general drilling purposes and in six sizes for portable drills. As will be noticed, the body is made large,

in order to permit the use of jaws of large diameter and still leave enough metal to prevent liability of the jaw hole or runway breaking through the side.

The jaws are ground all over to insure interchangeability and are tempered in such a manner as to make the gripping surface and the threads hard while the remainder is left soft enough to insure toughness and strength. Milled teeth are used on the ferrule, which is of heat-treated chrome-nickel steel. The split nut is hardened and ground. The pinion locating hole is equipped with a hardened bushing.

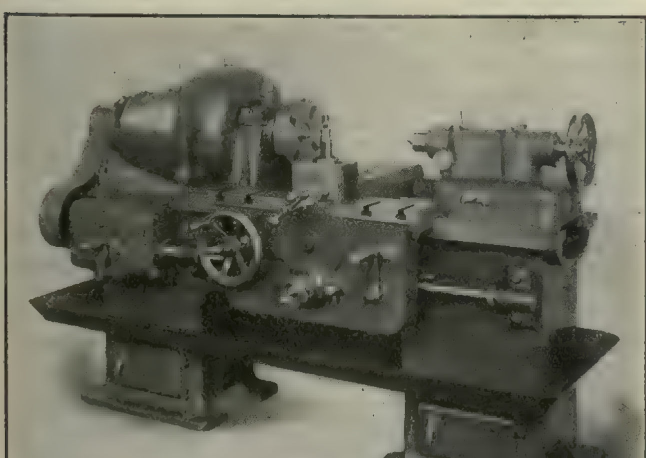


PARKER DRILL CHUCK

Manufacturing Lathe

The illustration shows a 17-in. lathe that has recently been placed upon the market by Wickes Bros., Saginaw, Michigan.

The machine is intended for fast heavy work, but is not equipped with back gears or screw-cutting mechanism. It is of the cabinet-leg type, doors in the legs permitting the storage of tools. A deep oil pan is provided Three feeds are included, and these are operated by the quick-change lever, shown at the front of the headstock. The spindle has ball thrust bearings for taking up the end thrust and is equipped with a clutch. An automatic stop can be provided if desired.



SINGLE-PURPOSE 17-IN. LATHE

Maximum distance between centers, 8-ft. bed, 3 ft. 6 in.; swing over bed, $17\frac{1}{2}$ in.; swing over carriage, $9\frac{7}{8}$ in.; diameter of cone steps, $8\frac{3}{4}$, $11\frac{5}{8}$ and $14\frac{1}{2}$ in.; width of belt, 4 in.; front-spindle bearing, $3\frac{1}{2} \times 6$ in.; rear-spindle bearing, $2\frac{3}{4} \times 4$ in.; spindle-nose diameter, $3\frac{1}{4}$ in.; threads per inch, 4; No. 4 Morse taper centers; diameter of feed shaft, $1\frac{1}{4}$ in.; feeds, 0.02, 0.06 and 0.1 in.; diameter of tailstock spindle, $2\frac{3}{4}$ in.; travel of tailstock spindle, 8 in.; size of tool, $\frac{3}{4} \times 1\frac{1}{2}$ in.; headstock base length, $29\frac{1}{2}$ in.; tailstock base length, 16 in.; carriage length, 30 in.; carriage-bridge width, 9 in.

Munitions Board Appointed by the National Defense Council

The Council of National Defense, on Mar. 21, announced the personnel of the "Munitions Standards Board" that will have as its object the standardization of arms and ammunition to be manufactured in the United States for the use of our Government. The statement issued by the council, with the names of the appointees, is as follows:

To make possible efficient and economical quantity production of arms and ammunition, the Council of National Defense announces the appointment of the following experts to compose a munitions-standards board:

Frank A. Scott, of Warner & Swasey Co., Cleveland, manufacturer of automatic machinery and optical instruments; W. H. Van Dervoort, of Root & Van Dervoort, builder of special machine tools, and president of the Moline Automobile Co.; E. A. Deeds, formerly general manager of the National Cash Register Co., president of the Dayton Engineering Laboratories Co. and interested in many industrial activities; Frank Pratt, of General Electric Co., Schenectady; Samuel Vauclain, of Baldwin Locomotive Works, Remington and Westinghouse companies; John E. Otterson, vice president of Winchester Arms Co.

The board, which met for the first time on Mar. 20 at the office of the Secretary of War, who is chairman of the council, is created by the Army Appropriations act of Aug. 29, 1916, which permits the Council of National Defense to "organize subordinate bodies for its assistance in special investigations."

The present appointees will serve without compensation. They were appointed by Secretary Baker, as chairman of the council, on the nomination of the Advisory Commission, through its Committee on Munitions and Manufacturing, headed by Howard E. Coffin. They are, in a large measure, experts who for the past three years have had intimate knowledge of the production and delivery of munitions of war to foreign governments, and their services, particularly in point of quantity production, will obviously be of great value to the War and Navy Departments.

The appointment of this board will no doubt result in an understanding of limits, finish requirements and the like, which will greatly facilitate the manufacture of these munitions by private shops. It is quite possible also that features of design may be considered from the standpoint of practicability for quantity manufacture.

The Hell Gate Bridge

The Hell Gate Bridge route for through-rail passenger service over the Pennsylvania R.R. and the New York, New Haven & Hartford was dedicated on March 9 by a special train containing an inspection party representing both railroads. This route connects via the New York Connecting R.R. with the New York, New Haven & Hartford R.R. east of New York, goes over the Hell Gate Bridge with its 1000-ft. span, over the Long Island R.R., through Long Island City and the East River tubes to the Pennsylvania Station in New York City. This is made possible by the construction of the largest bridge in the world, which cost over $27,000,000 and was designed by Gustav Lindenthal, of the American Bridge Co. The single span of 1000 ft. is supported by a double arch of steel across the East River.

Danger of Oxygen

The attention of the Bureau of Explosives was recently directed to a number of serious explosions of oxygen, but as that bureau is not equipped for investigations of this type the matter was turned over to the Bureau of Mines. The investigations have not yet been completed, but in answer to a recent inquiry George S. Rice, Chief Mining Engineer of the Bureau, said:

It is very true that there have been a large number of explosions in various parts of the country of tanks containing oxygen made by the electrolytic process, due to the presence of hydrogen mixed with oxygen, and the bureau has been making an investigation of this subject.

In general the findings of the bureau are these: That strictly speaking, there is no spontaneous combustion, but in all cases where sufficient data have been obtained the oxygen has been used in conjunction with a torch for welding or cutting, and the flame has flashed back through the mixture. It is possible that ignition may occur by a jet of oxygen playing on a carbonaceous material under certain special conditions; nevertheless, these conditions are most unusual, as in many experimental tests made by the bureau the jet could not be so arranged as to cause ignition, although there was a rise of temperature at a certain point and cooling due to expansion at a point beyond.

In all cases, however, the real danger is in the hydrogen getting into the oxygen, and it has been found that this is due to improper design in the manufacturing apparatus—that is, the cells and electrical connections; to insufficient safeguards connected with the electric apparatus, the polarity suddenly and unexpectedly shifting; to the manufacture of oxygen without frequent analyses; and to incompetent or ignorant attendants.

Unfortunately, certain makers of oxygen-manufacturing apparatus have advertised that any laborer can take care of their apparatus. It is believed that the manufacture of electrolytic oxygen can be carried on in a manner to make it entirely safe. In fact, there has to be over 9 per cent. of hydrogen with the oxygen to make an explosive mixture. Nevertheless, certain tanks from one batch caused three widely separated explosions in California, killing seven men in all, and an analysis of gas from a tank filled at the same time showed that it contained over 50 per cent. of hydrogen.

New Publications

Industrial Arithmetic—By Nelson L. Roray. One hundred and fifty-three $4\frac{3}{4}$ x $7\frac{1}{4}$-in. pages; 85 illustrations; cloth bound. Published by P. Blakiston's Son & Co., Philadelphia. Price, 75c.

This is another of the recent attempts to put together an arithmetic that will assist the learner to a better comprehension of the value of a knowledge of arithmetic and at the same time afford him a path of entrance to industry. It is, however, subject to many of the same criticisms as apply to most of these efforts. It offers a very considerable proportion of entirely abstract problems, which in no way have any visible contact with industry, and its industrial problems are often stated in terms that do not obtain in the industries. For example: "If the rent of $5\frac{3}{16}$ acres of land is $\$21\frac{3}{8}$, what will be the rent of $19\frac{5}{16}$ acres at the same rate?" This is an extremely improbable problem, apparently made up in a struggle to find application for common fractions. Another problem starts out with a grinding wheel running at 500 surface feet per minute and requiring the speed of a motor to drive it; the resulting answer comes out 100 r.p.m.

When there are so many problems coming up for solution in our shops and drafting rooms every day, it seems too bad that more of actual value and use could not have been incorporated in this book. Outside the actual selection of problems, the presentation is clear and logical and the subjects are treated in a way to make the learner's path as easy as is for his good.

The Use of the Slide Rule—By Allan R. Cullimore. Thirty-six 6 x 9-in. pages; 9 diagrams; cloth bound. Published by Keuffel & Esser Co., New York. Price, 50c

This is a refreshing variation from the usual manual for the use of the slide rule. It demonstrates the degree of accuracy of slide-rule results in a manner that should check the tendency of engineering undergraduates to term it a "guessing stick."

The author takes up each of the uses of the rule and shows the way in which that use is developed. Empirical rules are not employed.

A considerable number of problems, with their answers, are given. They are taken from problems in mechanics and hydraulics or else are abstract problems involving the use of the same principles.

Predetermination of Prices—By Frederic A. Parkhurst. Ninety 6 x 9-in. pages; 30 illustrations; cloth bound. Published by John Wiley & Sons, Inc. Price, $1.25.

A better title for this book would have been the "Estimating of Costs," as borne out by the first sentence in the author's preface, "I have attempted in the following pages to present an argument on the possibilities of predetermining true costs"

Possibly the greatest value of the book lies in the arguments brought out in the first chapter on the importance of absolute control of all sources of information. The author breaks away from traditional practice in favor of conducting business in full coöperation with the cost department rather than leaving the cost finding as an afterthought and as something that drags weeks or months after production.

The system explained in this book is a definite one for a given type of manufacture, and the forms shown are taken from the practice of two shops only. If there is a criticism to be made, it is that the lack of broad analysis of the work makes it hard for others to apply the underlying principles to their own business without expert assistance.

The system described is complete, from the purchase of raw materials, and even the hiring of help, through to the completed article sold, delivered and paid for.

In spite of the fact that the underlying principles are not brought to the surface, the book is well worth study; not merely by the cost keeper, but by everyone who has any part in production, sales accounting and even with the personnel of the organization.

Elementary Mathematics for Engineers—By Ernest H. Sprague. Two hundred and forty-four $4\frac{1}{2}$ x 7-in. pages; 101 diagrams. Published by Scott, Greenwood & Son, London.

The purpose of this book, as stated in the preface and fully borne out by the contents, is to enable a man who desires to acquaint himself with mathematics as used in engineering work to do so without wading through the customary textbooks. For those who have the time and the mental makeup to study mathematics for mathematics' sake, there is an abundance of good works in which he can browse to his heart's content. This book, however, contains the portions of this deeper work which have so far been applied to engineering problems.

The following subjects are treated: Arithmetic, with special reference to approximations and limits of accuracy essential; Algebra, founded on the assumption that the reader is familiar with the solution of simple simultaneous equations; Plane Trigonometry, or the solution of plane triangles; Mensuration, based largely on the work of the civil engineer; Spherical Trigonometry, which, however, is written so far removed from the rest of the work that it can be omitted by the mechanical engineer who does not feel the need of it; Algebraic Geometry, or the relation between plotted curves and their corresponding equations; Calculus, handled in such a way as to remove most of the frightfulness of the college textbooks.

The book is not elementary enough so that it can be picked up and mastered by anyone without some acquaintance with mathematics, but for the engineering graduate whose mathematics has grown rusty it is excellent as a means of refreshing his memory.

Export Trade Directory—Compiled by Olney Hough, Editor of the "American Exporter." Five hundred and thirty-seven $5\frac{3}{4}$ x $8\frac{3}{4}$-in. pages; cloth bound; 5th edition. Published by the "American Exporter," New York City.

This book is an indispensable reference book for American manufacturers whose aim is toward the intensive cultivation of foreign markets. Part 1 of this reference book lists the export merchants in the United States, giving their address, date of establishment, cable address, code, the foreign market in which they trade, and their exports and imports. The trade rating is provided wherever possible, which indicates the volume of trade of the firm. Part 2 lists manufacturers' export agents, managers of export departments and export brokers, stating the address, date of establishment, telephone and cable address, codes, agencies and specialties. Part 3 lists the leading bankers engaged in foreign exchange business. Part 4 is a list of the foreign exchange brokers in New York City, and Part 5 lists the marine insurance companies, also in New York. Part 6 contains a list of the foreign freight forwarders in the principal cities. Part 7 is the export trucking companies of New York. Part 8 deals in steamship services to foreign ports, or principal seaports. Part 9 contains a compendium of how to ship to foreign markets. Part 10 lists the consuls of foreign countries in the United States, Part 11 the United States consuls in foreign countries and Part 12 the associations for the promotion of export trade. There is also a classification of export merchants arranged according to the principal goods shipped. Altogether, this book is indispensable to anyone who wishes to systematically and scientifically cultivate his export trade.

Personals

W. A. Rosenberger, of the Pangborn Corporation, has resigned from the company and will sail for Europe.

H. E. Brunner is in charge of the new New York office of the Hess-Bright Manufacturing Co. and will be assisted by **H. A. Fonda**. The new Cleveland office is in charge of **R. E. Clingan**, who is assisted by **W. Rippien** and **M. S. McNay**.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. J. H. Warder, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

Machining an Aeroplane Motor Crank Case

By Fred F. Bowen

SYNOPSIS—Some detailed operations and the time required for performing them by regular machine-shop methods. These show how airplane motors can be successfully handled in moderate-sized lots in any well-equipped shop.

The Thomas airplane motor is an eight-cylinder V-type, requiring accurate machining on the crank case in order to have the cylinders, crankshafts and valve mechanism line up properly. The operations are given in detail.

The first operation on the crank case is to mill the joint face, bearing-cap seats and support arms in the fixture shown in Fig. 1. We have cast-iron plates that we use for locating the gear case and propeller ends. These plates have all the important dimensions machined on them the same as the drawing and also two hardened and ground pins *A*, which are used to locate the case squarely in the V-blocks shown. These V-blocks have two machine-steel flat bars *B* on each side, pivoted on the adjusting screws *C*. The case is clamped to the fixture through the cylinder holes. The milling cutter is $2\frac{1}{4}$ in. in diameter and runs 125 ft. per min. The feed is $^3/_{64}$ in. per revolution. This makes the operation time 1 hr. 45 min. from floor to floor.

The second operation mills the cylinder faces (see Fig. 2) the case being located on 45-deg. angle blocks. The bearing-cap seat locates on *A* and *B*, Fig. 3. Measurement is made with depth micrometers to the hardened pin *C*. The case is clamped to the fixture by the four slotted clamps *D*. The milling cutter is 10 in. in diameter and runs 85 ft. per min. The feed is $\frac{3}{16}$ in. per revolution. Time, 30 min. per case.

Milling the gear-case end and the propeller ends on a Lucas horizontal boring mill constitutes the third operation. This fixture, shown in Fig. 4, is tongued to the machine. The gage points fit in the bearing-cap seats *A* and *B*. Hardened blocks on both ends of the fixture (*C* and *D*) are used to set the cutter with the aid of special size blocks. The case is clamped to the fixture by the four slotted clamps *E*. The milling cutter is 10 in. in diameter and runs 80 ft. per min. The feed is $\frac{1}{16}$ in. per revolution. Time, 15 min. per case.

The fourth operation is to drill and tap the main bearing-cap stud holes in a V-block under the radial drilling machine. The drill jig used is shown in Fig. 5. The jig *B* locates in the main bearing-cap seats and at the end of the case, which has already been finish-milled. Time, 30 min.

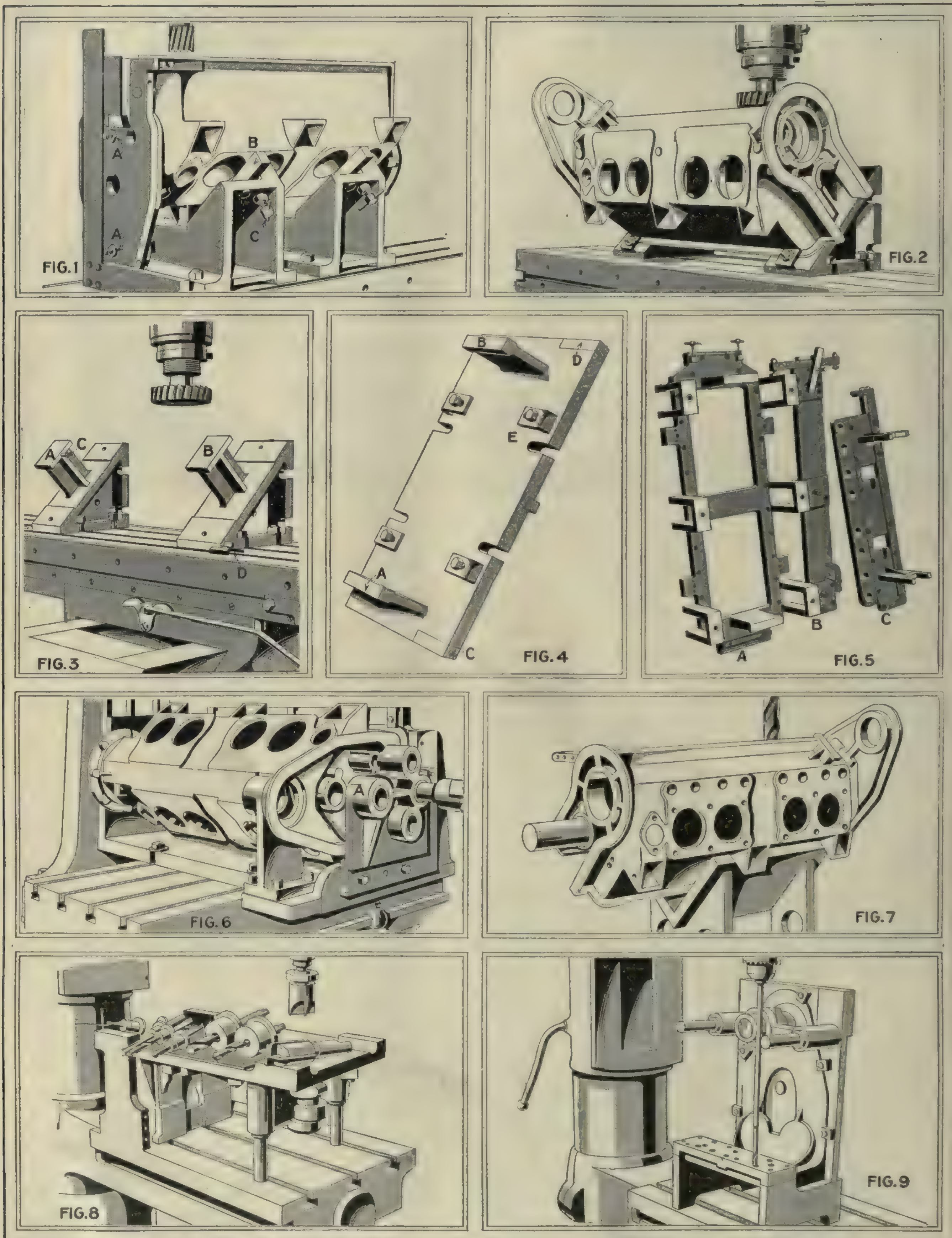
The fifth operation is to drill the joint face and the suspension-arm holes with the case held in a V position. The jig used is shown in Fig. 5. The jig *A* locates from the same points as in the fourth operation. Time, 18 min.

The sixth operation is to stud and assemble the crankshaft bearing caps. This operation is watched very closely by an inspector, to see that the studs are driven in tightly. Time, 35 min.

The seventh operation covers the boring of the crank-, cam- and magneto-shaft holes in a boring jig, as shown in Fig. 6, using a Lucas horizontal boring machine. The case is located in the jig on the width of the machined surface of the bearing caps. It is positioned lengthwise by the machined surface of the gear-case end against the end plate *A*. The boring tools are made of $\frac{1}{2}$-in. diameter drill rod held in bars by No. 4 taper pins. Two sets of tools are used for the magneto-shaft holes—one for roughing, the other tool for finishing. Stop collars are set at the proper depth so that the operator cannot make a mistake. All the holes are bored within a limit of 0.0005 in. The tools are run 65 ft. per min. The feed is 0.012 in. per revolution. Time, 1 hr. 45 min.

The propeller end is bored in the same jig shown in Fig. 6. In this, the eighth operation, the jig is reversed on the machine, or turned end for end. Time, 20 min.

The plunger guide and cylinder stud holes are drilled under a radial drilling machine. The ninth operation is



FIGS. 1 TO 9. FIXTURES AND TOOLS FOR CRANK CASE

Fig. 1—Milling lower face of crank case. Fig. 2—Milling one of the cylinder decks. Fig. 3—Fixture used in milling cylinder decks. Fig. 4—Fixture for milling ends of crank case. Fig. 5—Drilling jigs for drilling and tapping main bearings. Fig. 6—Boring for crank and cam shafts on Lucas machines. Fig. 7—Drilling plunger guide and cylinder stud holes. Fig. 8—Tools and fixtures used in machining gear-case cover. Fig. 9—Drilling magneto dowel holes

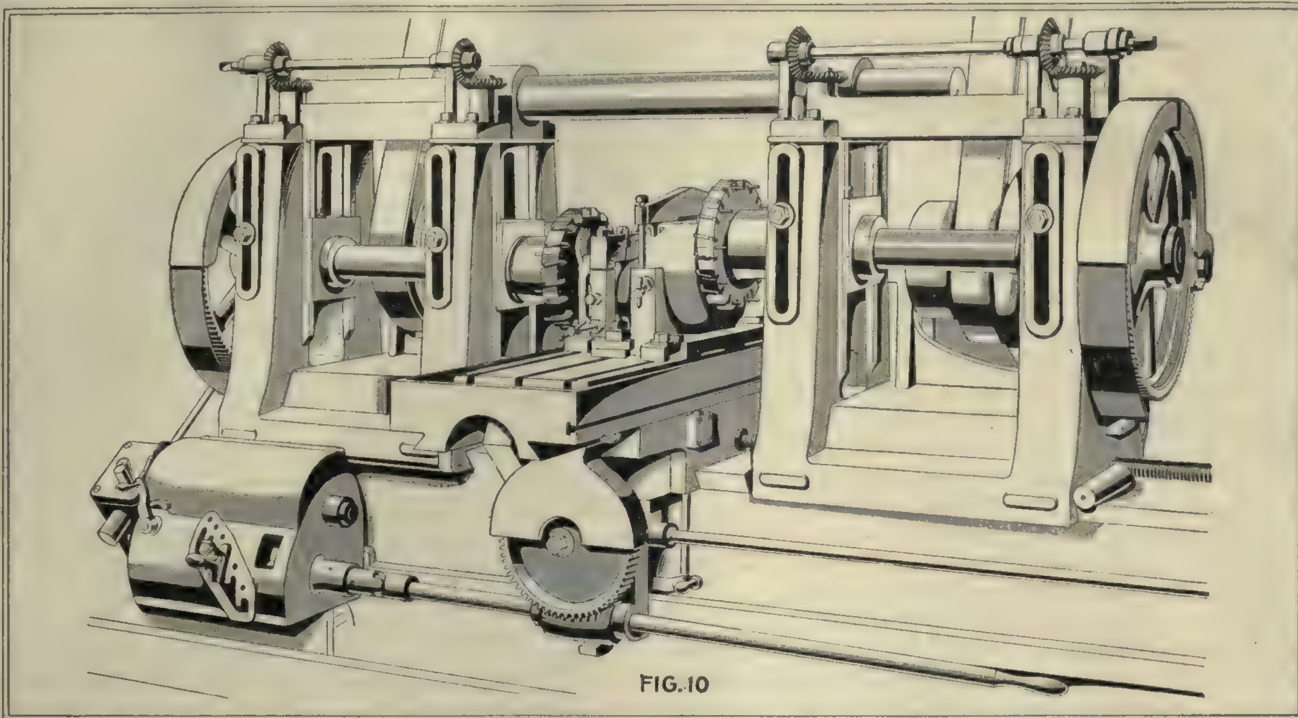


FIG. 10

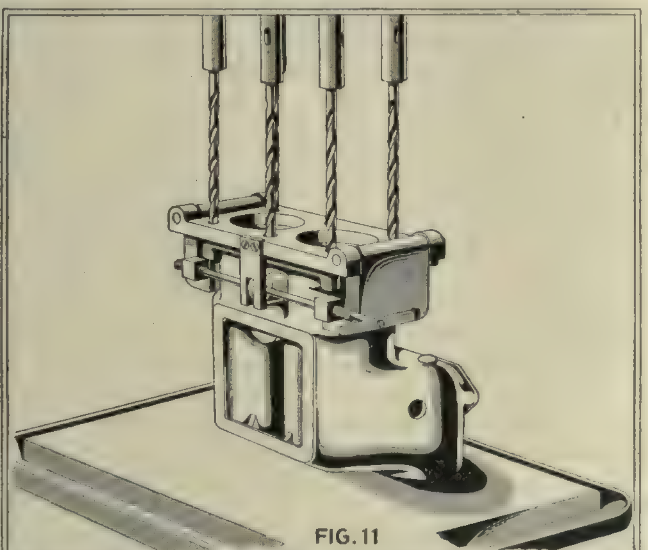


FIG. 11

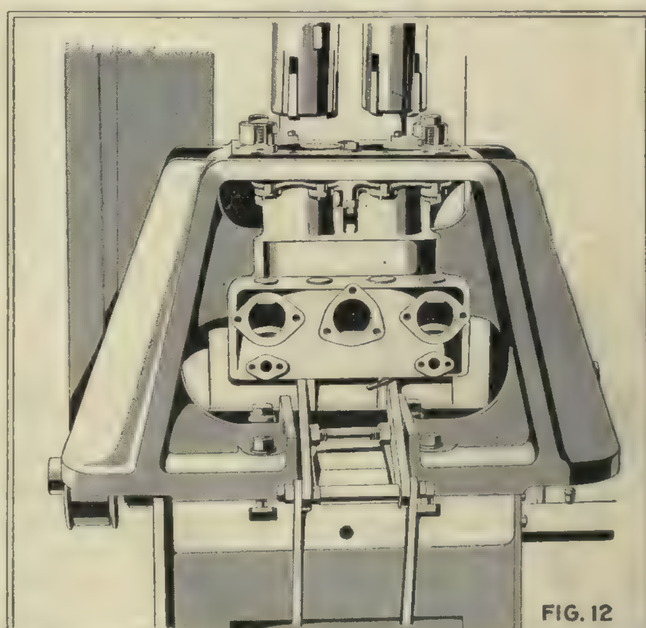


FIG. 12

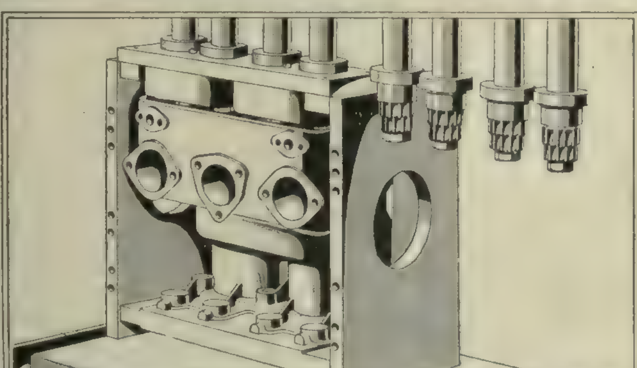


FIG. 13

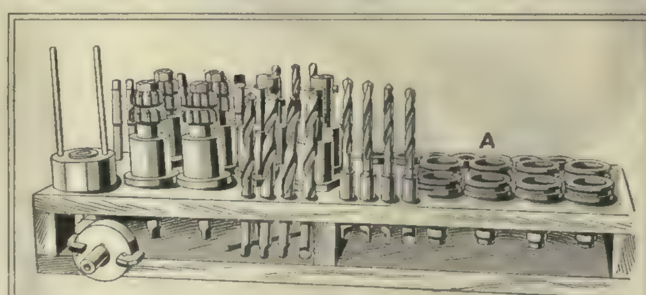


FIG. 14

FIGS. 10 TO 14. MACHINING THE CYLINDER BLOCKS

Fig. 10—Straddle-milling top and bottom of cylinder on Hendey double-head Lincoln miller. Fig. 11—Drilling six stud holes in cylinder base, Bausch multiple-spindle machine. Fig. 12—Boring both cylinders at once on heavy-duty double-spindle drilling machine. Fig. 13—Boring port plugs and valve-seat holes, equipped with double set of tools. Fig. 14—Drills, reamers and bushings used for valve guides

shown in Fig. 7. The jig locates from the propeller end and is centered by two forked registering points located over a ground bar. The box is slipped through crankshaft bearings. Time, 1 hr.

The first machining operation of the gear-case cover is to surface it on a wood buzz planer. Time, 6 min.

The second operation, shown in Fig. 8, includes the boring of the magneto and the joint face holes. This engine has two magnetos mounted on the front part of the cover. Fig. 9 shows the drilling of the magneto dowel and clamp holes. Time, 35 min.

The cylinders are made of semisteel castings. The first operation is to drill and tap two core-plug holes, which takes 15 min. They are then water-tested to 120-lb. pressure, using a plate with $\frac{3}{8}$ in. soft rubber mounted on it, as a gasket to take up the unevenness of the rough casting. The cylinder is held in a hardwood fixture. One screw in top of the fixture holds the plate down and also holds the cylinder in the fixture. This makes all the openings water-tight. We perform this operation to be sure that the castings are O. K. before we put any more labor in them. Time, 10 min.

The third operation is to straddle-mill the top and bottom, as shown in Fig. 10, on a Hendey double-headed Lincoln miller. The milling cutters are 10 in. in diameter and run 40 ft. per min. Feed, $\frac{1}{16}$-in. per revolution. Time 20 min.

The fourth operation is to drill the six stud holes in the base of the cylinder with a Baush multiple-spindle drilling machine. A jig with V-jaws locates the cylinders and is operated with one right- and one left-hand screw, as shown in Fig. 11. All the other operations are located from these six drilled holes. Time, 3 min.

The fifth operation is another straddle-milling job. This mills the front end and the back with a 3-deg. plate on a Hendey double-spindle slab mill. The cutters are 8 in. in diameter and run 40 ft. per min. Feed, $\frac{1}{16}$ in. per revolution. Time, 20 min.

Rough-Boring Cylinders

Next comes the sixth operation, rough-boring the two piston holes (see Fig. 12). This machine will bore a pair of cylinders every 9 min. We leave $\frac{3}{32}$ in. of stock for finish-bore. Between this operation and the finishing operation the castings are allowed to season for 10 days. Then they are bored 3.985 in., leaving 0.015 in. for grinding stock. The cutters run 35 ft. per min. and the feed is $\frac{1}{16}$ in. per revolution.

The seventh operation bores the port plugs and the valve-seat holes on an eight-spindle drilling machine, Fig. 13. We first rough-bore and then shift jig over to the next four spindles and finish-bore. Time, 12 min.

The eighth operation drills and reams the valve guide holes on an eight-spindle multiple drilling machine, using a 3-deg. plate. The valves and the port plug holes are machined at a 3-deg. angle. The drills and reamers, with their bushings *A*, are shown in Fig. 14. These bushings slip into the reamed port plug holes. Time, 10 min.

The next operation, the ninth, is to drill the manifold stud holes, using an angle jig locating in the valve guide holes. Time, 3 min.

Tapping the manifold stud holes under a special tapping head, the tenth operation, takes 6 min.

In the eleventh operation the cylinders are given a final water test to make sure that no leak has developed since the machining. Time, 8 min.

For the twelfth operation the cylinders are ground to size on a Heald cylinder grinder. Time, 30 min.

In the final operation, the thirteenth, the cylinders are taken to the polishing room, where they are scraped, bushed and polished, then nickelplated with a dull nickel finish. Time allowed, 12 hr.

Garage Equipment

By O. D. Carter

In the inquiry concerning the machinery for garage equipment, Mr. Fama starts a long train of thought with a few words. From his geographical location one might be led to think of cars of many makes and from various countries, mostly at a distance and in most instances represented by agencies without a sufficient stock of repairs.

In such a case the expense necessary to put the car back into service in a short time would be negligible compared with the delay for stock repairs. With the factory competition thus eliminated, an able machinist with general experience can greatly curtail his equipment outlay and yet do considerable work of good quality.

The following machine tools would constitute an ideal equipment for a beginning: One 14-in. by 8-ft. lathe, equipped with one large 4-jaw independent chuck, one 3-jaw 12-in. universal chuck and one 3-jaw 6-in. universal chuck for light work, used for work from magneto and carburetor repairs to axles and pistons. One 20-in. by 16-ft. lathe with one large 4-jaw independent chuck and a 14-in. 3-jaw universal chuck. This lathe will swing almost any automobile part, including the assembled rear axle minus the wheels. It can be fitted with external grinder for crankshafts, pistons, etc., and internal grinder for cylinders; or a turret for quantity work may be mounted.

A tool grinder for cutters, reamers, pistons, pins and small surface work is essential. A No. 2 universal miller will machine axles, transmission shafts, gears of all descriptions and silent-chain sprockets, and it may be used as a roughing machine for the lathes in an emergency. Its equipment should consist of the vertical head and a few end mills, a set of Woodruff cutters, slitting saws from $\frac{1}{16}$ in. to $\frac{3}{8}$ in., an assortment of side mills up to 8 in. in diameter, a few slab mills, also gear cutters between 2 and 16 diametral pitch. A small drilling machine that can drive a $\frac{5}{8}$-in. drill and the smaller sizes to $\frac{1}{32}$ in., and a large machine with about 36-in. swing and capable of pulling a 2-in. drill will do.

The addition of a shaper would be appreciated. A useful tool is a screw press of about 50 tons' capacity. It is reliable, always ready and requires no regular operator. A small casehardening furnace must be included if results are successful, and do not forget the forge and anvil. Most shops would be lost now without the oxyacetylene-welding outfit. Remember that a torch of large capacity is absolutely necessary, if good results are expected. Hand tools, taps, dies and reamers may be bought in sets to answer most requirements, and a set of expanding reamers up to $1\frac{1}{2}$ in. would be valuable. The inserted-blade type is to be preferred, since the expansion is greater and the reamer can be brought to size after grinding.

The foregoing list of machine tools will get out great quantities of work and keep all machines equally busy.

Method for Cutting a Large Radius on a Miller

By William C. Roemer

In the course of shop practice, it frequently becomes necessary to cut an arc of a circle on a piece that is comparatively narrow in proportion to the radius of the arc to be cut. The method to be explained applies particularly to cases where the radius to be cut is beyond the capacity of the circle-milling attachment or where the length of the radial cut renders its use impractical.

In a problem of this kind all calculations are based upon the radius and chord of the arc to be cut. In Fig. 1,

R = Radius of arc to be cut:
r = Radius of cutter:
C = Chord of arc to be cut.

In determining the chord of the arc the length should slightly exceed the actual requirement in order to calculate a setting that will produce a curve whose accuracy will extend beyond the work. The diameter of the cutter should be at least one-third greater than the chord of the arc.

For example, let us assume that it is required to cut an arc of 10-in. radius on a piece similar in shape to that shown in Fig. 1, whose width is 1 in. The first step is to determine the chord of the arc. To insure an accurate curve, we will allow 0.1-in. overlap at each end of the arc, which will make the chord 1.2 in. long, the work being 1 in. wide. The diameter of the cutter must be at least one-third greater than the length of this chord; therefore, a cutter 2 in. in diameter will be amply large. We have now found the following values for the dimensions shown in Fig. 1:

$R = 10$ in.;
$r = 1$ in.;
$C = 1.2$ in.

The next step is to calculate the values of A and B by substituting the foregoing values as required by the following formulas:

$$A = r - \tfrac{1}{2}\sqrt{4r^2 - C^2} \qquad (1)$$

$$A = 1 - \tfrac{1}{2}\sqrt{4 \times 1^2 - 1.2^2} = 0.2\ in.$$

$$B = R - \tfrac{1}{2}\sqrt{4R^2 - C^2} \qquad (2)$$

$$B = 10 - \tfrac{1}{2}\sqrt{4 \times 10^2 - 1.2^2} = 0.018\ in.$$

$$Sin\ X = \frac{B}{A} \qquad (3)$$

$$Sin\ X = \frac{0.018}{0.2} = 0.090 = 5\ deg.\ 10\ min.$$

$$Cutting\ angle\ X = 5\ deg.\ 10\ min.$$

The logic of this method is shown by the construction on the diagram, Fig. 1. It will be noticed that the radius R, to be cut, and its chord C fix the height of the segment B. Likewise the radius r of the cutter used in conjunction with the chord determines what portion of the cutter engages the work and fixes the distance A, which represents the height of the cutter segment. The two distances thus established form a right triangle at Y, which is solved to find the required cutting angle. When the cutting angle is known, the required curve can be readily projected as shown on the diagram, Fig. 1.

The curvature of the arc thus generated, being a portion of an ellipse, is not constant. Therefore, the arc is not theoretically a true radius; but for practical purposes this condition is negligible, as the accuracy of the method has been demonstrated on work demanding the utmost precision.

In order to obtain accurate results with the method described above, the cutter used must have a square corner. This necessitates a slow feed in order to avoid scratchy work. If many pieces are to be cut in this way, it is advisable to use a cutter with round corners.

Cutters with Rounded Corners

The foregoing method will not give accurate results when using a cutter with rounded corners, as further calculations are necessary, owing to the fact that the required curve will not be cut by a predetermined point of the cutter, such as a square corner. The cutting point that generates the curve will be that point on the rounded tooth which is tangent to the cutting angle. In other words, the shape of the curve will be determined by the cutting angle, the point of the cutter that touches the work first and the distance from this point to the center of the cutter or the cutting radius. This condition is clearly shown by Fig. 2. The enlarged view of the cutter tooth shows that the shape of the arc to be cut is not determined by the outside cutter diameter, unless the cutter has square corners. The effective cutting radius of a cutter with rounded corners is determined by the

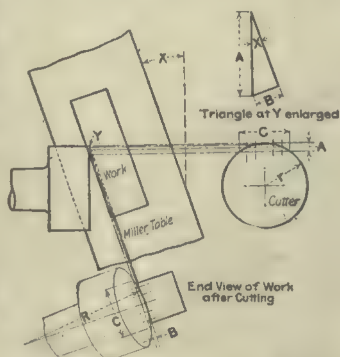


FIG. 1. CONDITIONS WITH SQUARE-CORNERED CUTTERS

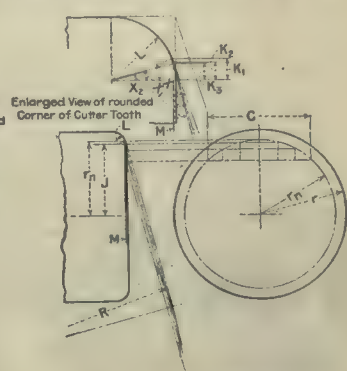


FIG. 2. CONDITIONS WITH ROUND-CORNERED CUTTERS

distance from its axis to the point where the round on the tooth is tangent to the cutting angle. The effective cutting point will move in a path perpendicular to the axis of the cutter, as shown by the line M.

The determination of the effective diameter involves a series of identical computations, the extent of which depends upon the accuracy required. As a basis we use the outside cutter radius minus the radius of the rounded corner, as shown by the distance J. For example, let us assume that we wish to cut a 10-in. radius on a piece 1 in. wide, using a cutter of 2-in. outside diameter with corners rounded with 0.1-in. radius. Radius J will be $1 - 0.1 = 0.9$ in. In making the first computation, we consider the cutter as square cornered. We found the cutting angle for a 10-in. radius to be 5 deg. 10 min., using a 2-in. outside diameter cutter with square corners. It is obvious that the point of tangency will be at the point where the radius of the cutter round forms a right angle with the trial cutting angle; therefore, angles X will be equal, as shown by Fig. 2. This angle can be solved for the distance K_1, which equals 0.009 in. This distance added to the radius J will give the trial effec-

tive radius r_n and equals 0.909 in. This radius has the same cutting value as the outside radius r, Fig. 1; therefore, we use it in the same formula and make another computation for A:

$$A = 0.909 - \tfrac{1}{2}\sqrt{4 \times 0.909^2 - 1.2^2} = 0.2262\ in.$$

$$B = 0.018\ in.\ (same\ as\ before)$$

$$Sin\ X_1 = \frac{B}{A} = 4\ deg.\ 33\ min.\ 49\ sec.$$

Reference to Fig. 2 will show that this result is not final, due to the fact that a line drawn at the angle thus found (4 deg. 33 min. 49 sec.) will not be tangent to the cutter-tooth radius at the same point as the previous angle (5 deg. 10 min.), upon which the trial effective radius was based, used for computing the former angle (4 deg. 33 min. 49 sec.). For this reason the radius is called a trial radius and the cutting angle a trial cutting angle. It is called the effective radius because it is the point of the cutter that determines the shape of the cut. We again calculate the distance K_1, Fig. 2, basing our calculation upon the last trial cutting angle (X = 4 deg. 33 min. 49 sec.). This gives a value of 0.0079 in. for K_2. The second trial effective radius r_n will then be 0.9 + 0.0079 = 0.9079 in. This value is used to find the third trial cutting angle:

$$A = 0.9079 - \tfrac{1}{2}\sqrt{4 \times 0.9079^2 - 1.2^2} = 0.2266\ in.$$

$$B = 0.018\ (same\ as\ before)$$

$$Sin\ X_2 = \frac{B}{A} = 4\ deg.\ 33\ min.\ 20\ sec.$$

As it serves no useful purpose to carry the trial effective radius beyond four decimal places, it is apparent that the next trial effective radius will be practically the same, because the distance K will correspond to the similar distance used in the last computation when carried out four decimal places (0.9 + 0.9079 = 0.9079). Therefore, the cutting angle will be 4 deg. 33 min. 20 sec.

From the preceding computations it will be noticed that the value of B, which is fixed by the radius R to be cut, does not change; also, that the error is always less than the difference between the results of the last two computations. The latter point shows that it is useless to carry the process beyond a degree of accuracy warranted by the facilities provided on the machine for obtaining the required adjustment. Therefore, if two successive computations give the same result in degrees and minutes, the error will be less than a minute and the angle thus found will be more accurate than the setting obtainable by the graduations on a miller.

Summing up the method employed for finding the cutting angle when a cutter with rounded teeth is used, we obtain the following formulas, the various values being shown on Fig. 2:

L = Radius of cutter tooth;
r = Outside radius of cutter;
R = Radius to be cut;
C = Chord of arc to be cut.

The first trial cutting angle is established by considering the cutter as square cornered and proceeding in accordance with formulas (1), (2) and (3). This calculation will give the first value of X.

$$K = L\ sin\ X \quad (4)$$

$$J = r - L \text{ (outside radius of cutter less radius of round corner on tooth)} \quad (5)$$

$$r_n = J + L\ sin\ X \text{ or } J + K \text{ (trial effective radius)} \quad (6)$$

$$A = r_n - \tfrac{1}{2}\sqrt{4r_n^2 - C^2} \quad (7)$$

$$B = R - \tfrac{1}{2}\sqrt{4R^2 - C^2} \text{ (same as with square-cornered cutter)} \quad (2)$$

$$Sin\ of\ X \text{ (trial cutting angle)} = \frac{B}{A} \quad (3)$$

Repeat the operations called for by formulas (6), (7), (2) and (3), using the last-found value for the sin of X to determine the new trial effective radius r_n, until the difference between two successive results is less than the allowable error. Accurate work generally requires not more than four computations. The outside diameter of the cutter must be at least one-third greater than the chord C plus twice the radius of the round corner.

Hardening High-Speed Steel Tools

By F. H. Korff

In answer to the question on page 126, relative to the hardening of high-speed-steel circular forming tools with delicate edges, I submit the following process for obtaining cutters which when hardened will be hard, but not brittle, and retain a long cutting life. The method has been in successful use for a number of years.

The equipment consists of two furnaces with pyrometers attached; a pot of cyanide large enough to hold the tool; an oil quenching bath, without mixing air jet, and a water quenching bath, with mixing air jet. Clean the cutter thoroughly of all grease and foreign substances and place in the furnace.

When lighting the furnace, gradually advance the heat until it reaches 1000 deg. F. The heating must not be forced, but kept at a slow, gradual increase. When the above temperature has been reached, do not allow the furnace to get any hotter, but hold it to that temperature for 15 min.: then shut off the gas, allowing the furnace to become cold, leaving the cutter inside the furnace.

This preheating is for the purpose of eliminating all stress or strain that the steel in the cutter might have been subject to. When the furnace has become cold, place the pot of cyanide in furnace number two and bring to a heat of 1500 deg. F.

While the second furnace, containing the cyanide, is warming up, start the first furnace, containing the cutter, and bring it to a heat of 1400 deg. F. Having reached this temperature, hold it for about 5 min.; then gradually drop back to 1200 deg. F., holding this temperature for 10 min.; advance to 1500 deg. F. and hold for 5 min.

When you are sure that the cyanide is heated to 1500 deg. F., withdraw the cutter and immerse it in the cyanide, then place the pot of cyanide, containing the cutter, back into the furnace and heat to 2200 deg. F., holding the heat, when obtained, for 10 min. Remove the cutter from the cyanide and plunge it into the oil bath.

The most difficult part of the entire process has now been reached. With a stick of solder, test the heat of the cutter until the heat contained therein is barely enough to melt the solder. When this point has been reached, plunge the cutter into the water bath and leave it there until thoroughly cold.

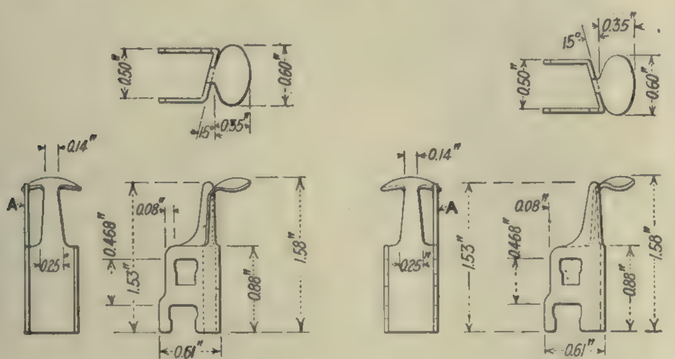
The cyanide heating bath is used to prevent the fine cutting edges from becoming brittle or subject to internal strains, and to eliminate scalding.

Press Tools for Manufacturing a Margin Stop

By Frank A. Stanley

SYNOPSIS—These tools comprise the combination blanking and piercing dies for producing the margin stop and piercing a hole in one side of the blank, after which the work is bent to a channel form and the third operation follows. It consists in nesting the work by the holes already pierced and punching a second pair of openings directly opposite in the other wing of the stop. This is accomplished by slipping the work over the punch, which serves to close a swinging stripper on the downstroke of the press, the stripper being opened automatically upon the upstroke to allow the work to be removed.

The margin stop on the Noiseless typewriter is made in the form illustrated in Figs. 1 and 2, which show both the right- and the left-hand stop. It will be seen from the drawing that this piece is of sheet metal formed up to box shape with a clip at the top, by which it may be lifted and moved along readily from one notch to another in the stop bar. These pieces have an opposite working side for the right- and the left-hand stop respectively and for the projecting lugs at *A*, which constitute the stop proper and which engage the corresponding member on the carriage, thus determining the length of travel of the carriage in either direction. The material for these stops is sheet steel 0.040 in. thick, and the size of the blank punched out prior to bending is approximately 2 in. wide by 2¼ in. long.



FIGS. 1 AND 2. THE TWO MARGIN STOPS

The first operation in the punch press is performed with the tools shown in Fig. 3, illustrating the proportions of the punch and die with which the notches at the top and the bottom of the stops are cut out, and a rectangular hole is pierced near one edge. These openings are plainly seen in the blanks at the front of the strip of stock lying near the die.

Blanking Die Arranged To Save Stock

It will be noticed upon examination of this scrap metal that the stock is passed through the die twice, it being reversed for the second trip, so that the blank, which is considerably narrower at the top than at the bottom, is shown reversed on the second passage of the material through the die and points the other way from its position in the first operation. This means that very little material is wasted between adjoining blanks, as compared with the waste that would be made if the material was sent through only once. With the broad faces of the blank brought close together instead of leaving them far enough apart so that the narrow top fits in between on the second movement of the stock through the tools, much stock would be lost.

Fig. 3, in conjunction with Fig. 4, shows the construction of these tools clearly. The strip of metal feeding first under the punches, Fig. 4, is notched by the irregular-outline punch *D* and pierced by the square punch *E*. It then advances under the blanking punch *F*, where the end of the stock is stopped by the spring stop pin, distinctly shown in the drawing. At the next stroke of the press the blanking punch cuts out the blank, the pins in the punch locating the stock accurately so that the blanking is done in correct position relatively to the openings cut by the piercing punch. Following, each downstroke of the press finishes the blank.

FIG. 3. PROPORTIONS OF THE PUNCH AND DIE

After the strip has been passed through once, it is reversed and then fed against another set of stops so that the blank stock between the openings punched out in its original passage through the tool is pierced and a second row of blanks cut out. This is indicated by the dotted lines in the plan view, Fig. 4, which shows the way in which the stock stops against the spring plug in its second travel through the press.

The bending, or forming, tools are seen in position in the press in Fig. 5. They consist of a simple punch and a die with a gap of the right width to bend up

the ears on opposite sides of the punch blank and a suitable nesting pin over which the blank is located properly before the punch descends. The die carries a

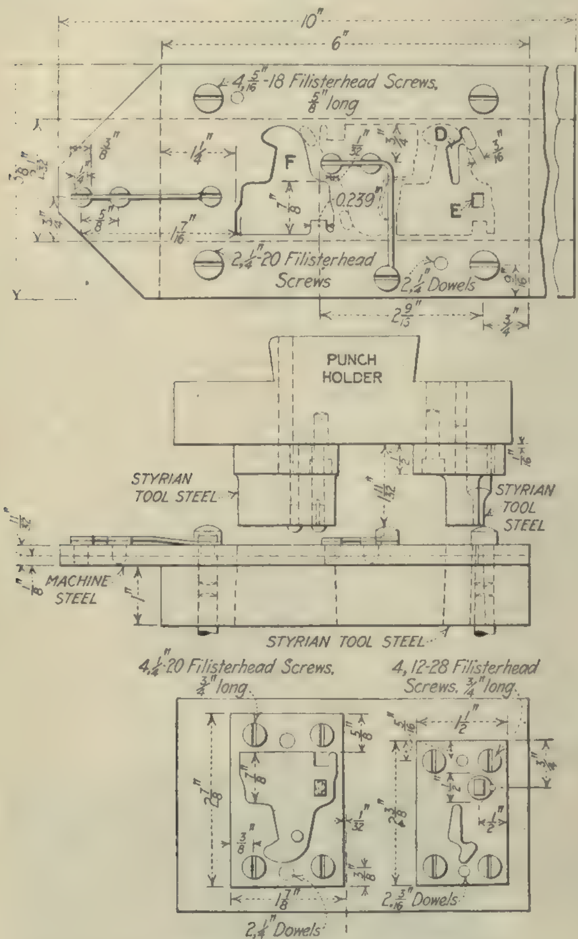


FIG. 4. PIERCING AND BLANKING DIE

shedder that is forced down against the spring action to allow the blank to be bent up on opposite sides. Upon the upstroke of the press this shedder forces the

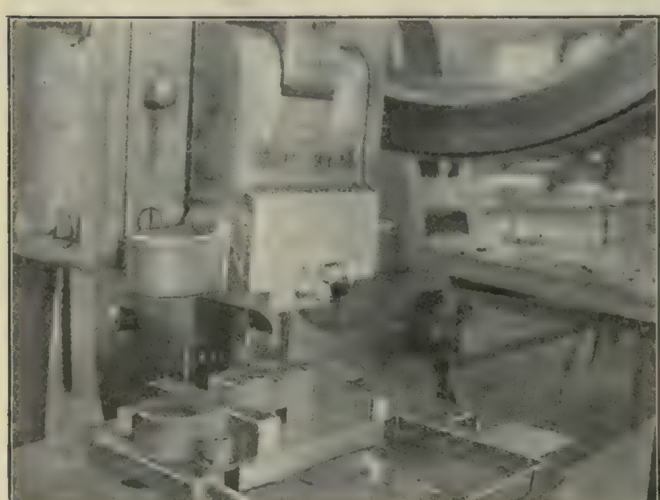


FIG. 5. THE BENDING TOOLS

bent work upward and out of the tool. The margin stops are then ready for the piercing operation performed by the tools illustrated in Figs. 6 and 7.

The press tools for the final piercing are illustrated clearly by Fig. 7, and the construction will be obvious upon examination of Fig. 6. It should be noticed that the purpose of these tools is to pierce the plain side of the blank exactly in line with the hole and notch punched in the opposite side of the blank in the first operation of the tools, as already described.

The method of aligning these holes in the press tools is shown distinctly in Fig. 7. These dies are made right

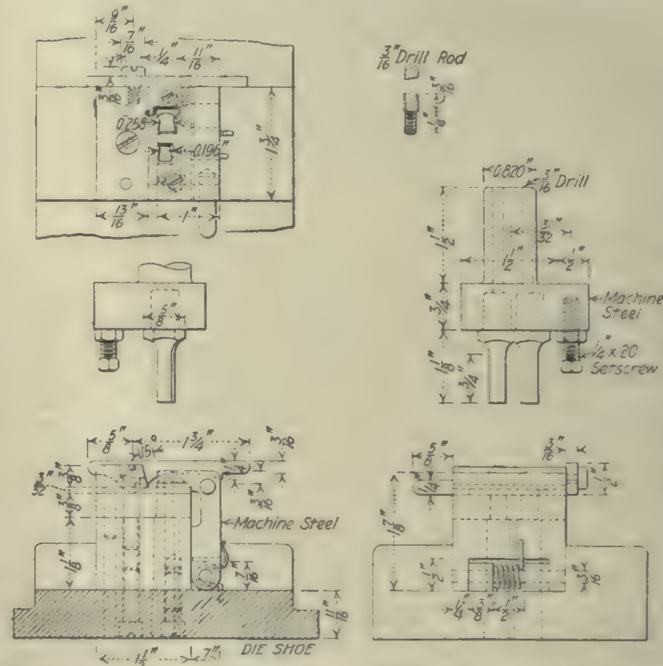


FIG. 6. DETAILS OF PIERCING TOOLS

and left hand, as can be seen, and perform exactly the same work, but on opposite stops. The work is nested on the punch. That is, the bent blank with the holes punched in one side is slipped up over the punch; and when the punch and work descend together, a leaf on the die, which is clearly shown in Fig. 6, snaps shut and, coming between the upper and lower rings on the

FIG. 7. THE PRESS TOOLS

bent blank, is designed to serve as a stripper upon the upstroke of the punch. The tools shown at the right of Fig. 7 represent the punch in its lower position and

show the method of operating this pivoted stripper. The letters on the drawing will enable this operation to be understood.

As the punch comes down, it strikes the leaf on the stripper, which is swung into place between the two wings of the bent blank. In this position the leaf is locked shut by a beveled-end spring plunger lying horizontally, which snaps outside of the vertical lever on the side and slides along up this upright when the punch ascends.

This arrangement of locking mechanism and releasing device for the stripper is illustrated in Fig. 7, where the horizontal spring plunger can be seen at A, while the lever against which it acts and rests during its upper stroke is at B, which is slightly modified from the construction details shown in Fig. 6, although in principle remaining the same. When the punch has reached the top of its stroke, the spring plunger is out of contact with the lever. The latter then swings outward, allowing the stripper to fly open so as completely to clear the work, which is then removed from the die and another part put in place for piercing. This arrangement forms a safety device for the die and punch; for if the stripper were to swing open during contact of the punch, the latter or some part of the die might be broken.

Steam Hammer Swage Holder

By J. V. Hunter*

With the price of steel climbing upward until now mild steel bars cost something like 3½c. or more a pound delivered, one almost gets a feeling of discouragement when reading the monthly cost sheets. Every single pound of steel that has been wasted in excess stock at this price begins to loom up pretty big.

It was only the other day that I saw the advertisement of a tool for which the maker made the claim that it could remove something like 1200 lb. of stock in 10 hours. That is about $42 worth of good material going into the waste bin. Perhaps the maker of the forgings could not work any closer to size. On the other hand, perhaps he might have; then the same lathe tool could have traveled just as far in the course of the day without putting such an expensive pile of turnings into the scrap bin.

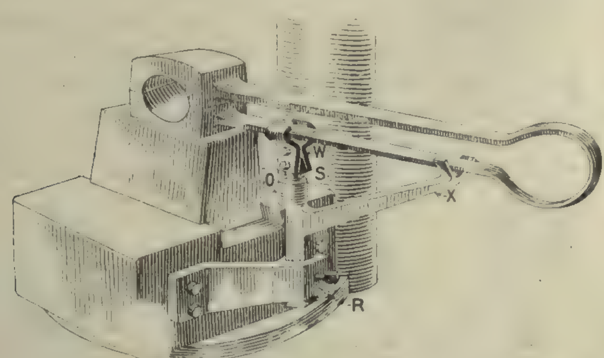
That is the way we looked at it in getting out a lot of car axles. By arranging to work the forging much closer to the finished size, we were able to save just 6 in. in length on a 6-in. square axle billet. On a few hundred billets you will find that the amount saved is considerable.

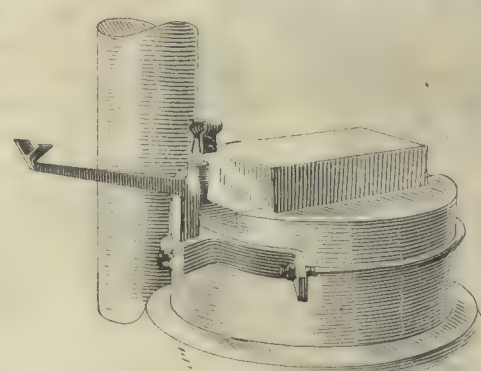
Previously the forgings had always been worked out between the flat dies of a 2500-lb. steam hammer, which was the largest hammer in the shop. The dies on a hammer of this size are too small to hold more than one swaging pass for a 5-in. axle. The center of the axles was considerably smaller, about 4¼ in., or less, so that by drawing the forging down smaller at this point, and forging all of it more truly round than was possible by flat die forging, we could work to closer limits.

To meet this condition the master forge shop foreman made a suggestion based on an earlier experience of his own. "One day," he said, "when there were only two of us in the shop where I was working, I asked for an extra helper to hold the swage under the hammer. The shop superintendent would not give me one, so I made up an 'extra man' in the shape of a steel forging." He made a sketch of the rigging he had in mind and from this sketch it only took a few hours to get out the working drawings to make up a similar arrangement for handling the axles.

This "extra man" not only held the swages for that lot of axles, but for dozens of other jobs as well; and similar rigs have since been put on every power hammer in the place, holding swages that no human arms could hold. Using a swage with this holder under an ordinary steam hammer has made it possible to do work that might almost be considered as belonging to the drop-hammer field. There must be many shops without a drop-hammer that would occasionally care to work out a small job in this manner.

The device in its arrangement is somewhat similar to a man holding a spring swage and is shown attached to the original hammer in Fig. 1. A main forged part X extends out to the side and terminates in a V-shaped prong, in which the outer end of the spring swage rests of its own weight. Never attempt a more secure fastening at this point; it is not only unnecessary, but the vibration would cause a breakdown at some other place.





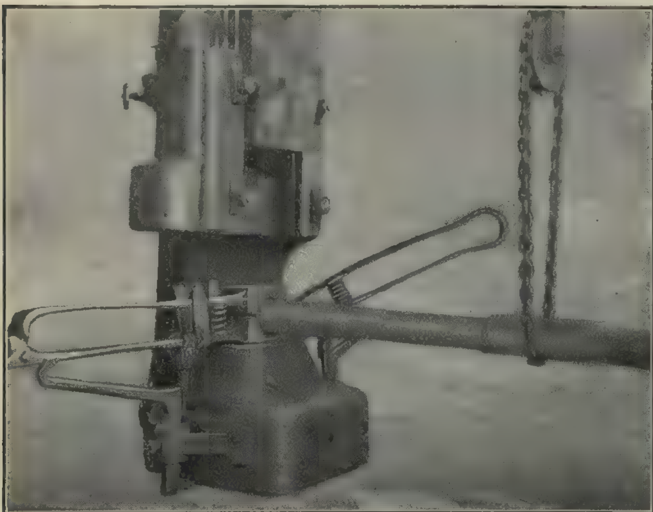
FIGS. 1 AND 2. TWO SWAGE HOLDERS

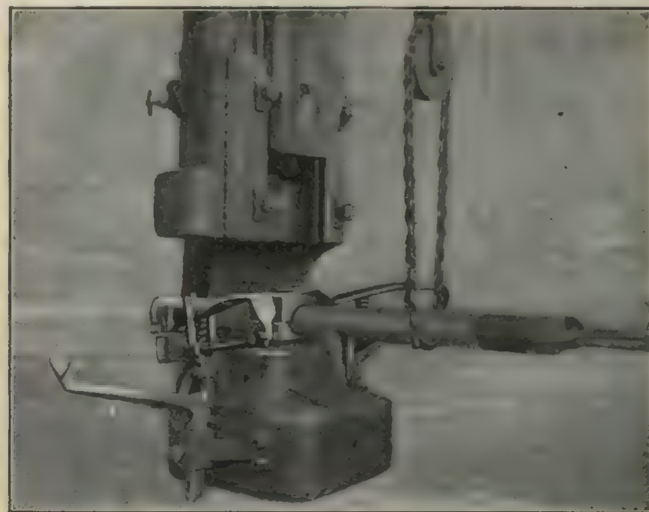
The swage is also held by the bolted clamp at W; this holds the spring handle securely, but as will be noticed from the position of the bolts the swage itself can be moved in a vertical direction as well as be swung about on the swivel stud S, which is the lower part of W. This stud S passes through a hole that has been drilled through the lug which is a part of the butt end of the arm X. Its bearing in this hole should be at least 3 in., because it must take up all the side thrust that comes upon the swage. It is not to be anchored in this hole in any man-

*Minneapolis, Minn.

ner, because the stud slips up and down when the swage is swung on and off the hammer dies. The lower portion of X terminates in an arm of rectangular section, arranged to fit in an adjustable slot in the cast-steel bracket R.

This bracket can be either a steel casting or a forging. I presume that many shops would prefer to forge this out for themselves when making the rest of the device. In the case of this hammer it will be noticed that provision was made for bolting it to the base block of the die.





FIGS. 3 AND 4. THE SWAGE HOLDERS IN USE

In Fig. 2 will be seen a variation of the bracket referred to. It is simpler to produce as a forging and is easier to attach to die base blocks of cylindrical shape, as it avoids the necessity of trying to fit the feet of a bracket to a rough casting.

It has been our usual practice to fit two of these brackets to each hammer on opposite sides of the die, the hammer smith working from the front. As soon as the forging has been worked through the swage of one size it is removed, and the other swage is swung into position from the opposite side. To remove a swage from under the hammer the operator lifts the outer, or spring, end sufficiently to clear the prongs, moving it slightly to one side. This permits the clamp W, Fig. 1, to bear on the lug O Throwing his weight on the outer end, the operator secures sufficient leverage to lift the swage clear of the dies and swings it off to let it fall on the base block until it is again needed.

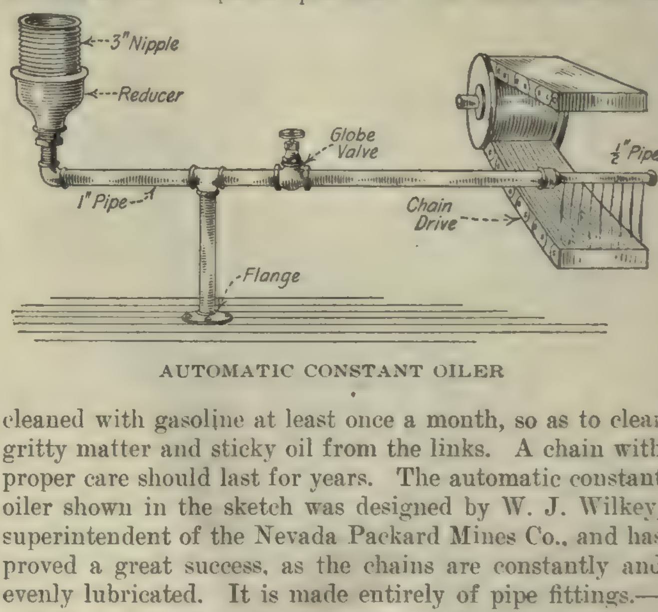
Since the large and small dies vary somewhat in height, an adjusting setscrew is provided where X passes through the bracket R, so that the arm may be set up or down as required.

In Figs. 3 and 4 is shown the actual application of these swage holders to an axle-forging job, the one to the left being used for the larger diameter on the ends of the axle, followed by the right-hand swage for the smaller inside diameter. In connection with these swages there are several points of interest that have facilitated operation on heavy forging work. One of these is the rough guides that are bolted to the spring arm of the lower half. Though loose-fitting, these are yet sufficient to guide the upper half and hold it correctly in line over the lower.

A second point in the swage construction is the placing of a coil spring between the arms, directly back of the swage halves. This increases the power of an ordinary spring arm, which otherwise would not have enough strength to raise the upper half of a heavy die with this length of arm. This spring also acts for a very quick opening, permitting the turning of the forging before the next stroke of the hammer. Occasionally, by employing a spring in this manner, swages are made with simply a hinged joint at the outer end of the arm. This is shown in the construction of the left-hand swage, the lower arm in this case being prolonged about 2 ft. in order to gain additional leverage for lifting and swinging a heavy die.

A Chain-Drive Oiler

Silent-chain drives, if not properly handled, are a continual nuisance. One of the greatest abuses of a chain drive is in the oiling. I have seen heavy tar-oil used as a lubricant, and in a short time it gummed up so badly and dirt was so impregnated in the chain that its pliability was gone, wear was excessive and breaks became frequent. The various manufacturers recommend a special oil, or at least an oil of special qualities. The chains should be cleaned with gasoline at least once a month, so as to clear gritty matter and sticky oil from the links. A chain with proper care should last for years. The automatic constant oiler shown in the sketch was designed by W. J. Wilkey, superintendent of the Nevada Packard Mines Co., and has proved a great success, as the chains are constantly and evenly lubricated. It is made entirely of pipe fittings.—Arthur C. Daman, in *Engineering and Mining Journal.*



AUTOMATIC CONSTANT OILER

Economy in Hacksaw Blades

By Frank E. Merriam

SYNOPSIS—The power hacksaw is now so extensively used and so necessary in machine-shop practice that its economical operation is of great importance. The selection of hacksaw blades has heretofore been considered of little moment, but with their more extensive use and the increased price of tool steel the subject is beginning to receive the consideration it merits.

The modern hacksawing machine is larger, more powerful and faster than its predecessors and consequently demonstrates more forcibly any difference in the relative quality of the blades. For these reasons the selection of blades has become as important as similar determinations for other cutting tools.

The conditions that demand better machines and blades require that tests be conducted more carefully and systematically than in the past. In days gone by it was considered that nothing more was required in a hacksaw test than to determine which blade would cut off the greatest number of pieces, no consideration being given to many elements that have a direct, and in many cases a decisive, bearing upon the results of the test. The selection of a hacksaw blade for any particular job will depend upon the material to be cut, the conditions under which it is to be used, etc. For example, a saw that is best for cutting bar steel is not suitable for cutting thin tubing; neither will the same saw be satisfactory for both hard and soft material.

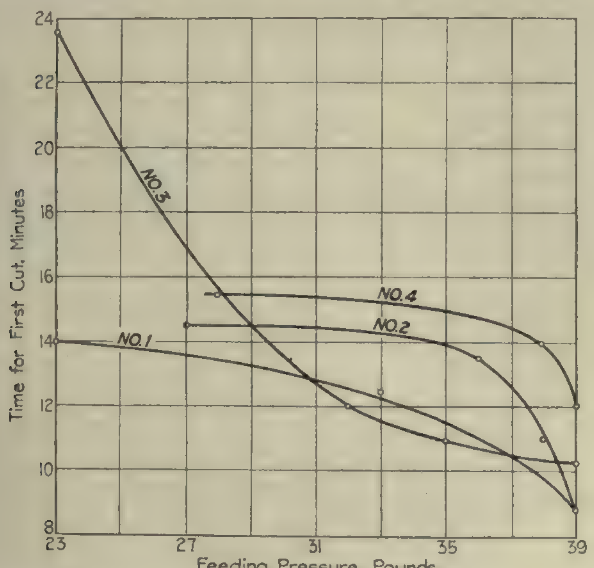


FIG. 1. EFFECT OF FEED PRESSURE ON RATE OF CUTTING

Blades differ as to thickness, pitch, manner of setting, manner of forming teeth, etc., all of which influence the performance of the saws.

Blades for a heavy machine running at a high speed with coarse feed must necessarily be heavier than those for a machine doing lighter work at a slower speed. However, the metal cut is sometimes so valuable as to be a determining factor in blade thickness.

The tooth pitch is determined by the material to be cut and the cutting conditions. A pitch sufficiently coarse to allow suitable chip room and free cutting of soft steel will, if used for tubing, lock on the walls and not cut at all; while in the case of soft material the pitch must be finer than for ordinary steel, in order to prevent taking too heavy a cut for the machine. In the case of hard material little chip room is required, and a finer pitch distributes the wear among a greater number of teeth, thus giving better results.

The extent and manner of setting the teeth also have an important effect upon cutting. Probably the most common style of "set" is that in which the teeth are set alternately to each side of the blade, thus making the kerf slightly wider than the blade thickness and preventing binding and heating. Some makers set the teeth alternately, others set one tooth to the left and the next to the right, while the third is not set at all. It is apparent that most of these styles of setting throw up the corners of the teeth. Wear takes place first on the corners, which, being small, dull rapidly, causing the rate of cutting to decrease quickly. The style of set with every third tooth straight should be an improvement, since the unset teeth present a comparatively wide cutting edge, which in combination with the set teeth gives a comparatively wide cutting face.

There is a third method in which the teeth are so set that the whole width of the tooth edge cuts. This distributes the wear more uniformly and should show a better average performance.

The essential features of a hacksaw blade as indicated must receive consideration in order to determine the relative qualities of the saws. In addition the type and kind of machine used must also receive consideration, since the machine must provide suitable cutting conditions for the blade and develop its full capacity.

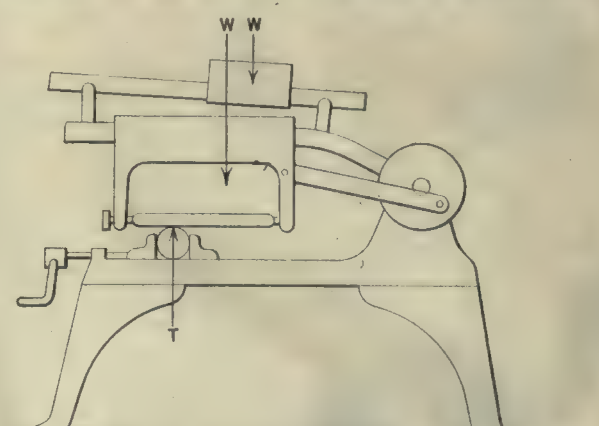


FIG. 2. HACKSAW MACHINE

The cutting speed is dependent upon hardness of material, kind of material, character of machine, kind of blade used, etc. If a saw must handle a variety of materials, one should select the most economical speed, considering the variety and the relative frequency with which each is cut.

The most important factor in determining the speed is the kind of material, since hard material cannot be

cut at as high a speed as soft; and the nature of the material, aside from the hardness, will cause great differences, such as are found for example between Monel metal and steel.

The condition of the machine is next in importance. For high speeds the slides of the saw frames should be so designed as to prevent their working loose, and the apparatus for securing saw tension must also be proof against loosening when the machine is running. These two items are prolific causes of saw breakage. These matters receive suitable attention in the case of other metal-cutting machines, but not often in the case of hacksaw machinery.

The use of a cutting solution of soluble oil, or cutting compound, and water is usually desirable because it cools the blades and thus makes it possible for them to run at a higher speed.

The feed is ordinarily given little attention, though it is of great importance. The proper feed in any particular case is dependent largely upon the nature of the material to be cut, yet most operators entirely neglect to give this fact any attention whatever and leave the feed weights where they find them. That this is wrong is shown by Fig. 1, which indicates the effect of the feeding pressure upon the rate of cutting soft steel, and shows that it is determined very largely by the position of the weights and that they must be properly located if the best results are to be secured.

The curves are not uniform, but this is undoubtedly owing to variations in the quality of the saws, the material cut, and probably to some extent in the observations. The variations in the average curve would have been minimized by a greater number of tests, but the writer did not have the opportunity to continue the work and these data are presented as they were found because they represent the general effect of the feeding pressure upon the rate of cutting.

Difficulties in Testing

The ordinary method of testing is not satisfactory, since it does not take into account the feeding pressure, which must be uniform in order to make the tests comparable. The feeding pressure, depending as it does upon the construction of the saw, calls for a much more complete knowledge of conditions than was formerly considered necessary. Furthermore, there has always been the difficulty of knowing when to stop a test and telling when the blades are equally dulled, which of course made impossible any accurate determination of relative performance. This is a most important consideration when making an economical selection of blades.

From this it is apparent that a relative test demands that the usual variations receive proper consideration and be controlled in such a way as to make the results comparable. As already indicated, it is necessary to classify the blades as to thickness, pitch and manner of set, and such classification shows considerable differences. This having been done, the relative values of the blades can readily be determined. The speed of the saws being the same, the regulation, or adjustment, is a matter of varying the pressure or feed; and in order to secure this condition it is first necessary to adopt a standard pressure, which can best be specified in pounds per inch of tooth width, thus caring for the variation in tooth width and pitch. Twenty to thirty pounds has been found to be productive of the best results, since it does not overload the saws and is still sufficient to produce quick test results.

The feed pressure is the force necessary to produce a moment equal and opposite to the combined moment of the adjustable weights and the saw frame. This force has a moment arm equal to the distance between the center of the bar being cut and the point of frame suspension, and for good test conditions should be at least 50 to 60 lb. A standard feed pressure per inch of tooth

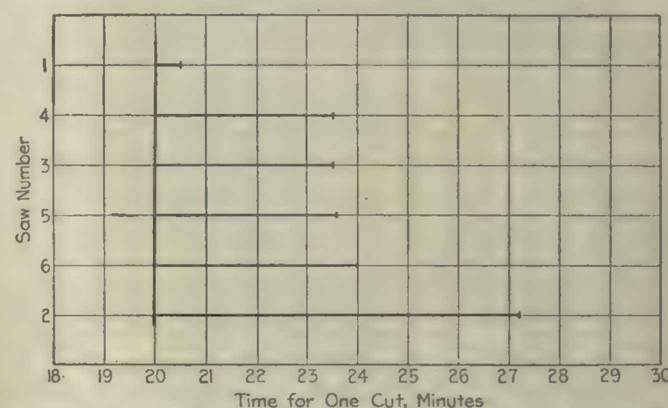


FIG. 3. TEST OF BLADES WITH EQUAL PRESSURES ON MONEL METAL

width should be adopted and, as already mentioned, 20 to 30 lb. will produce good results. From this unit pressure the total pressure on the saw can be worked out and the location of the adjustable weight determined from the equation of equilibrium of the forces in question. The following formulas give the location of the adjustable weight:

$$r = \frac{(T \times K) - (W \times R)}{w} \qquad (1)$$

$$T = S \times p \times t \times l \qquad (2)$$

where

r = Distance center of gravity of adjustable weight from point of frame suspension;
R = Distance center of gravity of saw frame to point of suspension;
w = Weight of adjustable weight;
W = Weight of saw frame, etc.;
T = Total pressure on saw;
K = Distance center of bar cut to point of frame suspension;
S = Standard pressure per inch of tooth width;
p = Pitch of saw;
t = Thickness of blade;
l = Length of saw cut = diameter of bar cut.

To illustrate, assume conditions as following:

r = To be determined;	K = 18 in.;
R = 20 in.;	S = 30 lb.;
w = 15 lb.;	p = 12;
W = 30 lb.;	t = 0.048 in.;
T = To be calculated;	l = 3 in.

T = 51.8 lb. from (2)

r = 22 in. from (1)

In Fig. 2 is shown a hacksaw machine that illustrates the approximate lines of action of the forces mentioned above.

The figures given for feeding pressure on saws are, of course, general, and to secure the best results tests

should be made not only of the different blades but, after the most desirable has been selected, the most efficient feed should be determined for the different materials on which it will be used. Obviously, it is not practical to carry such testing to the extent of determining the best feed for materials that are cut only occasionally and in small quantities. The minimum quantity of any material to be cut that will justify making a test must, of course, be determined in each case as it arises.

A case directly in point is Monel metal. This is an extremely difficult material to cut, and saws do not behave in anything like the same manner that they do when cutting steel. On steel, as shown by the tests, the blades gradually become dull and increase the cutting time with each succeeding cut: but when cutting Monel metal they dull very quickly, and after losing the keen edge characteristic of new saws, almost entirely cease work. That this is due to the characteristics of the metal is certain, because saws that will no longer cut Monel metal will still do excellent work on steel. A test on Monel metal is shown in Fig. 3.

The results of a test made according to the methods outlined are shown in Fig. 4. In this test new blades were cutting steel 3 in. in diameter with a uniform feed pressure per inch of tooth width. The style of set was

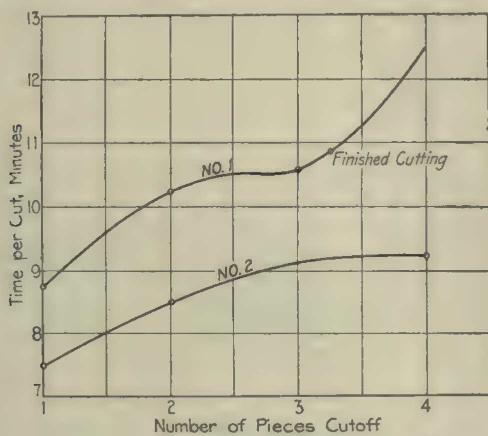


FIG. 4. TEST OF BLADES WITH EQUAL PRESSURES ON STEEL

the same in each case, hence the cutting conditions were similar. The uniformity of the curves is not so great as could be desired, but this is undoubtedly owing to individual variations in the quality of the blades, experimental errors and similar causes, and would have been less apparent had it been possible to average a greater number of tests. In the case of saw No. 2 it will be observed that the times for the third and fourth cuts are the same, which is obviously incorrect, since a blade dulls each time it is used, and consequently the cutting time will increase for each succeeding cut. Such discrepancies would have been eliminated had a greater number of tests been made and averaged, but those represented by Fig. 4 are sufficient to demonstrate the superiority of the test methods advocated herein.

To go into greater detail regarding this testing it should first be observed that all the saws had equal opportunity to cut, since the unit feeding pressure was always the same and the extent of dulling the same in each case, the latter being controlled by allowing a certain percentage of time increase per cut over the time required for the first cut. The value of this method of determining when the saws are equally dull is very great and will be particularly apparent to anyone who has undertaken tests of cutting tools.

The comparison of hacksaw blades as to relative economy should be as to capacity, or number of pieces cut off in the allowed time, rate or speed at which the pieces are cut off, and costs.

The item of cost—that is, ultimate cost—is the most difficult to determine, because there is more than the matter of blade cost to be considered. A blade may be expensive per gross, but the most economical when overhead, labor and other similar charges are given proper consideration. In other words, a blade may be much more desirable to use on account of the saving in labor and overhead, or because a higher rate of cutting is more desirable than the cost saved by the slower saw. In short there may be other characteristics that are of more importance than the saving on the cutting operation itself.

In making the following comparisons it should be remembered that the data included are presented as illustrating the method herein advocated and not as covering a particular case, although the results given are of actual tests.

Tabulating the data we have the comparisons:

Saw Production:
No. 1 cut off 3½ pieces in allowed time.
No. 2 cut off 4 pieces in allowed time.
No. 2 cut off 23 per cent. more than No. 1.

Rate of Cutting:
No. 1 averaged for the test 10 min. per piece.
No. 2 averaged for the test 8.60 min. per piece.
No. 2 averaged 14 per cent. less time per cut than No. 1.

Blade Cost:
No. 1 cost \$0.0625 each.
No. 2 cost \$0.0875 each.
No. 2 cost 40 per cent. more per blade.

Considered simply as saws, No. 2 is manifestly a better tool than No. 1; but to determine really the relative value in factory service we will take a case where 500 pieces are to be cut and let them be similar to those cut in the tests. Let us consider the machine cost to be 10c. per hour and the labor charge for attendance 8c. per hour, one man handling several machines.

TABLE I. COST OF CUTTING 500 PIECES WITH SAWS 1 AND 2

Saw No.	1	2
Time required, hours	83.00	72.00
Number of saws required	154.00	125.00
Total saw cost	\$9.62	\$10.94
Labor cost	6.64	5.76
Overhead expense	8.30	7.20
Total expense or cost	\$24.56	\$23.90
Cost per piece	.049	.048

Saw No. 2 will do the work for 2.7 per cent. less cost than saw No. 1, under test conditions.

As far as actual cost is concerned, there is but little choice between the saws in question; but the time element rather than the cost will probably be the determining factor in most cases. In the illustration used there will be a saving of a day, roughly speaking, by using No. 2, which will permit a much more rapid filling of orders, of great importance when much work is to be done. In addition it is also likely to effect a considerable saving where the pieces are to be used.

While the economy of saw No. 2 is obvious, it should be borne in mind that its record was made under certain favorable and proper conditions that might not obtain in actual practice. For example, in a shop where no particular attention is paid to the location of the feed

weights, or perhaps no weight is used at all, the whole relation between the saws, as outlined above, is likely to be upset and the cost relation be just the reverse or even show a much greater difference than it should. Plainly, the conclusion is that the comparison is not likely to be of much value unless the sawing operation is standardized in the proper manner and then so maintained. Thus a test of this kind, to determine the relative value of saw blades, will also point out the way to more efficient saw operation, making the gain twofold.

As an example of this, take the tests on Monel metal. Here the tests show that the unit feeding pressure should not be so great as in the case of steel and that a saw should be used for one cut only, while the blades are still good for cutting ordinary materials after they are useless on Monel metal; and they should be reserved and used in that way. This is using the blades in the most economical fashion and to the best advantage. The tests on steel show the advantage of a uniform unit feeding pressure and what it should be, besides pointing out the desirability of instructions to hacksaw machine operators, indicating proper weight positions for different diameters and materials that are to be cut.

Characteristics of Hacksaw Machines

The tests also indicate certain desirable and undesirable characteristics in hacksaw machines, as has already been pointed out, and these are found to be identical with the characteristics found most desirable in all metalworking machinery—namely, rigidity and durability. If an examination of the ordinary hacksaw machine is made, keeping these two points in mind, it will be found that often the slides of the saw frame are narrow and do not have any convenient and durable method of maintaining alignment. The device for maintaining saw tension often is weak and cannot be locked to prevent loosening while the saw is in operation. These two features are important because unless the machine is well designed saw breakage will be excessive. The device for relief on the return stroke is also important and must be positive if the saws are to give maximum service.

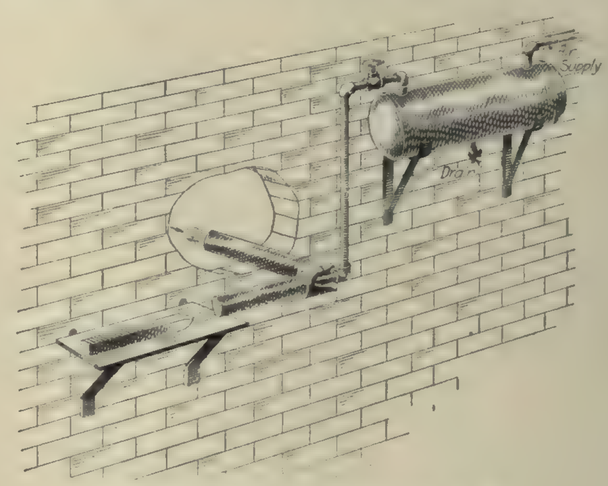
To repeat, testing hacksaw blades is desirable and productive of economy because it makes possible the selection of the most economical saw and the most efficient method of operation. The method of testing is of the greatest importance because the various makes of saws are so differently constructed that unless each receives proper consideration a true comparison cannot be made. The manner of testing outlined in this article is recommended because it gives suitable attention to these features and clearly points out their relative value.

An Improved Air Blast for Hardening Tools

By J. V. Arthur

Have you walked by the tool dresser's fire, day after day, and heard the roar of the blast of compressed air escaping where it is used for chilling the cutting edges of the lathe and planer tools? And have you wondered whether anything could help relieve this tax on an already overloaded compressed-air plant? The tool dresser will tell you that he needs lots of air, because that being used is too hot for good hardening. Incidentally he will probably complain that the air carries so much moisture that the water is causing the steel of the tools to check, and out will come a display of several tools that were "perfectly good" before they were put before the air blast.

Those were a few of the conditions that the air installation, shown in the accompanying figure, was designed to meet. In this particular case the air blast was located immediately above the steam-heating coils, so there was a probability that the temperature of the surrounding air was relatively very much higher than that of the rest of the room. The nozzle was at that time arranged to blow into the open end of a piece of 3-in. pipe about



ARRANGEMENT OF THE AIR BLAST

12 in. long, the air coming out of the other end upon the tools in a diffused condition, so that it would cover a larger portion of the work placed before it. At the same time the air blowing into the open end of that pipe created a suction that carried a large volume of the outside air through the pipe with it, so that really the volume of air delivered for cooling the tools was greatly increased.

To overcome the difficulties due to the hot inside air, an elbow was placed on the 3-in. pipe with an extension through the outside wall to draw in cool air. Then using a side-outlet elbow, the air nozzle was drawn to a point and extended in about 2 in. This arrangement formed an injector, which delivered several times the amount of air to the tools that the system would otherwise have permitted.

The problem of the disposal of the excess moisture in the air was met by the installation of the small tank in the pipe line close to the air-blast connections. This tank, about 10 in. in diameter by 20 in. long, was made of galvanized sheet steel with welded seams and was fitted with a small drain cock at the bottom. The drain cock was for the purpose of drawing off any water that might condense in the tank.

Since this installation was made, the shop has been very successful with the tools that have been redressed. Perhaps this has been due in part to the greater interest taken in seeing that the work should come as near right as possible, but it also seems probable that the elimination of a large part of the trouble caused by the old air blast has had considerable to do with the better results that have been obtained since the installation of the new system.

Electric Arc Welding on Automobile Parts

By Robert Mawson

SYNOPSIS—Electric arc welding on the steering column and top supports. The making of an axle housing so that the joint is oil-tight is interesting. Examples of building up difficult forgings from simple parts by means of the arc welder are also shown.

The Reo Motor Car Co., Lansing, Mich., is using the electric arc welding method for manufacturing parts for automobiles and also on many repair jobs. On manufacturing work it is possible to unite pieces which for production reasons have been made separate. On repair jobs, the operation is quick and convenient. At this factory a C. & C. generator is used to provide the electricity, which passes through panels made by the General Electric Co. The current used is between 200 and 450 amp. at 70 volts.

In Fig. 1 is shown a steering column and coupling assembled ready for welding. The column is slid into the coupling, which has had four holes *A* previously drilled in it. Metal is then allowed to flow into these holes and onto the columns, thus holding the parts securely together, the metal being supplied from the filling rod, which is melted by the electric arc. One of the steering columns after the welding operation is shown in Fig. 2. The average time to weld one of these parts—four spots—is 5 min.

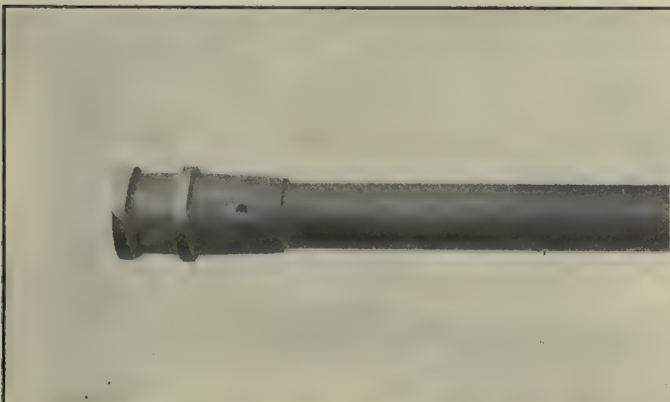


FIG. 1. STEERING COLUMN BEFORE WELDING

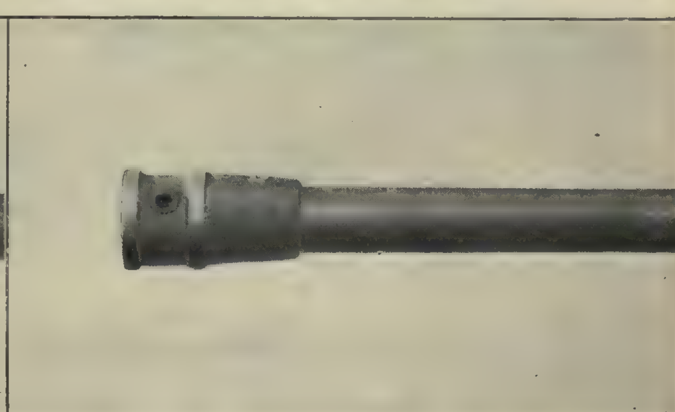


FIG. 2. STEERING COLUMN AFTER WELDING

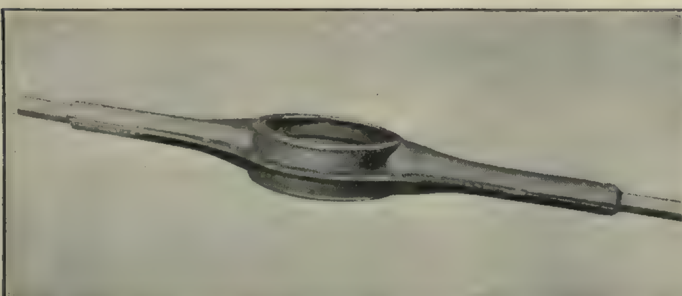


FIG. 3. HOUSING READY FOR WELDING

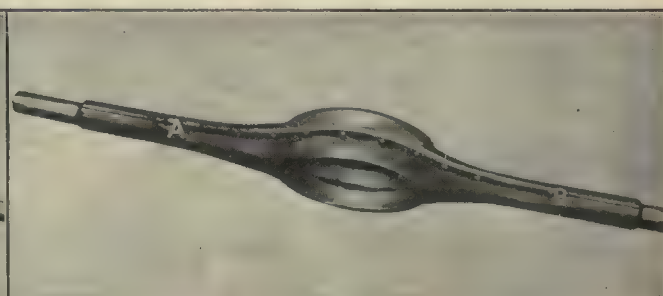


FIG. 4. FIRST WELDING OPERATION

FIG. 5. THE WELDING FIXTURE

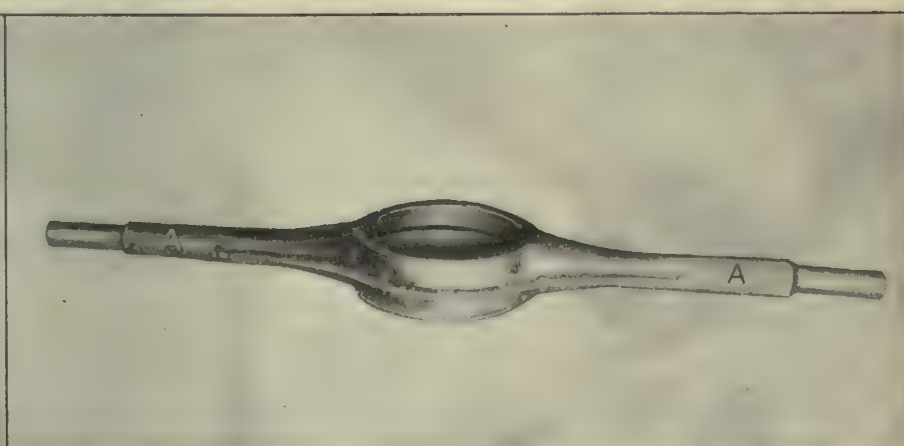


FIG. 6. FINAL WELDING OPERATION ON AXLE HOUSING

When manufacturing the rear axle housing the two parts are first fastened together with rivets, as shown in Fig. 3. The problem is then to make the joint between the two sections oil-tight. The first welding operation is performed with a carbon arc. The joints between the points *A* and *B* on the housing, Fig. 4, are welded in this manner. The purpose of this operation is to melt down the edges and allow it to flow together to make a tight joint, no filling rod being necessary. The average time required to weld a housing to the condition shown in Fig. 4 is 8 min. The carbon arc is then removed and a metallic one substituted in the welding machine.

FIG. 7. A TOP SUPPORT

FIG. 8. NUMBER OF WELDED TOP SUPPORTS

The joints *A* in Fig. 6, are then welded, the metal being supplied by the filling rod. This is of necessity a slower operation than the carbon arc, the filling material having to be fed in by the operator; time required, 16 min. per housing.

In Fig. 5 is shown the fixture used to hold the housing during the welding operations. The housing fits over the semicircular part *A* and pushes back against the flange *B*. It will be observed that this part of the fixture can be swung around on the shaft *C* so that the housing may be placed in a position convenient for welding.

Welding Top Supports

In Fig. 7 is shown an automobile top support which was repaired with the arc welder. The weld may be observed at *A*, the metallic arc being used for the operation; time required, 4 min. In Fig. 8 are shown five different top supports that have been manufactured with the aid of the arc welder.

The part *A* has had two flat sections welded onto it after the various holes had been machined. At *B* is shown how a difficult part was built up. The head of this support was made separate and then welded on the flat section. A flat bar was welded at an angle to the circular bar of *C* and two flat bars were welded at angles on the forging *D*. The time required to weld these five parts is approximately 15 min.

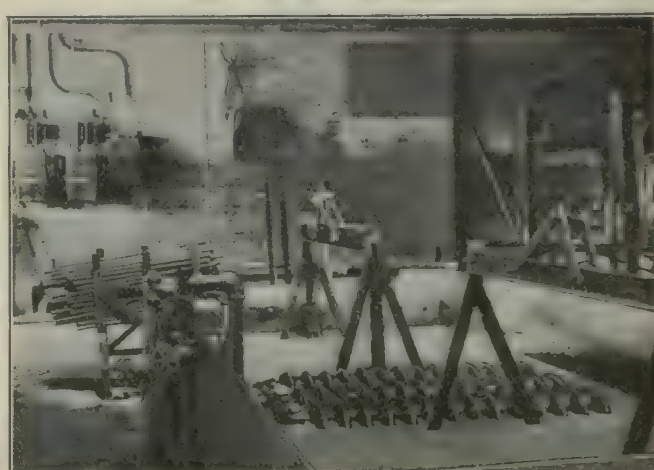
Professional-Classes War Relief Council

The professional man in England is having a difficult time now that all his usual avenues of occupation are closed by the war. There is no work for architects and similar engineers except on Government work, and this is not plentiful. Those who cannot find employment in munition and similar lines are largely without income, and this condition bears hard on the family. The Professional-Classes War Relief Council has been carrying on a systematic relief in several ways, disbursing about $5000 a week with an administration expense of less than 2 per cent. The J. Pierpont Morgan house in Prince's Gate is used as a maternity hospital, and approximately 300 cases were cared for last year. This is only one of the methods of relieving families of engineers and other professional men, those who are unable to earn even a fair living owing to the unusual conditions imposed by the war; there are also other and equally efficient activities.

After a careful investigation a committee of well-known engineers has been formed in this country to assist in this work, and contributions are being forwarded to Lewis B. Stillwell, treasurer, care of Farmers Loan and Trust Co., 475 Fifth Ave., New York City, to carry on the good work from this side of the water.

Cooling the Quenching Oil in Hardening Tanks

The illustration shows an interesting and economical method of cooling oil in the quenching tanks employed by Wheelock, Lovejoy & Co., Cambridge, Mass. Three sections of cast-iron steam-heating radiators were piped up in the center of a long tank, and cold water was forced through them in the usual manner. This made it possible to equip the tank much more quickly and at lower cost than if pipes and pipe fittings had been used.



USING CAST-IRON RADIATORS TO COOL OIL

In this particular case there was no objection to a portion of the space being occupied by the radiator; but in cases where this might be an objection, the flat or wall cast-iron radiators could be readily used either in the bottom or around the sides of the tank. With the radiators in the center, a large tray or catching basket is placed at each end of the tank, as shown.

The Design of Cut-Steel Bushed Roller-Chain Drives

By H. R. Connor

SYNOPSIS—Of late, there seems to be a more marked tendency toward the use of automobile roller-chain drives for power-transmission purposes, and since there appears to be quite a dearth of usable data on this subject, this article is therefore undertaken. There are computations and assumptions that must be made in order to properly proportion and select the various elements of a roller-chain drive, and it is desirable that some easy and accurate means be found to make these determinations quickly. This article furnishes those means.

Almost every means for the mechanical transmission of power in common use today has a certain definite application and range of possibilities. The cut roller chain bridges the gap between the so-called malleable class of cast, or pintle, chains and the high-speed silent chains. We all know the most common use of roller chains is in connection with automobile trucks, but here we will treat of them for power-transmission purposes only.

There are two types of roller chains on the market, the main difference being one of mechanical construction. One type has its side bars punched to size and has split bushings which are not carefully machined, being merely slipped into the side bars. This type is to be avoided as it stretches easily, thus causing meshing chain action. The type of chain for which the accompanying tables were designed has side bars which are punched small and then reamed to size, the bushings being machined from the solid and shouldered at the ends, the pins being made to suit the bushings. Few people seem to recognize the fact that one of the first requirements for the successful operation of one of these cut roller chains is the selection of the best grade of chain obtainable.

Limiting Features of Chain Drives

In the primary consideration of the problem of roller chain driving, there are a few limiting features that should be considered. The small driving sprocket should have as many teeth as possible and, under no consideration, less than 13. When the small sprocket is the driven wheel, it should have not less than 15 teeth. The exact reason for the larger number of teeth in a driven than in a driving wheel seems to be somewhat in doubt, but all apparently agree that there appears to be better chain action. For speeds exceeding 700 ft. per min., it is good practice to case-harden the steel wheels, wheels below 25 teeth being made of steel. The principal difficulty with the small wheels is that they have a tendency to become worn at the pitch line, and with a small number of teeth, say 11 and under, the teeth become decidedly hook-shaped, which soon wrecks the chain. It might be added that 8- and 9-tooth sprockets are absolute chain wreckers, 10- and 11-tooth sprockets being but little better. A 13-tooth sprocket is fair for moderate speeds—for example, not over 800 ft. per min.—and for speeds from 800 to 900 ft. per min. a 15-tooth sprocket should be used, etc. It should always be remembered that the successful chain drive depends more upon the number of teeth in the small wheel than the chain speed. In other words, chain speed is secondary to sprocket size, and the number of teeth should always be made as large as possible. Too much cannot be said in regard to the number of teeth in sprockets. It is also better to make an uneven number of teeth in the small wheel, say 15, 17, 19, etc., and if possible avoid the even numbers. The reason for this is obvious, as there is usually an even number of links in the chain, a roller link and a side-bar link being known as two links, every link in the chain in a given time coming in contact with every tooth in the small wheel. Offset couplers should be avoided, as they tend to elongate more rapidly than the rest of the chain.

Successful Chain Drives

Successful chain drives are not those of high reduction, the maximum being about 3 to 1. For this, there are two reasons, the first being that manufacturers with one cutter cannot cut accurately sprockets having much over 75 teeth. In some factories where they are especially equipped, better work than the average can be done and a large number of teeth can be cut successfully. Secondly, if the chain is traveling at high speed there is considerable wear, and on a large sprocket this accumulates, and it is only at the points where the chain starts and leaves the large sprocket that proper contact is made. If, as has been suggested by the Link-Belt Co., these sprockets were cut with a different form of tooth similar to a 60-deg. silent-chain sprocket, with a rounded bottom the size of the chain roller, as the chain wore and the pitch became longer the chain could ride out farther on the teeth and have good chain action. This is the reason that silent-chain drives can operate successfully over a much greater number of teeth than roller-chain drives.

The tensile strength enters into the design of a chain drive only as a secondary consideration. The limitations are those only for wear, and the factors are so chosen that there is a large factor of safety based on the tensile strength. The working load is determined by the amount of pull allowable per square inch of projected area of pin found for various speeds (by referring to Table 9) multiplied by the projected pin area of the chain (that is, rivet diameter $\times$ bushing length). (See Table 8.) Hp.-working load $\times$ ft. per min. $\div$ 33,000.

For good running conditions the centers should be made 1½ times the diameter of the large wheel, although in cases of necessity, as for small centers, the diameter of the large wheel plus half the diameter of the small wheel is permissible. The correct center distance also depends upon the nature of the load. If the load is impulsive, longer centers are required than if there is a more even turning moment. When designing the drive it is better to reverse belt practice and select the direction of rotation so that the tight side is on top. If possible the drive should be kept horizontal, or nearly so, and

in a vertical plane. The maximum centers are about 12 ft. If the chain has a tendency to wabble, chain idlers may be used, but in all cases they should be sprocket idlers and not rollers. Besides the single chains so commonly used, manufacturers are developing the multiple

TABLE 1. KEY TO FIGS. 1 AND 2

Conditions of Chain Drives

The Chart Is Laid Out for Condition D

Condition A

Number of teeth in driver, 17 or over. Chain must be absolutely free from dirt, incased and regularly lubricated. No shock.

Condition B

Number of teeth in driver, 17. Chain must be kept clean and regularly lubricated. No shock.

Condition C

Number of teeth, 15. Chain run with slight amount of dust present. Chain taken off regularly, cleaned and lubricated.

Condition D (Millwork)

This condition is that for which the chart is designed. Number of teeth, 13. Slight amount of dust present. Slight shock. Chain must be regularly cleaned and lubricated.

Condition E (Pumpwork)

Number of teeth in driver, 17 or over. Slight amount of dirt and grit present. Run exposed. Not often lubricated. Moderate shock.

Condition F (Pumpwork)

Number of teeth in driver, 15 to 17. Run in dirty location, such as rock plants. Little attention to lubrication. Moderate shock.

Condition G

Number of teeth in driver, 13 to 15. Run in very dirty condition in presence of water, dirt and grit, such as automobile use. Worst condition. Noticeable shock.

The above conditions are only suggestive for general guidance, as the final choice must be determined by best judging the conditions at hand.

strands, two strands in one being quite common, and even three and four. This latter type of three and four strands in one was developed by the Link-Belt Co. The chief reason for the multistrand chain is to obtain a

TABLE 2. PRINCIPAL DIMENSIONS AND COMPARATIVE CHAIN DESIGNATING NUMBERS

Chain Number			Principal Chain Dimensions						
Diamond	Whitney	Baldwin	Pitch, In.	Roller Width	Roller Diameter	Pin Length	Side Plate Width	Maximum Chain Speed in F.P.M. 16 Teeth or Over	Weight of Diamond Chain per Ft.
149	...	....	5/8	[illegible]	0.4	0.822	0.551	.....	[illegible]
153	101	74 or 75	3/4	5/16	15/32	0.870	0.612	1,400	[illegible]
153	202	85 13 or 8	3/4	[illegible]	15/32	0.933	0.612	1,500	7/8
155	105	11	1	[illegible]	9/16	1.101	0.734	1,200	1¼
155	106	46 or 60	1	[illegible]	9/16	1.226	0.734	1,320	1¼
155	...	37 or 37½	1	[illegible]	5/8	1.351	0.734	1,410	1½
156	206	14	1	[illegible]	[illegible]	1.226	.....	1,320	1¼
156	207	15	1	[illegible]	[illegible]	1.351	.....	1,410	1⅜
154	...	....	1	[illegible]	[illegible]	1.632	0.820	1,650	2
151	...	....	1¼	[illegible]	[illegible]	1.382	0.900	1,050	1¾
151	471	36	1¼	[illegible]	[illegible]	1.507	0.900	1,140	1¾
151	...	35	1¼	[illegible]	[illegible]	1.632	0.900	1,225	2
152	...	....	1¼	[illegible]	[illegible]	1.507	.....	1,140	2
152	...	....	1¼	[illegible]	[illegible]	1.632	.....	1,225	2⅛
157	...	....	1½	[illegible]	3/4	1.614	1.097	1,000	2
157	76	62	1½	[illegible]	3/4	1.739	1.097	1,050	2 6/11
157	...	....	1½	1	3/4	1.994	1.097	1,150	2 7/10
158	...	....	1½	3/4	7/8	1.739	.....	1,050	2 8/11
158	...	....	1½	1	7/8	1.994	.....	1,150	3
159	...	....	1¾	1	1	2.249	.....	915	4⅓
167	...	....	2	1¼	1¼	2.651	.....	900	6¼

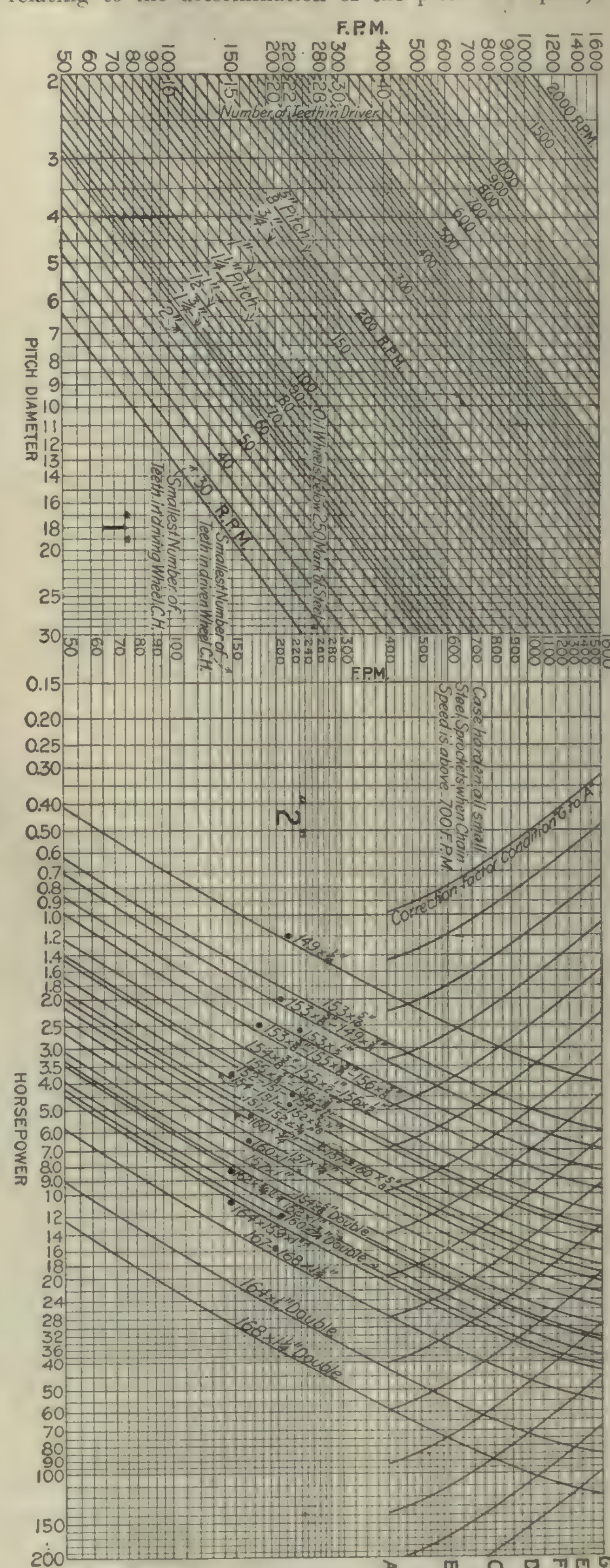
medium for power transmission capable of heavy pull, and of short pitch so as to have the requisite number of teeth to satisfy the conditions and retain a small pitch diameter.

With the foregoing explanation we will pass to a description of the charts. These charts have been

TABLE 3. MAXIMUM BORE FOR STEEL SPROCKETS

No. of Teeth	Pitch of Chain, Inches 5/8	3/4	1	1¼	1½	1¾	2
10	1/2	3/4	1⅛	1½	1⅞	2¼	2⅝
11	5/8	7/8	1½	1⅞	2¼	2¾	3⅛
12	3/4	1⅛	1¾	2⅛	2⅝	3¼	3⅝
13	1	1¼	2	2½	3	3⅝	4¼
14	1⅛	1½	2¼	2¾	3⅜	4⅛	4¾
15	1¼	1⅝	2½	3⅛	3¾	4½	5¼
16	1½	1⅞	2¾	3⅜	4⅛	5	5¾
17	1⅝	2	3	3¾	4½	5⅜	6¼
18	1¾	2¼	3¼	4⅛	4⅞	5⅞	6¾
19	2	2⅜	3½	4⅜	5¼	6¼	7¼
20	2⅛	2⅝	3¾	4¾	5⅝	6⅞	7¾
21	2¼	2¾	4	5	6	7⅛	8¼
22	2⅜	3	4¼	5¼	6⅜	7½	8¾
23	2½	3⅛	4½	5⅝	6¾	8	9¼

purposely plotted on logarithmic grids, which for size and clarity occupy the least space. The charts have been made up for desk use and so are combined on one sheet and made compact. The diagram, Fig. 1, relating to the determination of the pitch-line speed, is



FIGS. 1 AND 2. CURVES FOR CHAIN SPEED
Fig. 1—Determination of pitch-line speed. Fig. 2—Chain speed in feet per minute and horsepower

one having for abscissas speeds in feet per minute for the smallest wheel allowable, and for ordinates the various

values of pitch diameter. The inclined lines are selected to give revolutions per minute and the pitch of the chain. After a little experience, given the amount of horsepower to transmit and the revolutions per minute you can select a pitch to start with for trial, finding this given on the inclined lines. Select the number of

TABLE 4. LEAST PITCH DIAMETER FOR ANY PITCH OF CHAIN*

Pitch, In.	Quantity, In.	Pitch, In.	Quantity, In.
5/8	0.710	1 1/2	1.690
3/4	0.850	1 3/4	1.960
1	1.125	2	2.250
1 1/4	1.410		

*Subtract tabular quantity from pitch diameter to find maximum hub diameter.

teeth required for trial, and then locate the intersection of the pitch line and the horizontal line giving the number of teeth selected. This determines as near as required the pitch diameter of the wheel. Then follow parallel to the nearest line until this line intersects with the inclined line, giving the number of revolutions per minute for the driving wheel and, at this point, read horizontally the speed in feet per minute. In Fig. 2 we have the remainder of the chart in which the abscissas are values of chain speed in feet per minute and the ordinates values of horsepower and correction factors. The longer inclined curves give the number of the chain and its width. The shorter inclined curves are those for correction factors which are to be applied, the key to which will be found in Table 1. The number of the chains refer to those manufactured by the Diamond Chain and Manufacturing Co., of Indianapolis, general dimensions of which may be found in Tables 2 and 3. The horsepower is found by determining the pitch-line speed. Locate this quantity on the horizontal line in Fig. 2. Locate the vertical line giving the required horsepower, then note the intersection of the horizontal and the vertical, and trace horizontally to the right until you meet the first long, inclined line. Then for the average application (Condition D) see Table 1, you have the size of chain required. It is next necessary to check back and determine if the number of chain selected

TABLE 6. WIDTH OF SPROCKET TEETH FOR GIVEN WIDTH OF CHAIN

Teeth Width Chain, In.	Teeth Width Sprocket, In.	Teeth Width Chain, In.	Teeth Width Sprocket, In.
1/4	7/32	5/8	9/16
5/16	9/32	3/4	43/64
3/8	11/32	1	29/32
1/2	29/64	1 1/4	1 1/8

corresponds with the pitch assumed at first. For power-transmission purposes it is better to select, especially if high speed is encountered, the short-pitch wide chains rather than the long-pitch narrow chains. If the case at hand calls for a better or worse condition than that

TABLE 7. FORMULAS FOR BENDING AND TORSION OF SHAFTS

Horsepower of Shafting for Torsion Only

Maximum outside fiber stress 10,000 lb. per sq.in.

$$d = 3.2\sqrt[3]{\frac{\text{Hp.}}{\text{R.p.m.}}}$$

Formula corrected for ordinary bending

$$d = 4.8\sqrt[3]{\frac{\text{Hp.}}{\text{R.p.m.}}}$$

Length of Chain

$$L = 2C + \frac{\Sigma}{2} + \frac{\left(\frac{\Delta}{2\pi}\right)^2}{C}$$

$$C = \frac{L - \frac{\Sigma}{2} + \sqrt{\left(L - \frac{\Sigma}{2}\right)^2 - 8\left(\frac{\Delta}{2\pi}\right)^2}}{4}$$

$(C \times P) \div 12$ = chain length in feet

C = Center distance in pitches;
Σ = Sum of number of teeth in both sprockets;
Δ = Difference of number of teeth in both sprockets;
L = Chain length in pitches;
P = Pitch in inches.

mentioned for D, it is necessary to find the intersection of the horsepower vertical with the horizontal at condition D, then trace parallel to the short curves up or down, as the case may be, for a better or worse condition, until this imaginary curve meets one of the horizontals

TABLE 5. PITCH DIAMETERS FOR STEEL BUSHED ROLLER CHAIN SPROCKETS

Teeth	Pitch 5/8	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2
5	1.063	1.276	1.701	2.126	2.552	2.977	3.402	3.827	4.252
6	1.250	1.500	2.000	2.500	3.000	3.500	4.000	4.500	5.000
7	1.441	1.729	2.305	2.882	3.458	4.034	4.610	5.187	5.764
8	1.663	1.960	2.613	3.326	3.920	4.573	5.226	5.939	6.652
9	1.827	2.193	2.924	3.654	4.386	5.117	5.848	6.578	7.308
10	2.023	2.427	3.236	4.045	4.854	5.663	6.472	7.281	8.090
11	2.218	2.662	3.549	4.437	5.324	6.212	7.099	7.986	8.874
12	2.415	2.898	3.864	4.830	5.796	6.762	7.727	8.694	9.660
13	2.612	3.134	4.179	5.223	6.268	7.313	8.357	9.402	10.446
14	2.809	3.371	4.494	5.618	6.741	7.864	8.988	10.112	11.236
15	3.006	3.607	4.810	6.012	7.215	8.417	9.620	10.822	12.024
16	3.204	3.844	5.126	6.407	7.689	8.970	10.252	11.533	12.814
17	3.401	4.082	5.442	6.803	8.163	9.524	10.884	12.245	13.606
18	3.599	4.319	5.759	7.199	8.638	10.078	11.518	12.958	14.398
19	3.797	4.557	6.076	7.595	9.113	10.632	12.151	13.671	15.190
20	3.995	4.794	6.393	7.991	9.589	11.187	12.785	14.384	15.982
21	4.194	5.032	6.710	8.387	10.064	11.742	13.419	15.097	16.774
22	4.392	5.270	7.027	8.783	10.540	12.297	14.053	15.810	17.566
23	4.590	5.508	7.344	9.180	11.016	12.852	14.688	16.524	18.360
24	4.788	5.746	7.661	9.577	11.492	13.407	15.323	17.238	19.154
25	4.987	5.984	7.979	9.973	11.968	13.963	15.958	17.952	19.946
26	5.185	6.222	8.296	10.370	12.444	14.518	16.593	18.666	20.740
27	5.384	6.460	8.614	10.767	12.921	15.074	17.228	19.381	21.534
28	5.582	6.699	8.932	11.164	13.397	15.630	17.863	20.096	22.328
29	5.781	6.937	9.249	11.561	13.874	16.186	18.498	20.710	23.122
30	5.979	7.175	9.567	11.958	14.350	16.742	19.134	21.525	23.916
31	6.178	7.413	9.885	12.356	14.827	17.298	19.769	22.241	24.712
32	6.376	7.652	10.202	12.753	15.303	17.854	20.405	22.955	25.506
33	6.575	7.890	10.520	13.150	15.780	18.410	21.040	23.670	26.300
34	6.774	8.129	10.838	13.548	16.257	18.966	21.676	24.386	27.096
35	6.972	8.367	11.156	13.945	16.734	19.523	22.312	25.101	27.890
36	7.171	8.665	11.474	14.342	17.211	20.079	22.947	25.816	28.684
37	7.370	8.844	11.792	14.740	17.687	20.635	23.583	26.532	29.480
38	7.569	9.082	12.110	15.137	18.164	21.192	24.419	27.247	30.274
39	7.767	9.321	12.428	15.534	18.641	21.748	24.855	27.962	31.068
40	7.966	9.559	12.746	15.932	19.118	22.305	25.491	28.678	31.864
41	8.165	9.798	13.064	16.329	19.595	22.861	26.127	29.393	32.658
42	8.363	10.036	13.382	16.727	20.072	23.418	26.763	30.109	33.454
43	3.562	10.275	13.700	17.124	20.549	23.974	27.399	30.824	34.248
44	8.761	10.513	14.018	17.522	21.026	24.531	28.035	31.540	35.044
45	8.960	10.752	14.336	17.920	21.503	25.087	28.671	32.256	35.840
46	9.159	10.990	14.654	18.317	21.980	25.644	29.307	32.971	36.634
47	9.357	11.229	14.972	18.715	22.458	26.201	29.943	33.687	37.430
48	9.556	11.467	15.290	19.112	22.935	26.757	30.580	34.402	38.224
49	9.755	11.706	15.608	19.510	23.412	27.314	31.216	35.118	39.020
50	9.954	11.945	15.926	19.908	23.889	27.871	31.852	35.834	39.816
51	10.153	12.183	16.244	20.305	24.366	28.427	32.488	36.549	40.610
52	10.351	12.422	16.562	20.705	24.843	28.984	33.124	37.265	41.406
53	10.550	12.660	16.880	21.100	25.320	29.541	33.761	37.980	42.200
54	10.749	12.899	17.198	21.498	25.798	30.097	34.397	38.646	42.996
55	10.948	13.137	17.517	21.896	26.275	30.654	35.033	39.413	43.792
56	11.147	13.376	17.835	22.293	26.752	31.211	35.669	40.128	44.586
57	11.346	13.615	18.153	22.691	27.229	31.768	36.306	40.844	45.382
58	11.544	13.853	18.471	23.089	27.707	32.324	36.942	41.560	46.178
59	11.743	14.092	18.789	23.486	28.184	32.881	37.528	42.275	46.972
60	11.942	14.330	19.107	23.884	28.660	33.437	38.214	42.991	47.768
61	12.141	14.568	19.425	24.282	29.126	33.993	38.850	43.707	48.564
62	12.339	14.807	19.743	24.678	29.614	34.550	39.486	44.421	49.356
63	12.543	15.045	20.061	25.086	30.090	35.106	40.122	45.147	50.172
64	12.737	15.285	20.380	25.474	30.570	35.665	40.760	45.854	50.948
65	12.936	15.523	20.698	25.872	31.046	36.221	41.396	46.570	51.744
66	13.135	15.762	21.016	26.270	31.524	36.778	42.032	47.288	52.540
67	13.333	15.999	21.333	26.666	31.998	37.332	42.666	47.999	53.332
68	13.533	16.239	21.653	27.066	32.478	37.992	43.306	48.719	54.132
69	13.731	16.478	21.971	27.462	32.956	38.449	43.942	49.433	54.924
70	13.930	16.716	22.289	27.860	33.432	39.005	44.578	50.149	55.720
71	14.128	16.954	22.606	28.256	33.908	39.560	45.212	50.862	56.512
72	14.328	17.193	22.925	28.656	34.396	40.118	45.850	51.581	57.312
73	14.526	17.432	23.243	29.052	34.864	40.675	46.486	52.295	58.104
74	14.725	17.670	23.561	29.450	35.340	41.231	47.122	53.011	58.900
75	14.925	17.910	23.880	29.850	35.820	41.790	47.760	53.730	59.706
76	15.124	18.149	24.199	30.248	36.298	42.348	48.398	54.447	60.596
77	15.322	18.386	24.515	30.644	36.772	42.901	49.030	55.159	61.288
78	15.521	18.625	24.834	31.042	37.250	43.459	49.668	55.876	62.084
79	15.719	18.863	25.151	31.438	37.726	44.014	50.302	56.589	62.876
80	15.919	19.103	25.471	31.838	38.206	44.574	50.942	57.309	63.676
81	16.118	19.342	25.789	32.236	38.684	45.131	51.578	58.025	64.472
82	16.318	19.582	26.109	32.636	39.164	45.691	52.218	58.745	65.272
83	16.516	19.820	26.426	33.032	39.640	46.246	52.852	59.458	66.064
84	16.715	20.058	26.745	33.430	40.116	46.803	53.490	60.175	66.860
85	16.912	20.295	27.060	33.824	40.590	47.355	54.120	60.884	67.648
86	17.112	20.535	27.380	34.224	41.170	47.915	54.760	61.604	68.448
87	17.312	20.715	27.700	34.624	41.550	48.475	55.400	62.324	69.248
88	17.509	21.011	28.015	35.018	42.022	49.026	56.030	63.033	70.036
89	17.709	21.251	28.335	35.418	42.502	49.586	56.670	63.753	70.836
90	17.911	21.493	28.658	35.822	42.986	50.151	57.316	64.480	71.644
91	18.106	21.728	28.971	36.212	43.456	50.699	57.942	65.183	72.424
92	18.307	21.969	29.292	36.614	43.938	51.261	58.584	65.906	73.228
93	18.504	22.205	29.607	37.108	44.410	51.812	59.214	66.715	74.216
94	18.705	22.443	29.925	37.410	44.886	52.368	59.850	67.335	74.820
95	18.903	22.684	30.245	37.806	45.368	52.929	60.490	68.051	75.612
96	19.103	22.924	30.565	38.206	45.848	53.489	61.130	68.771	76.412
97	19.302	23.162	30.883	38.604	46.324	54.045	61.766	69.487	77.208
98	19.501	23.401	31.201	39.002	46.802	54.602	62.402	70.203	78.004
99	19.700	23.640	31.520	39.400	47.280	55.160	63.040	70.920	78.800
100	19.897	23.877	31.836	39.794	47.754	55.713	63.672	71.630	79.588

denoted by one of the letters from A to G, inclusive, as per instructions in Table 1. Table 2 gives principal dimensions of three well-known makes of chains.

For convenience, the maximum bores for sprockets have been provided in Table 3, which gives the largest bore advisable. Table 4 gives the quantity to be added to the outside diameter of the hub to give the least pitch diameter for any pitch of chain. This table is for rough estimate only, Table 3 being more accurate. We have also included a table of pitch diameters and have purposely not included the root and outside diameters, which may be found by adding or subtracting the roller diameter from the pitch diameter, as found in Table 5. In Table 6 is given the width of the sprocket teeth for a given width of chain. This is a matter that has been often left to the gear cutter, to the detriment of the chain drive.

Formulas for bending and torsion of shafts, a formula for combined bending and torsion, a formula for chain centers and chain length are given in Table 7. Table 8 gives ultimate strengths of Diamond chains. Table 9 gives allowable chain pull.

TABLE 8. ULTIMATE TENSILE STRENGTH AND PROJECTED RIVET AREA OF VARIOUS DIAMOND CHAIN

					Nominal Chain Width: 1/4		5/16		3/8		1/2		5/8		3/4		1		1 1/4	
Chain Number	Chain Pitch, In.	Roller Diameter, In.	Rivet Diameter, In.	Ultimate Tensile Strength, Lb.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.	Bushing Length, In.	Projected Area, In.
149	5/8	0 4	0.200	3,500	0.4	0.08			0.6	0.12										
153	3/4	15/32	0.220	5,000			0.5	0.11	0.5625	0.124	0.6875	0.151	0.8125	0.119						
155	1	9/16	0.281	8,000					0.6250	0.176	0.7500	0.211	0.8750	0.246						
156	1	5/8	0.281	8,000					0.6250	0.176	0.7500	0.211	0.8750	0.246						
154	1	5/8	0.312	10,000					0.6875	0.215	0.8125	0.254	0.9375	0.293						
151	1 1/4	5/8	0.312	13,000							0.8125	0.254	0.9375	0.292	1.0625	0.332				
152	1 1/4	5/8	0.312	13,000							0.8125	0.254	0.9375	0.292	1.0625	0.332				
160	1 1/4	3/4	0.375	18,000									0.9375	0.352	1.0625	0.373	1.3125	0.461		
157	1 1/2	3/4	0.375	18,000									0.9375	0.352	1.125	0.422	1.4315	0.538		
162	1 1/2	7/8	0.437	21,000											1.430	0.625	1.5652	0.683		
159	1 3/4	1	0.500	24,000													1.5625	0.781		
164	1 3/4	1	0.500	30,000													1.5625	0.781		
167	2	1 1/8	0.5625	34,000															1.8125	1.020
168	2	1 1/8	0.5625	40,000															1.8125	1.020

TABLE 9. ALLOWABLE CHAIN PULL

Chain Speed in Ft. per Min.	Allowable Chain Pull per Sq.In. of Projected Area, Average Conditions	Chain Speed in Ft. per Min.	Allowable Chain Pull per Sq.In. of Projected Area, Average Conditions
1,500	1,200	800	1,670
1,400	1,250	700	1,790
1,300	1,300	600	1,900
1,200	1,380	500	2,020
1,100	1,440	400	2,200
1,000	1,500	300	2,400
900	1,580		

Making Counterbores

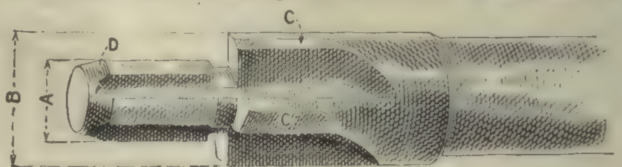
By Leroy M. Currey

The average small shop will more than likely be found to be using solid counterbores for fillister-head screws rather than those with inserted pilots or removable blades, especially in small and medium sizes. As they are required in small quantities, they are found to be most economical on account of low first cost. This is true, however, only if a few small but important points are closely observed in their manufacture. A solid counterbore correctly made and intelligently handled will last a surprisingly long time, while others taking a few minutes less to make will soon have to be replaced. It is quite customary to finish complete, ready for use, before hardening, not grinding afterward; and this is a satisfactory method if a good grade of steel is selected and the hardening is carefully done to reduce distortion to a minimum.

The pilot *A* in the accompanying illustration should be about 0.003 in. smaller than the nominal size of the drill hole. Entirely too many counterbores are made with the pilot to size, with the result that the pilot wedges in the hole and breaks off if the hole is the least bit undersize, as is often the case with an old drill in steel.

The body *B* should be about 0.010 in. larger than the screw head to be used and should have a back taper of about 0.003 or 0.004 in. in diameter per inch of length. A counterbore having the diameter *B* straight will begin to bind for its entire depth in the hole just as soon as the corners begin to wear slightly. It is also advisable to give relief to the body at *C*.

The fluting cutter should leave a slight fillet at *D* and should cut somewhat below the pilot diameter, so that the cutting edge may be extended inside the edge of the drilled hole. The grooves should extend to the end of the pilot to admit the passage of lubricant and also to collect dirt that would otherwise tend to wedge the pilot. Dirt in the hole is less apt to be drawn in between the



THE COUNTERBORE

pilot and the wall if the pilot has a straight level. as shown, rather than the usual rounded corner.

The flutes are shown as being straight, but of course they may be on a spiral. It may be remarked here, however, that a counterbore with straight flutes works very well in cast iron and does not refuse to cut in steel.

To some this article may seem superfluous, because all the points brought out are so obvious; yet the observing ones will testify that much undue breakage of counterbores occurs because they were not made quite right.

It will be found a paying proposition to have a standard drawing for each size of counterbore used, showing all dimensions and details of manufacture. Generally, Tom, Dick or Harry is simply told to "make a counterbore for a 7/16-in. fillister-head screw." Thomas may have got in late the night before; Richard may be using all his surplus brain power endeavoring to scheme out a way to do a job he knows is coming to him soon; and Harold may be more interested in getting the job done in short order than in the service the tool will give after completion. Definite instructions in all details, on paper, afford the remedy for these conditions, with the added advantage that any change or improvement found advisable may be adopted and made on the drawing. It will thus be followed in the future instead of being forgotten before the next tool is made.

Producing British Screw Gages

By I. W. Chubb

SYNOPSIS—An insistent demand for screw gages for munition purposes recently led a number of firms in Great Britian to undertake their production. Among these firms is E. G. Wrigley & Co., Ltd., Soho, Birmingham. The following notes (they pretend to be nothing else) relate to some of the methods there followed.

The British screw, of course, has the Whitworth, or 55-deg., thread. For finishing the ordinary plug-screw gage two tools are used—V and radius. In the formation of the V-tool, Fig. 1, a sharp-pointed tool is first produced. This is subsequently shortened by a quarter of the actual thread depth and given a radius in accordance with the Whitworth standard. Master gages for the tool are used for each particular thread. These gages take the form of turned reference cylinders, each having a V-groove to suit the thread produced. This is measured for all elements, the angles being determined by inspection under a microscope, the radius, size, shape, etc., being inspected and gaged as closely as possible. Angles can be read to minutes by means of a vernier on the microscope. The tool being prepared is then adjusted to these angles, also

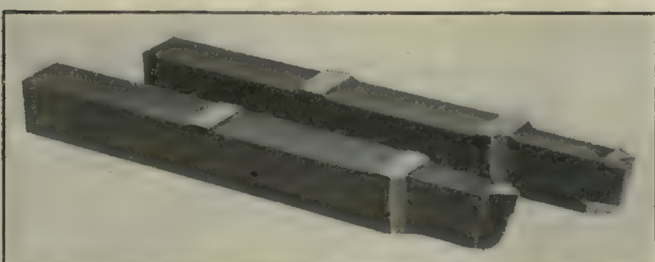


FIG. 1. THE V-TOOL

under a microscope; see Fig. 2. In its preparation the tool is first surface-ground on the top and then lapped on a surface plate charged with emery. Afterward it is lapped on the two sides with a copper strip, also emery-charged. All sharpening is done on the top surface.

As illustrated, the tool has three bearing surfaces, all in one plane, one being the top cutting edge. The three faces help to keep the tool flat in the lapping process and also serve another purpose—that is, for setting. The top of the thread is produced by a radius tool, which is made to a master gage viewed under a microscope that has a magnification of about ten diameters. A tool to cut the full thread form has been tried, but was given up in favor of the two tools mentioned.

In order to set the tool square with the axis of the thread, a cylinder with a deep groove to which the tool is fitted is placed between the lathe centers. This master cylinder has a plane surface that is exactly central. This surface is placed horizontal and the tool is brought up to height by means of an adjustable tool holder and tested by means of a straight-edge across this plane surface and the two front bearing surfaces of the tool. The radius tool is treated in the same manner.

The thread is first roughed-out in an ordinary commercial lathe, leaving, say, 0.003 in. for finishing in a Pratt & Whitney toolroom lathe, specially adjusted so that all end play is removed from the lead screw, collars, etc., with the head- and tailstock in line and the bearings scraped. In short, all wear, slackness and untruth are taken out. For giving a finer adjustment to the cut, a graduated disk larger than usual is placed on the cross-slide screw. The tool height is altered by a screw that gives a vertical lift and avoids the usual rocking motion. Otherwise the lathe can be said to be of ordinary form, yet a test thread turned in it and examined at the National Physical Laboratory showed only a regular increase of 0.00001 in. per inch in the lead-screw pitch. Since the gages usually produced are but ½ in. in length, this was considered sufficiently accurate.

A cylinder is ground and lapped to the exact core diameter of the thread and the tool is moved in by the slide

FIG. 2. THE TOOL UNDER THE MICROSCOPE

rest so as to touch the cylinder placed between centers, the reading on the graduated disk being noted. The workman then feeds in his tool to within 0.0002 in. of full depth before the gage is checked by an appliance made by the firm and shown in Fig. 3. This tests the pitch diameter by means of wires and the root diameter by means of prisms or V's. Usually two or three checkings are required. Then the V-tool is removed and the radius tool employed instead, the same appliance being used without wires for measuring the outside diameter. For this purpose the micrometer is preferred to the microscope. The rig takes the place of a measuring machine that was tried out by the firm and found unsatisfactory. The operator could not feel when the anvil was pressing the wire slightly into the thread. It is for this reason that the firm does not use a ratchet micrometer. In Fig. 3 is shown a screw gage placed between centers with a special micrometer device. The measuring part, however, is of

ordinary form. The micrometer itself is carried in a frame that slides across the bed on balls. By means of a projecting strip on top of the frame either wires or prisms may be suspended.

The illustration gives all the information necessary as to the process. No ratchet being employed with the micrometer, it is stated that the workman can judge to within 0.0001 in. by his sense of touch. The prisms are used for determining root diameter and the wires for pitch diameter. The method generally will be well known to readers of the *American Machinist.* The wires are needles, each tested for diameter by the National Physical Laboratory to 0.00001 in., and certificates with the necessary particulars are given.

For measuring small threads, a double prism is sometimes used, missing one thread. For large gages, say 6 in. in diameter, when it is awkward to hang three prisms,

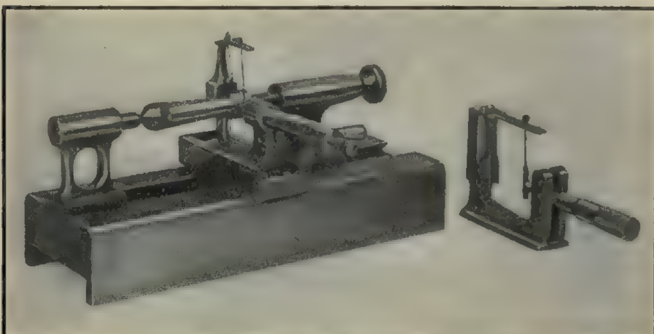


FIG. 3. TESTING PITCH DIAMETER

one prism only may be employed, measuring first the top diameter and then the diameter over one prism, and from this calculating the root diameter. The lathe man does not make measurements at the lathe as the gage is measured for him by an independent inspector. The lathe hand is guided by the cross-slide dial as to the material removed. The finishing tool cuts the full thread section.

A bench lathe is used for small gages, say up to 1 in. in diameter. It has a corrected lead screw guaranteed in pitch to within 0.0001 in. The gage is run on dead centers and the cutting tool is ground to exact size. No adjustment is provided for height or for squareness, the tool being set in V's on its base and sharpened on the angles instead of on top. The tailstock center is pushed in with the finger and clamped, no screw being employed, thus preventing distortion due to pressure from the centers. In fact screws are avoided, quick withdrawal to the tool being by means of a lever. A micrometer screw and dial are used for setting the feed and can be relied on to read to within, say, 0.0002 of size. There are independent ways for the carriage, the bed being flat but with V's for the tailstock. By means of an eyeglass and electric lamp it is possible to watch the cut closely. The threads produced by this lathe are from 6 to 72 to the inch. The lead screw is 16 to the inch, and the nut is never out of engagement, the screw being reversed to return the carriage. From 2½ to 3 hr. is the time required for roughing and finishing a gage thread 16 to the inch ¾ in. long. Soft plug gages are usually left as they come from the tool, without polishing or lapping.

As regards ring gages, the tools are similar, allowing for the form of the gage. No internal gages are cut with a tap. A set of eight master plug gages are employed to check all the elements; namely, go and not-go gages for root diameter (plain); go and not-go for pitch diameter (cut off at top and sharp at bottom); go and not-go gages to check full diameter (bearing on top of thread only) and go and not-go gages for checking the full thread.

When hardening gages it is usual to work from the analysis of the steel and the carbon-iron equilibrium diagram. A typical analysis gives carbon 0.96 per cent., silicon 0.19, sulphur 0.003, phosphorus 0.019 and manganese 1.15. Test pieces are heated to known temperatures by the electric furnace. The pieces are taken through the critical point and, the bars having previously been nicked, are broken in order to select the piece showing the best fracture. Then the temperature is determined for the steel in use, the hardener subsequently following instructions as to temperatures, which are established in the firm's laboratory. The heat treatment usually expands the plug gage. The pyrometer work establishes changes effected by the heat treatment, and the gages are then machined to suit the material under treatment. Records showing changes in dimensions are given in the following table:

SOLID THREADED PLUG

Part A	Before Hardening, In.	After Hardening, In.	After Tempering, In.
Root diameter	1.1996–7	1.2009	1.1999
Pitch diameter	1.217	1.217	1.216
Outside diameter	1.464	1.4655	1.4647
Part B			
Root diameter	1.2000	1.2011	1.2002
Pitch diameter	1.217	1.217	1.2158
Outside diameter	1.464	1.4652	1.4642

The measurements in the foregoing table are of first sets of gages made of a particular material. It was noticed that the effective diameter was dropped by the heat treatment; consequently, other gages of the same material were machined to suit.

Gages with holes show apparent shrinkage, due to the material closing on the holes; therefore, ring gages are plugged in order to make them practically solid, the plugs being made as tight as possible. The gages are sandblasted after hardening.

Industrial Export Exposition and Conference

An industrial export exposition and conference is to be held at Springfield, Mass., from May 26 to June 2, at the grounds of the Eastern States Exposition, in West Springfield, and will be the first event of this character to be held in the United States. This is the result of a desire to do something tangible to fortify the industrial interests of the Eastern States against any adverse conditions which may follow the close of the European War.

The exposition has the approval of the Department of Commerce, the Pan-American Union, and other similar agencies for the promotion of trade, and the Department of Commerce will actively coöperate by making an extensive exhibition of its data, charts and examples, as well as in the conference to be held at the same time. It is understood that machinery builders of various kinds are taking considerable interest in this proposed exposition and will be represented therein. Further details will be published from time to time.

United States Munitions*

The Springfield Model 1913 Service Rifle

Movable Base II and Leaf I

SYNOPSIS—This continues the base operations, which are both unusual and intricate in some cases. The adjusting thread at the end is finished on a special machine of interesting design, shown in detail. The base spring is comparatively simple but none the less important.

OPERATION 14. HAND MILLING REAR OF JOINT

Transformation—Fig. 1489. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1490. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed cutter, Fig. 1491. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Height of under cut from bottom; work goes over block and is gaged by straight-edge across top. Production—175 pieces per hr.

OPERATION 23. HAND MILLING REAR END TO FINISH

Transformation—Fig. 1496. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 1499. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1500 pieces. Gages—Fig. 1497, profile gage. Production—300 pieces per hr.

OPERATION 24. HAND MILLING FRONT END TO FINISH

Transformation—Fig. 1498. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 1499; lever forced against work by screws. Tool-Holding Devices—Taper shank. Cutting Tools—Pair of milling cutters, Fig. 1500. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—1500 pieces. Gages—Fig. 1501; location of shoulder; radius; thickness of tongue. Production—300 pieces per hr.

OPERATION 20. MILLING STUD TO FINISH

Transformation—Fig. 1502. Machine Used—Standard No. 4½ universal. Number of Operators per Machine—One. Work-Holding Devices—Located by stop at end, clamped by vise jaws, double fixture, Fig. 1503. Tool-Holding Devices—Standard arbor. Cutting Tools—Facing and slotting cutters, Fig. 1504. Number of Cuts—One. Cut Data—350 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1500 pieces. Gages—Fig. 1505, location of stud at A; width of stud at B and C, limit gages. Production—175 pieces per hr.

FIG. 1489

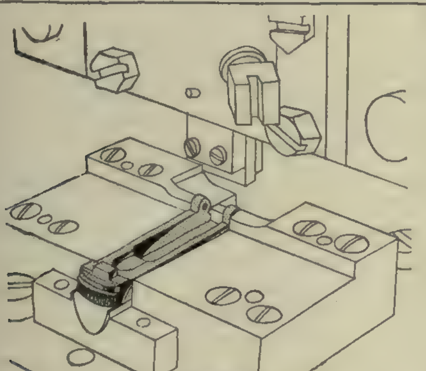


FIG. 1493

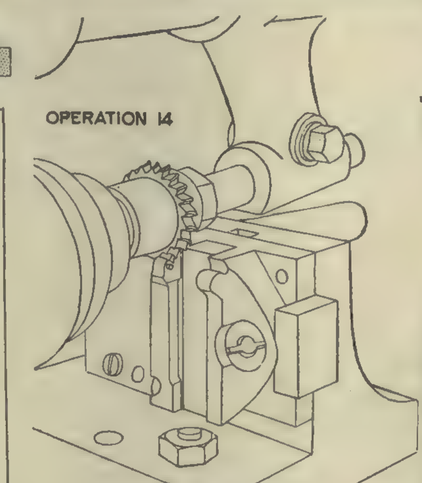


FIG. 1490

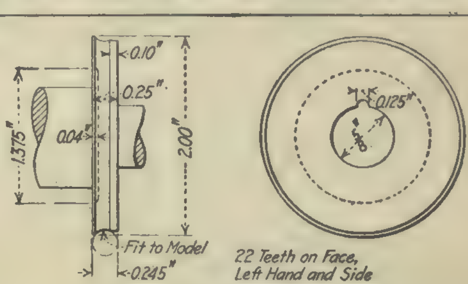


FIG. 1491

FIG. 1492

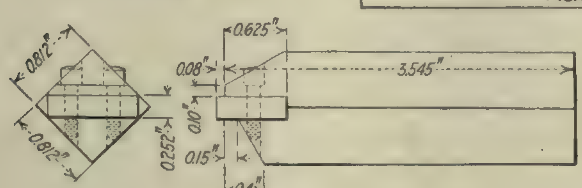


FIG. 1494

OPERATION 16

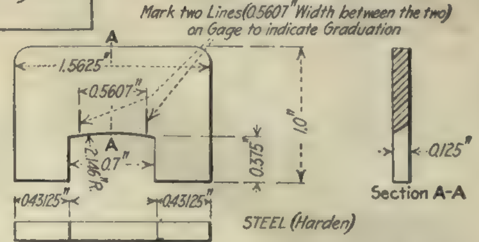


FIG. 1495

OPERATION HH. REMOVING BURRS LEFT BY OPERATION 14

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 14. Apparatus and Equipment Used—File. Production—600 pieces per hr.

OPERATION 16. STAMPING GRADUATIONS

Transformation—Fig. 1492. Machine Used—Snow-Brooks No. 0. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch, Fig. 1493; punch details in Fig. 1494. Dies and Die Holders—Bolted to bed of press. Gages—Fig. 1495. Production—500 pieces per hr. Note—Fixture screwed to bed of press.

OPERATION 17. REAMING JOINT AND PIVOT HOLE TO FINISH

Machine Used—Sigourney Tool Co. 3-spindle 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, same as Fig. 1462. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamers, for pivot hole and for joint holes. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Depth of pivot hole. Production—90 pieces per hr.

OPERATION 22. THREADING FRONT END FOR WINDAGE SCREW

Transformation—Fig. 1506. Machine Used—Special hobbing machine built at shops. Number of Operators per Machine—One. Work-Holding Devices—Clamped by strap A, Figs. 1507 and 1508, to rotating table. Tool-Holding Devices—Taper driver H and female center I, Figs. 1508 and 1509. Cutting Tools—Special hob, Fig. 1509. Number of Cuts—One. Cut Data—70 r.p.m. Coolant—Cutting oil, put on with brush. Special Fixtures—Hobbing machine; hob is driven by pulley C; worm D on same shaft drive gears E F G, which rotate work at proper speed for hobbing; these gears are kept in mesh by spring during feed movement of work; feed lever J gives predetermined feeds for each cut. Production—90 per hr.

OPERATION JJ. REMOVING BURRS LEFT BY OPERATION 24

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 24. Apparatus and Equipment Used—File. Production—500 pieces per hr.

OPERATION 23

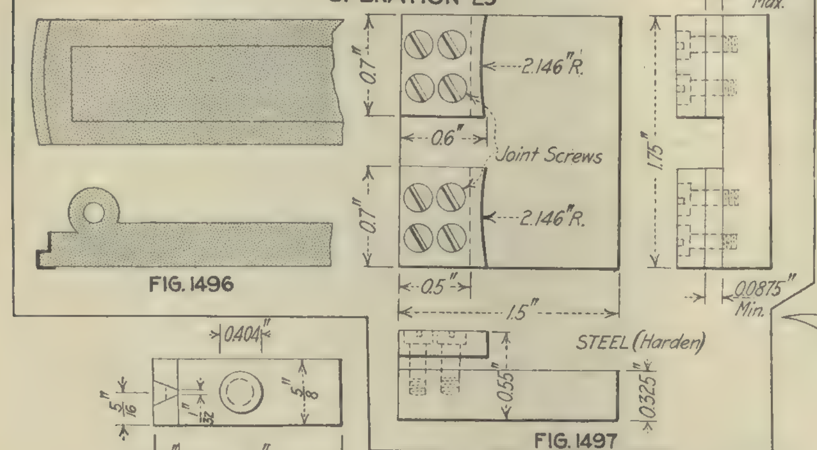


FIG. 1496

FIG. 1497

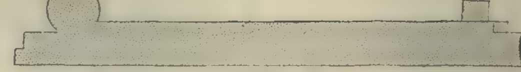


FIG. 1498

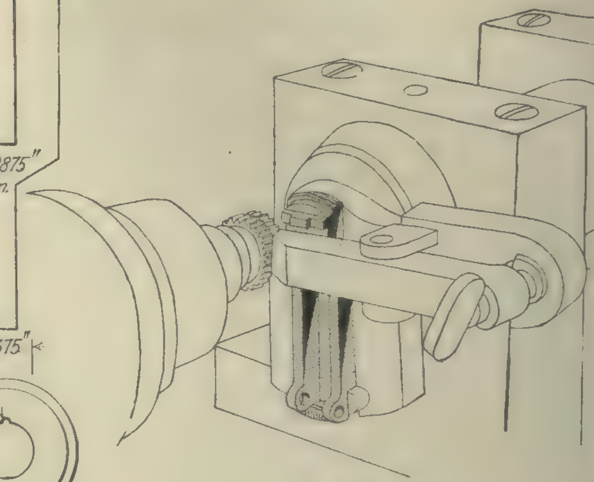


FIG. 1499

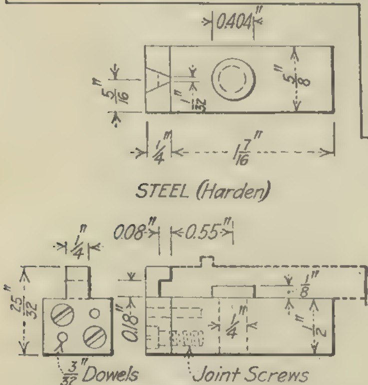


FIG. 1501

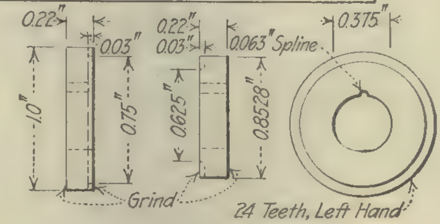


FIG. 1500

OPERATION 24

OPERATION 15½. FILING REAR OF JOINT FOR GRADUATIONS

Number of Operators—One. Description of Operation—Filing joint at rear for graduations. Apparatus and Equipment Used—File. Production—375 pieces per hr.

OPERATION 16½. FILING BOTTOM AND BURRING SPRING SEAT

Number of Operators—One. Description of Operation—Filing bottom and burring. Apparatus and Equipment Used—File. Production—125 pieces per hr.

OPERATION 25. POLISHING SIDES

Number of Operators—One. Description of Operation—Polishing sides. Apparatus and Equipment Used—Polishing jack and wheel. Production—400 pieces per hr.

OPERATION 26. FILING TOP BETWEEN EARS TO GAGE AND GENERAL CORNERING

Number of Operators—One. Description of Operation—Cornering and filing to gage between ears. Apparatus and Equipment Used—File and gage. Gages—For spring opening in base and thickness of side wall. Production—15 pieces per hr.

OPERATION 27. SPINNING IN MACHINE

Machine Used—Machine built in shop, Fig. 1510. Number of Operators per Machine—One. Work-Holding Devices—Pivoted in fixture by stud of fixed base forms holder. Tool-Holding Devices—In spindle, by setscrew. Cutting Tools—None; the teeth are smoothed out by a hardened worm. Number of Cuts—None. Cut Data—1,200 r.p.m.; hand feed. Production—350 pieces per hr. Note—Spindle A of machine drives a hardened worm B, which is a counterpart of the windage screw; movable base pivots on C; as the base is turned by worm, it strikes one of the springs D or E and throws a clutch that reverses the spindle and the direction of rotation of the worm.

OPERATION 28. CLEANING GRADUATIONS

Number of Operators—One. Description of Operation—Cleaning graduations. Apparatus and Equipment Used—Hand brush. Production—175 pieces per hr.

OPERATION 29. CASEHARDENING

Number of Operators—One. Description of Operation—Pack in bone ¾, leather ¼; heat to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quench in oil. Apparatus and Equipment Used—Same as other casehardening equipment.

OPERATION 30. POLISHING GRADUATIONS

Number of Operators—One. Description of Operation—Polishing graduations. Apparatus and Equipment Used—Polishing jack and wheel. Production—375 pieces per hr.

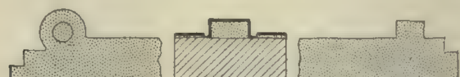


FIG. 1502

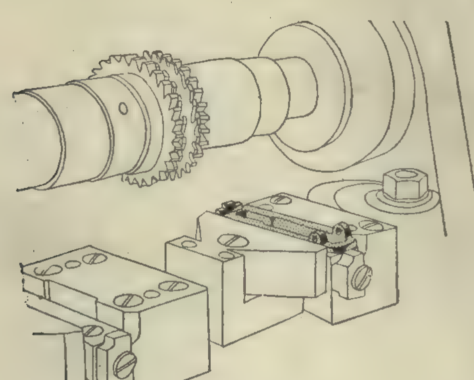


FIG. 1503

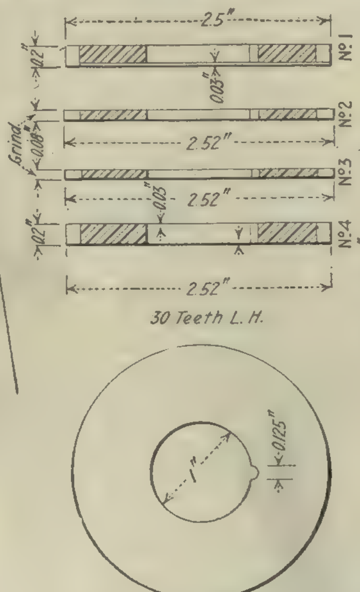


FIG. 1504

OPERATION 20

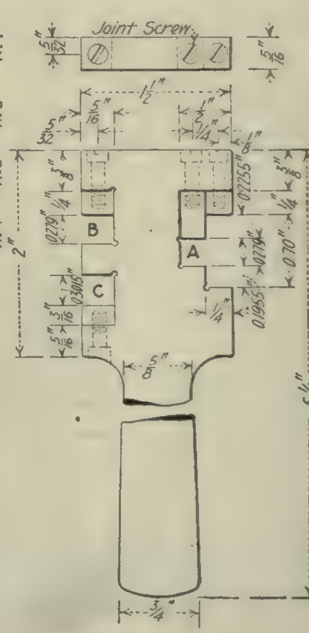


FIG. 1505

OPERATION 31. ASSEMBLING WITH SPRING

Number of Operators—One. Description of Operation—Assembling spring. Apparatus and Equipment Used—Hand and pliers. Production—175 pieces per hr.

OPERATION 32. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening. Apparatus and Equipment Used—Lead block, hammer and straight-edge. Production—95 pieces per hr.

OPERATION 33. ASSEMBLING WITH SLIDE

Number of Operators—One. Description of Operation—Assembling with slide. Apparatus and Equipment Used—Hands. Production—35 pieces per hr.

The Base Spring

This is a short, stiff spring, which holds the sight leaf in either its horizontal or vertical position. It is blanked out from sheet steel, slides into a groove in the movable base and has a hole in the base end. The spring being of the cantilever type is supported at one end only.

OPERATION 6. GRINDING

Transformation—Fig. 1514. Machine Used—Same as was used in grinding operation previously described. Number of Operators per Machine—One. Work-Holding Devices—Fixture, Fig. 1515. Production—144 pieces to a batch, four batches per hr.

OPERATION DD. REAMING ASSEMBLING HOLE

Number of Operators—One. Description of Operation—Reaming assembling hole. Apparatus and Equipment Used—Drilling machine and block. Gages—Fig. 1515, diameter of hole. Production—600 pieces per hr.

OPERATIONS 4 AND 5. MILLING RIGHT EDGE AND FRONT END

Transformation—Fig. 1516. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on pins, clamped by vise jaws, Fig. 1517; double fixture, one right and left. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1518. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1519; opening gages width; other openings gage thickness in operation 7; also gage for form of spring and working gage used at machine. Production—80 pieces per hr.

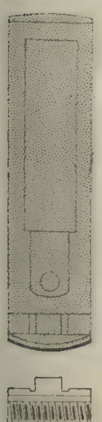


FIG. 1506

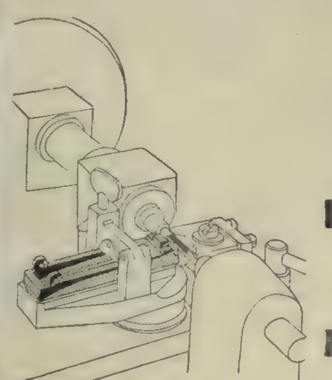
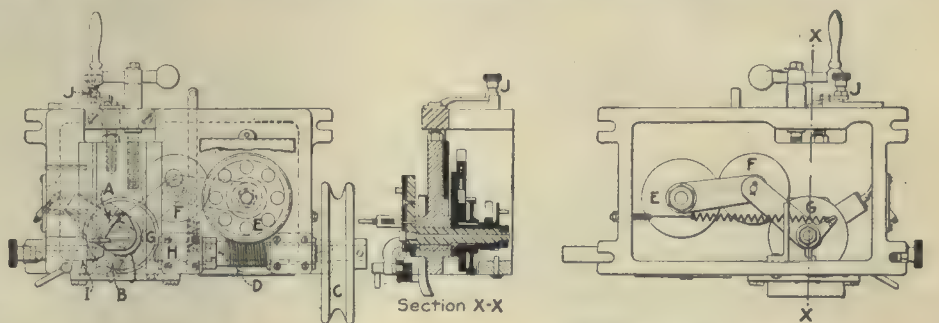


FIG. 1507



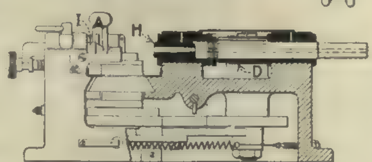


FIG. 1508

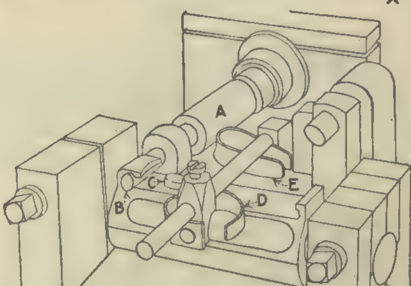


FIG. 1510

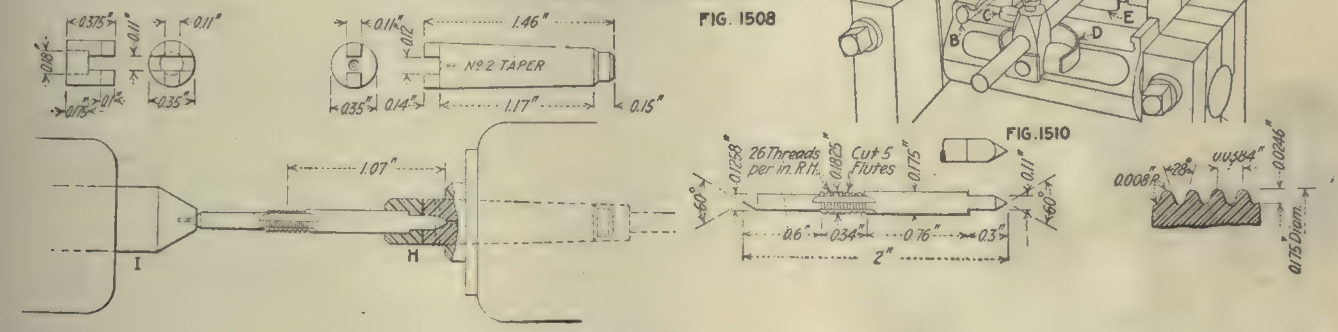


FIG. 1509
OPERATION 22

OPERATIONS ON THE BASE SPRING

Operation	
A	Blanking out spring from sheet cast steel
A-1	Punching dismounting hole
6	Grinding
DD	Reaming assembling hole
4	Milling left edge and front end
5	Milling right edge and front end
7	Milling top and rear end
AA	Reaming burrs on end left by operation 7
BB	Removing burrs on edge left by operation 7
EE	Removing burrs from assembling hole
8	Profiling front end
CC	Removing burrs left by operation 8
C-1	Polishing free end and burring fixed end
9	Bending
10	Tempering and hardening
11	Setting

OPERATION A. BLANKING OUT SPRING FROM SHEET CAST STEEL

Transformation—Fig. 1512. Machine Used—Perkins No. 19 press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew, compound die. Stripping Mechanism—Steel stripper, screwed to face of die. Average Life of Punches and Dies—25,000 pieces. Lubricant—Stock oil and cutting oil. Production—3,500 pieces per hr.

OPERATION A-1. PUNCHING DISMOUNTING HOLES

Transformation—Fig. 1513. Machine Used—Stiles No. 1 press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Stripper screwed to face of die. Average Life of Punches and Dies—5,000 pieces. Lubricant—Oil, put on with brush. Production—900 pieces per hr.

OPERATION 7. MILLING TOP AND REAR END

Transformation—Fig. 1520. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held in double vise jaws, Fig. 1521. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1522. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—See Fig. 1519. Production—80 pieces per hr.

OPERATION AA. REAMING BURRS ON END LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Reaming burrs from end left by operation 7. Apparatus and Equipment Used—Hand scraper. Production—700 pieces per hr.

OPERATION BB. REMOVING BURRS ON EDGE LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs from edge left by operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 8.

OPERATION EE. REMOVING BURRS FROM ASSEMBLING HOLE

Number of Operators—One. Description of Operation—Removing burrs from assembling hole. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operation 8.

OPERATION 8. PROFILING FRONT END

Transformation—Fig. 1523. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—On pin held by finger clamps, Fig. 1524; cams lock in place; profile form at side. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters and holder. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Cutting oil, ½-in. stream. Average

Life of Tool Between Grindings—250 pieces. Gages—Width of narrow part and relation to width of spring itself. Production—60 pieces per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 8

Number of Operators—One. Description of Operation—Removing burrs left by operation 8. Apparatus and Equipment Used—File. Production—Grouped with operation 8.

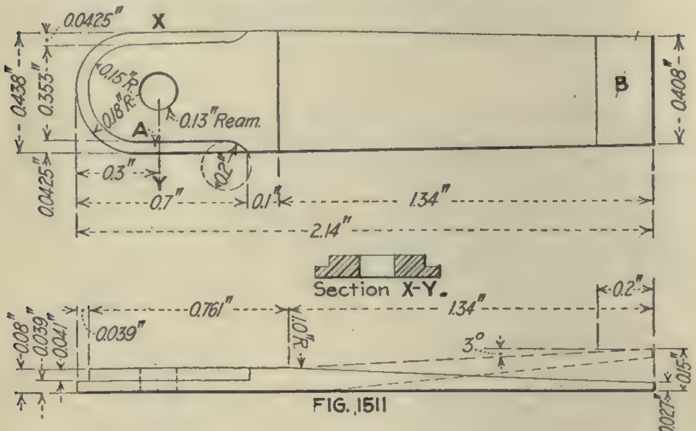


FIG. 1511

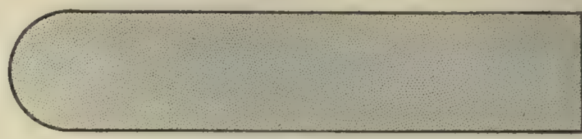


FIG. 1512
OPERATION A

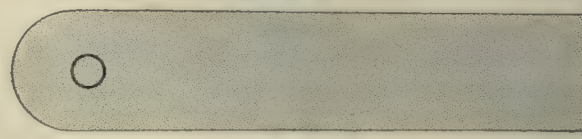


FIG. 1513
OPERATION A_1

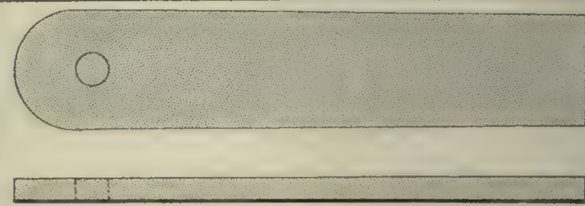


FIG. 1514

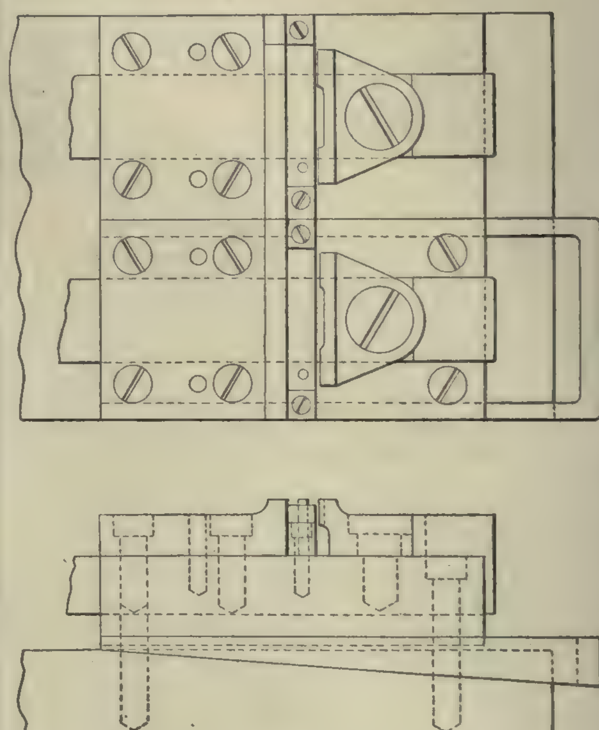


FIG. 1515
OPERATION 6


FIG. 1516

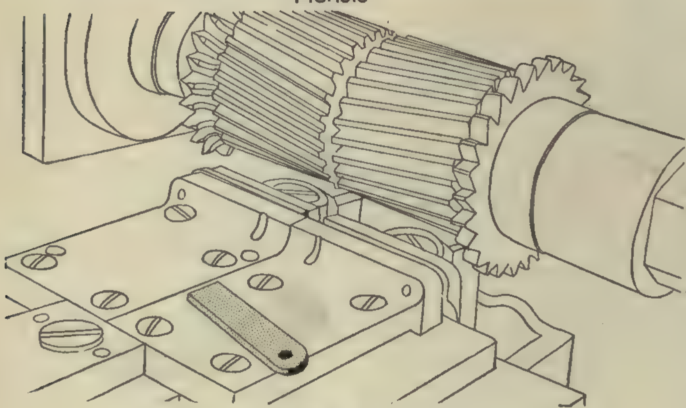


FIG. 1517

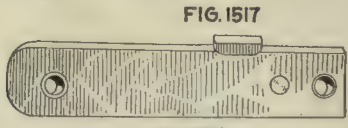


FIG. 1519

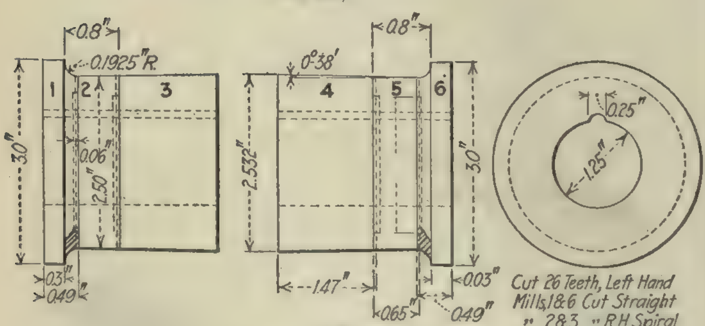


FIG. 1518
OPERATION 4&5

OPERATION C-1. POLISHING FREE END AND BURRING FIXED STUD

Number of Operators—One. Description of Operation—Polishing free end, burring fixed stud. Apparatus and Equipment Used—Polishing jack and wheel. Production—350 pieces per hr.

OPERATION 9. BENDING

Transformation—Fig. 1525. Machine Used—Stiles No. 1 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Fig. 1526. Dies and Die Holders—Fig. 1526. Stripping Mechanism—None. Average Life of Punches and Dies—Indefinite. Lubricant—None. Gages—Fig. 1527, contour. Production—960 pieces per hr.

OPERATION 10. TEMPERING AND HARDENING

Number of Operators—One. Description of Operation—Heat in open fire to 1,450 deg. F.; quench in oil; temper in lead bath at 900 deg. F. Apparatus and Equipment Used—Same as other equipment for tempering and hardening.

OPERATION 11. SETTING BASE SPRING AFTER ASSEMBLY

Number of Operators—One. Description of Operation—Leaf is opened and tested for squareness with movable base leg gage, Fig. 1529; if not square, the sight is placed on block, Fig. 1528, with leaf in notch of block; a blunt chisel and a light hammer are used to set spring in either direction, as may be necessary, when it is again tested. Apparatus and Equipment Used—Block, Fig. 1528; gage, Fig. 1529; hammer and blunt chisel. Gages—Fig. 1529. Production—100 per hr.

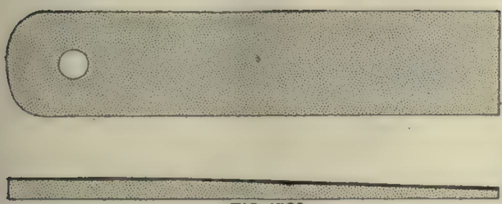


FIG. 1520

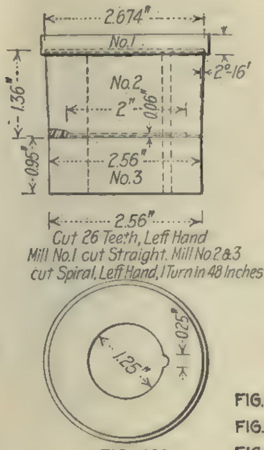


FIG. 1522

FIG. 1525

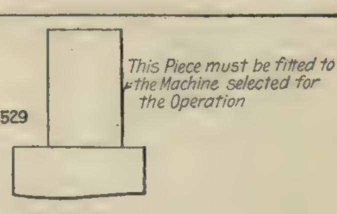


FIG. 1520, 1521 & 1522 OP. 7

FIG. 1523 & 1524 OP. 8

FIG. 1525, 1526, 1527, 1528 & 1529 OPERATION 9

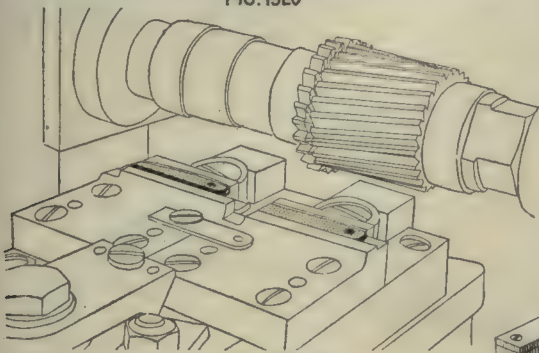


FIG. 1521

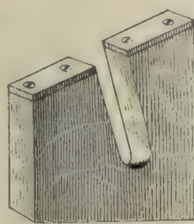


FIG. 1528

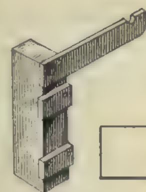


FIG. 1529

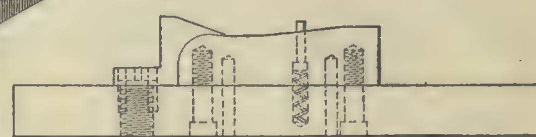


FIG. 1526

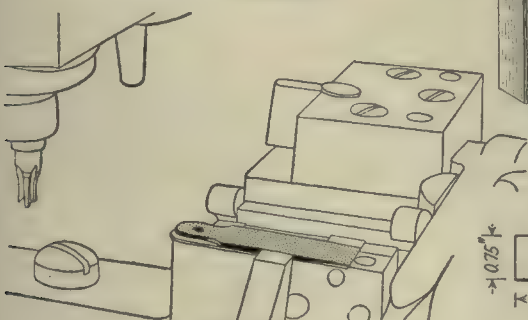
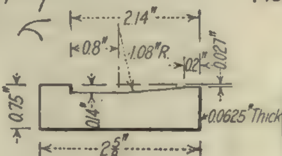


FIG. 1524

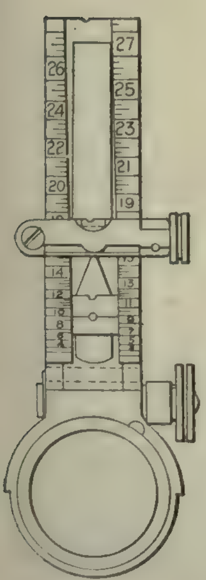


STEEL (Harden)
FIG. 1527

FIG. 1523

OPERATIONS ON THE LEAF

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
D	Cold dropping
1	Grinding top
2	Milling right edge and rear end
3	Milling left edge
5	Drilling joint pin hole
6	Reaming joint pin hole
7	Milling bottom, roughing
8	Milling bottom to finish
CC	Removing burrs left by operation 8
8½	Draw filing for graduation
9	Stamping graduations
10	Filing edge to remove burrs left by operation 9
GG	Removing burrs from joint pin hole (reamer)
10½	Milling top of joint, crossing
FF	Removing burrs left by operation 10½
12	Milling slide slot
DD	Removing burrs left by operation 12
13	Shaving slide slot
14	Removing burrs left by operation 13
15	Straightening
17	Countersinking sighting-notch clearance
18	Hand milling sighting notch
EE	Removing burrs left by operation 18
20	Hand milling rear end of joint
15½	Filing graduation
16	Profiling drift-slide notch
HH	Removing burrs left by operation 16



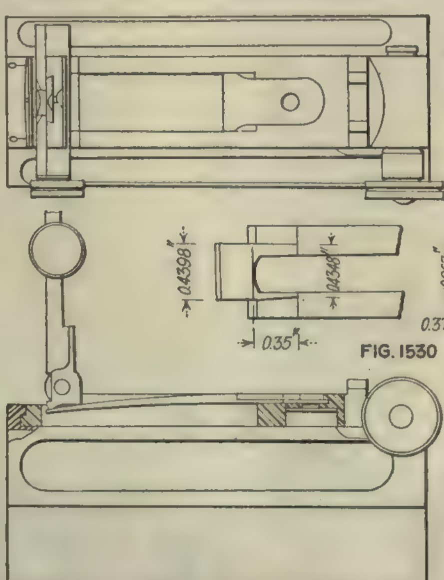
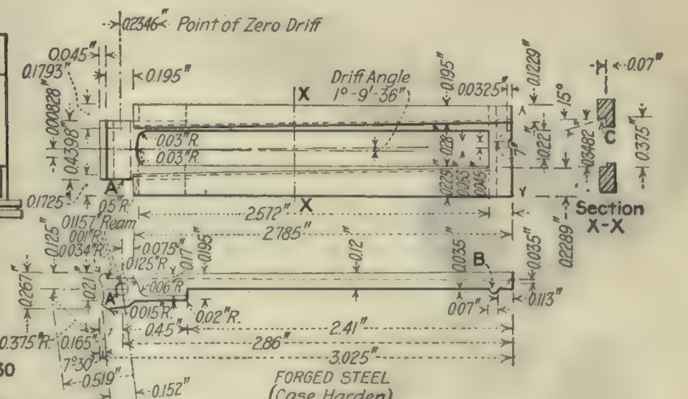


FIG. 1530



FORGED STEEL
(Case Harden)

19	Counterboring joint
21	Hand milling straddle joint
22	Hand milling joint, swing fixture
23	Countersinking and reaming joint pin hole
24	Filing to gage for thickness, width, width of straight slot, width of joint and general cornering
25	Cleaning graduation
26	Filing edges of drift slot to remove burrs
27	Casehardening
28	Straightening
29	Polishing graduations with emery cloth
30	Assembling with movable base.

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1531. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 600-lb. drop hammer. Production—125 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal, heated to 850 deg. C. (1,562 deg. F.), left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then in the pickling solution, which consists of 1 part sulphuric acid to 9 parts water, and left in this from 10 to 12 min. Apparatus and Equipment Used—Wire basket, wooden pickling tanks, hand hoist.

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 2 two-inch stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Punched down through die. Production—500 pieces per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

5000 pieces. Gages—Fig. 1536, width. Production—75 pieces per hr.

OPERATION 5. DRILLING JOINT PIN HOLE

Transformation—Fig. 1537. Machine Used—Ames two-spindle 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1538. Tool-Holding Devices—Drill chuck. Number of Cuts—One. Cut Data—1200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tools Between Grindings—250 pieces. Production—60 pieces per hr.

OPERATION 6. REAMING JOINT PIN HOLE

Machine Used—Ames two-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Work held in block by thumb-screw, Fig. 1539. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer, Fig. 1540.

FIG. 1531
OPERATION A

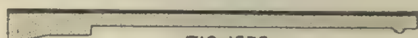


FIG. 1532

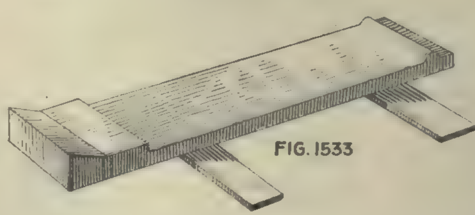
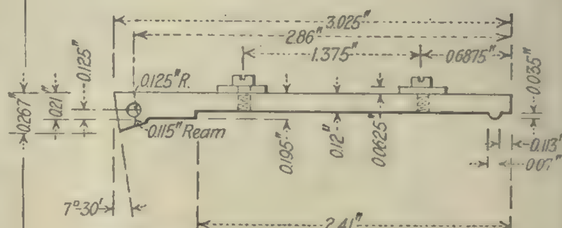


FIG. 1533



OPERATION 1

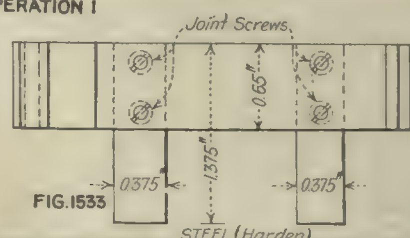


FIG. 1533

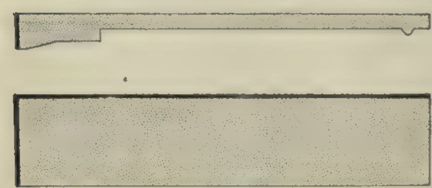


FIG. 1534
OPERATION 2

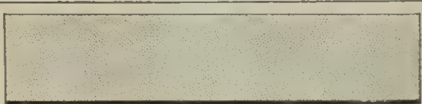


FIG. 1535

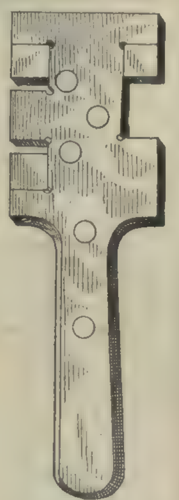


FIG. 1536

OPERATION 3

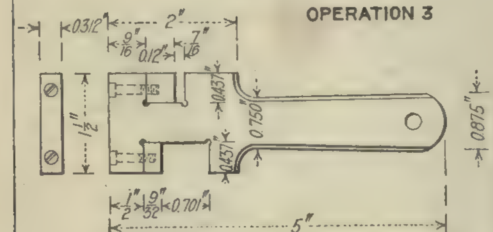


FIG. 1536 A

FIG. 1537

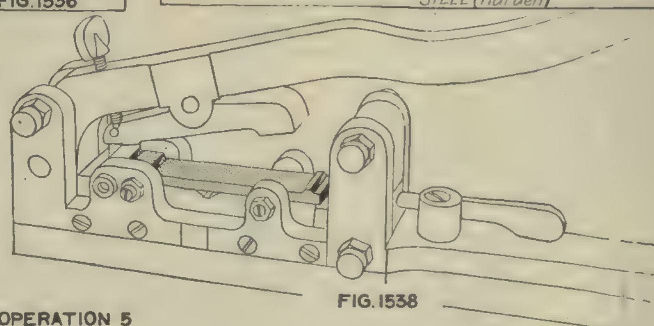


FIG. 1538

OPERATION 5

OPERATION 1. GRINDING TOP

Transformation—Fig. 1532. Machine Used—Pratt & Whitney vertical grinder. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck between strips. Tool-Holding Devices—Vertical spindle. Cutting Tools—14-in. wheel. Number of Cuts—About 15 trips of table. Cut Data—1500 r.p.m.; 15-in. feed. Coolant—Water. Gages—Fig. 1533, lay leaf on arms and see if it will clean up in future operations. Production—550 per hr.

OPERATION 2. MILLING RIGHT EDGE AND REAR END

Transformation—Fig. 1534. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Special vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—None. Production—75 pieces per hr.

OPERATION 3. MILLING LEFT EDGE

Transformation—Fig. 1535. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Vise jaws, same as for operation 2. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter similar to operation 2. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—

Number of Cuts—One. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig 1541; diameter of hole; squareness of hole with side of leaf. Production—350 pieces per hr.

OPERATIONS 7 AND 8. MILLING BOTTOM, ROUGHING AND FINISHING

Transformation—Fig. 1542. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1543. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{5}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width and thickness. Production—50 pieces per hr. of each operation.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 8

Number of Operators—One. Description of Operation—Removing burrs from operation 8. Apparatus and Equipment Used—File. Production—Grouped with operation 8.

OPERATION 8½. DRAW FILING FOR GRADUATIONS

Number of Operators—One. Description of Operation—Draw filing for graduations. Apparatus and Equipment Used—File. Production—275 pieces per hr.

OPERATION 9. STAMPING GRADUATIONS

Transformation—Fig. 1544. Machine Used—Roll stamping machine rebuilt at Hill shop, similar to machine for receivers. Number of Operators per Machine—One. Work-Holding Devices—Set in fixture, centered by pin in joint hole, Fig. 1545. Tool-Holding Devices—Roll; see Fig. 1546. Number of Cuts—One. Gages—Fig. 1547. Production—175 pieces per hr.

OPERATION 10. FILING EDGE TO REMOVE BURRS LEFT BY OPERATION 9

Number of Operators—One. Description of Operation—Filing edges. Apparatus and Equipment Used—File. Production—Grouped with operation 9.

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 10½

Number of Operators—One. Description of Operation—Removing burrs from operation 10½. Apparatus and Equipment Used—File. Production—Grouped with operation 10½.

OPERATION 12. MILLING SLIDE SLOT

Transformation—Fig. 1550. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Operators per Machine—One. Work-Holding Devices—In elevating fixture, held by vise jaws, Fig. 1551. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter. Number of Cuts—One. Cut Data—70 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5,000 pieces. Gages—Width of slot. Production—100 pieces per hr. Note—Handle at rear of fixture is for elevating fixture for width of slot.

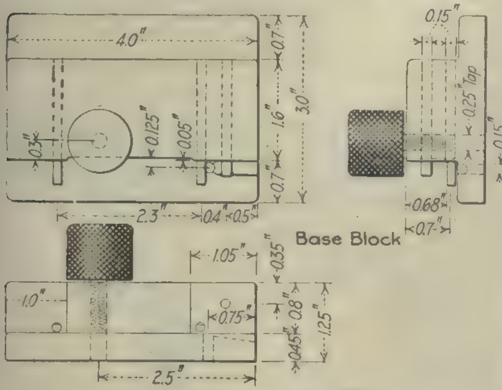


FIG. 1539

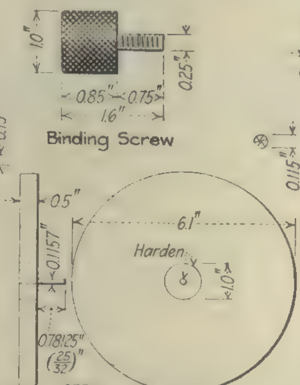


FIG. 1541

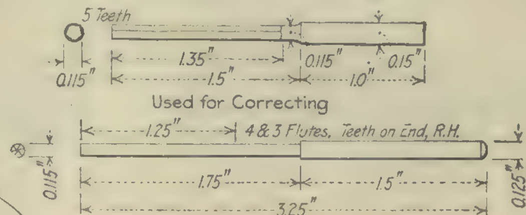


FIG. 1540


FIG. 1542

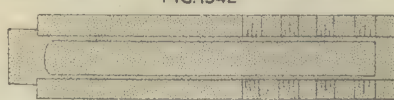


FIG. 1544

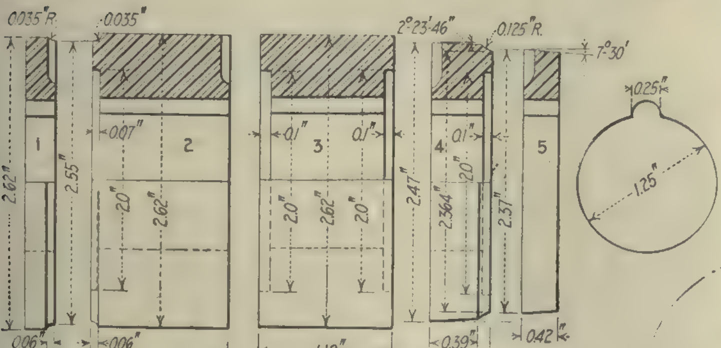

26 Teeth Left Hand, Mills 2 & 3 Spiral Left Hand, One Turn in 48 Inches, others Straight; 24 Teeth for Operation 7, Roughing

FIG. 1543

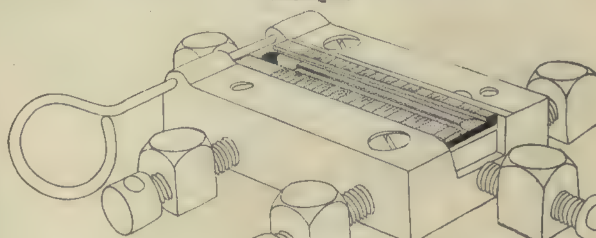


FIG. 1545

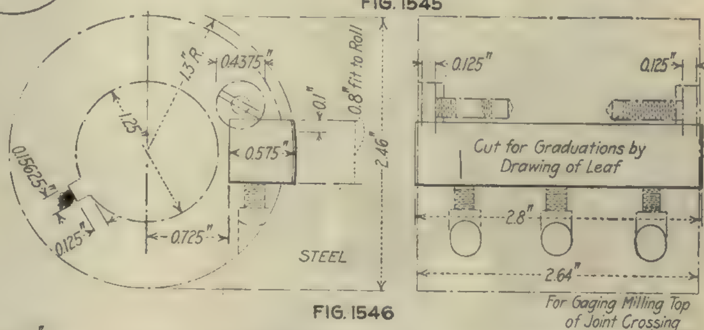


FIG. 1546

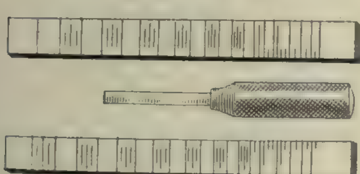


FIG. 1547


FIG. 1548

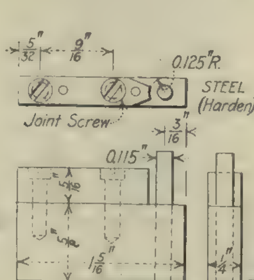


FIG. 1549-A

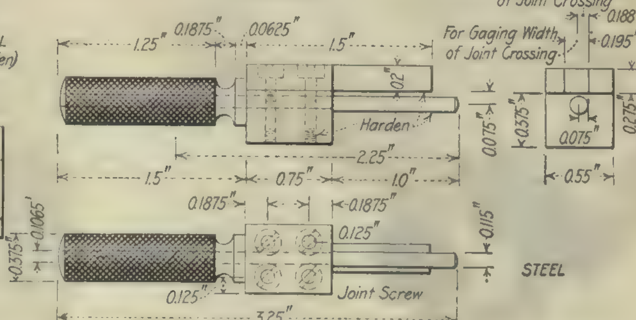


FIG. 1549-B

FIG. 1542, 1543, OP. 7 & 8
FIG. 1544, 1546, 1547 OP. 9
FIG. 1548, 1549 OP. 10½

OPERATION GG. REMOVING BURRS FROM JOINT PIN HOLE (REAMER)

Number of Operators—One. Description of Operation—Removing burrs from pin hole. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operations 9 and 10.

OPERATION 10½. MILLING TOP OF JOINT, CROSSING

Transformation—Fig. 1548. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held in vise jaws on pin. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling Cutter. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1549; A. radius over joint on each side; B. across both ears. Production—40 pieces per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 12

Number of Operators—One. Description of Operation—Removing burrs from operation 12. Apparatus and Equipment Used—File. Production—Grouped with operation 12.

OPERATION 13. SHAVING SLIDE SLOT

Transformation—Fig. 1552. Machine Used—Perkins-Snow No. 2 one-inch stroke press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Fig. 1553. Dies and Die Holders—Fixture screwed to bed of press Fig. 1554. Stripping Mechanism—None. Average Life of

Punches and Dies—700 pieces. Lubricant—Cutting or fish oil, put on with brush. Gages—Fig. 1555; width of slot; end of slot from pin; length of slot. Production—75 pieces per hr.

OPERATION 14. REMOVING BURRS LEFT BY OPERATION 13

Number of Operators—One. Description of Operation—Removing burrs from operation 13. Apparatus and Equipment Used—File. Production—Grouped with operation 13.

OPERATION 15. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening. Apparatus and Equipment Used—Lead block, hammer and straight-edge. Production—350 pieces per hr.

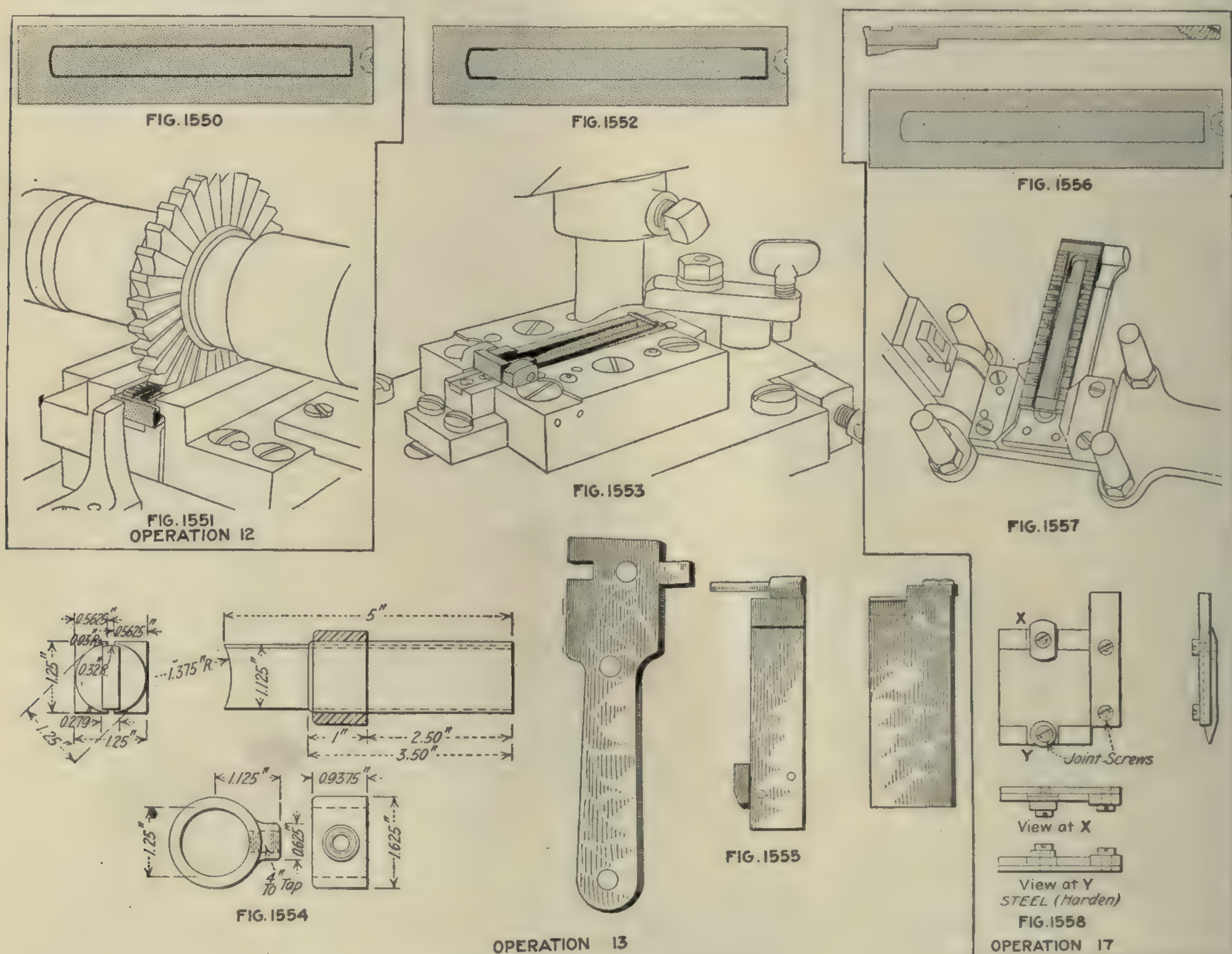


FIG. 1550 FIG. 1551 OPERATION 12 FIG. 1552 FIG. 1553 FIG. 1554 FIG. 1555 OPERATION 13 FIG. 1556 FIG. 1557 FIG. 1558 OPERATION 17

OPERATION 17. COUNTERSINKING SIGHTING-NOTCH CLEARANCE

Transformation—Fig. 1556. Machine Used—Sigourney three-spindle 18-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1557. Tool-Holding Devices—Drill chuck. Cutting Tools—Special twist drill. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1558; depth of counterbore; the point must cover the counterbore to give distance from end. Production—75 pieces per hr.

Are Ambitious Young Men Really Wanted?

By E. P. Baker

In reading current papers and magazines one comes across articles every once in a while regarding the scarcity of high-class men, those who are worth from \$5000 to \$10,000 a year. The question has occurred to me often, Why is it so hard to get these big men? I started to find out.

I am a young man, 30 years old, and have followed the machinist trade and toolmaking for the past 12 years. Conditions at home were such that I felt it my duty to earn all I could at the time, so I did not see my way clear to enter the office end or engineering at a reduced salary until a short time ago.

I have tried for the past month to get such a start, stating that I wanted an opportunity to work up and advance to the big positions. So far not one firm, of several I have interviewed, seems to want a man who is ambitious to get to the top. I have stated that I am willing to start in right, give them the full benefit of my shop experience and attend night school or otherwise educate myself for future duties, but I have received no encouragement.

This seems to indicate that the large firms are not as anxious to secure young men having ambition as some of the magazines would have us believe.

The men higher up seemed to be afraid of losing their own positions, so did not want ambitious men working for them. What they were looking for were men who were willing to be crowded into a \$15 a week chair and stay there.

[The trouble is that you did not see the right men. You got hold of some of the little fellows. The real boss, the real man highest up, wants men with ambition.—Editor.]

Letters from Practical Men

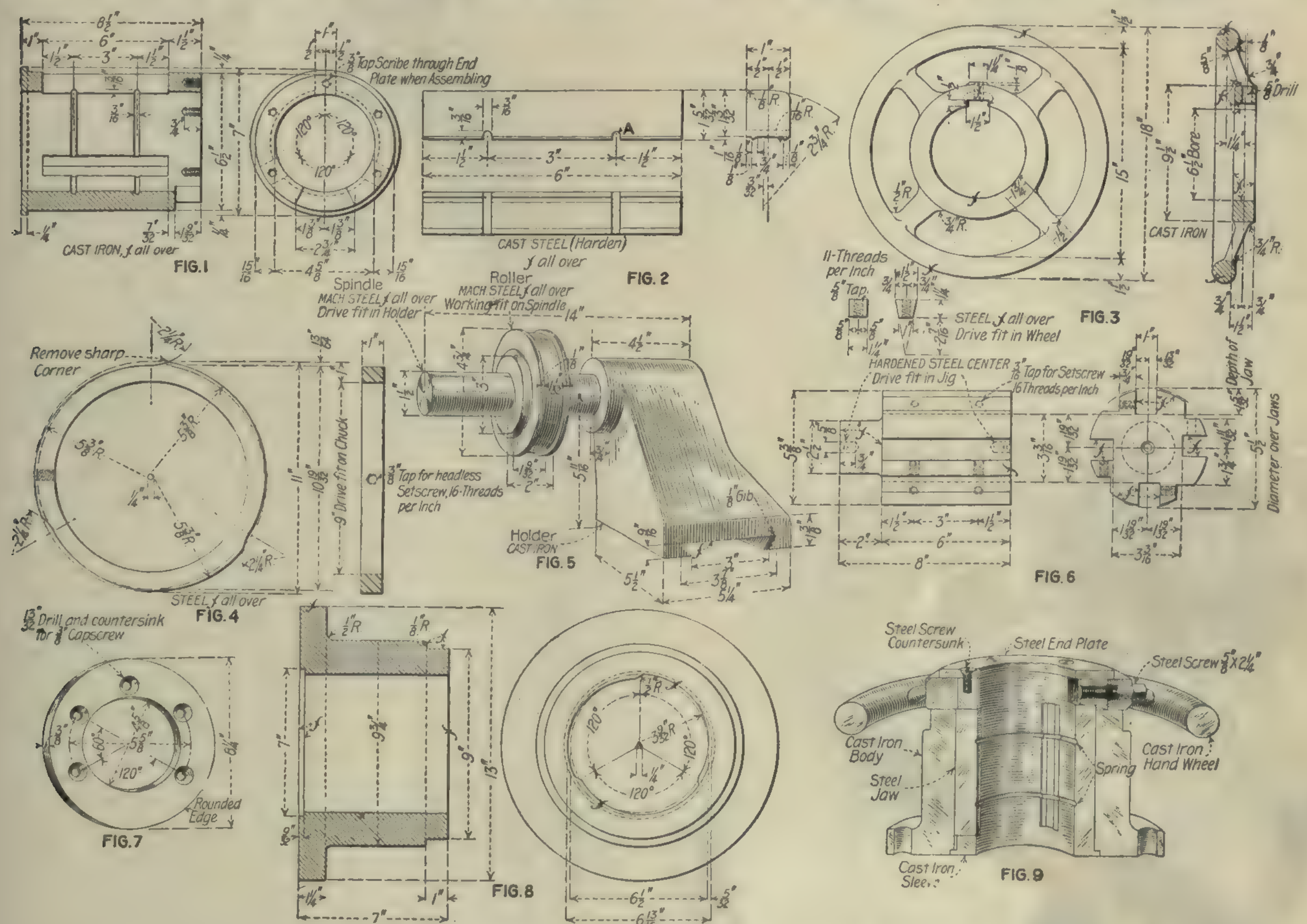
A Quick-Acting Chuck for Boring

The numerous operations on shell machining require chucks in one form or another. The following description covers a chuck that is simple in form and quick in operation. Under practical working conditions this chuck speeded up our boring from 7.5 shells to 11 per hour, and the base bore from 16 to 23 per hour. It gives no trouble, and countershafts may be eliminated.

The chuck consists of a flanged pot bolted by the flange to the face plate, or with a threaded bottom screwed directly onto the lathe arbor. This pot is 6½ in. in diameter and form-bored with three cams as hereinafter described. It is also counterbored at the bottom to hold a retaining flange on the sleeve, as shown in Fig. 1. This sleeve is a loose turning fit in the outer pot and rests on three lands each about ⅝ in. wide, located between the cams. It is retained by its flange in the counterbore at the base of the pot and is slotted to receive three hardened-steel jaws, Fig. 2, that are held in the slots and back against the cam surfaces by two wire springs seated in the grooves *A*. The end of the sleeve projects from the pot for the reception of a handwheel.

This handwheel, Fig. 3, has a knocking block, or heavy key, projecting into its center hole where it is bored to fit on the projecting end of the sleeve. The sleeve is cut away so that the handwheel can be rotated through a considerable arc before its key brings up against the ends of the cutaway part. In this way the handwheel can be made to give the sleeve a hammer blow, tightening or loosening it instantaneously.

The handwheel is held on the sleeve by a retaining washer bolted on the end of the sleeve. All the pots are bored to take the cam ring, Fig. 4. The attachment, Fig. 5, for boring the chuck bodies was fitted to a 12-in. toolroom lathe.



FIGS. 1 TO 9. DETAILS AND ASSEMBLY OF QUICK-ACTING CHUCK

After the pots were bored to take the sleeve, the bracket, Fig. 5, was mounted, the cam put on, the cross-slide screw taken out, the forming attachment weight put on, and everything was then ready for form-boring.

To turn the back of the jaws correctly, a very important item, we made up the slotted mandrel, Fig. 6.

In Fig. 7 is shown the end plate for the chuck. The body of the chuck is shown in Fig. 8. A sectional view of the chuck is shown in Fig. 9.

St. John, N. B. CHARLES FREDERICK WHYTE.

Use of Steel Cores

We recently had 100 friction disks, in each of which were to be inserted 72 corks. The method adopted may be of interest to your readers.

It is evident from Fig. 1 that under most favorable conditions an operator on a drilling machine would require from 45 to 60 min. to drill this number of holes. Thinking that this time could be reduced, the writer experimented with the idea of coring the holes with steel cores. The scheme was successful, inasmuch as the labor required from the time the molder started the mold until the holes were in the casting was but 38 min., whereas to drill the holes the entire labor would have taken more than 1 hour 30 min.

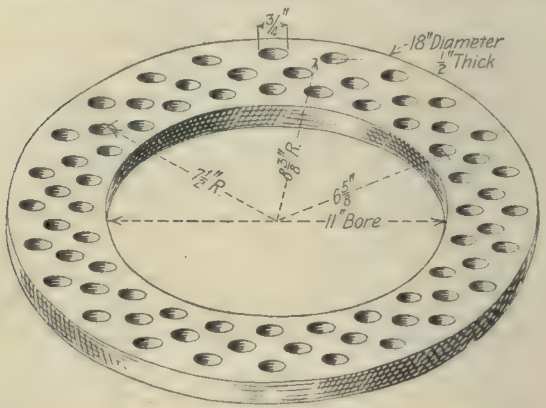


FIG. 1. THE PLATE

With the steel cores this labor was distributed over the casting as follows: The molder consumed 30 min. in making the mold, and 8 min. was necessary to remove the steel cores from the casting.

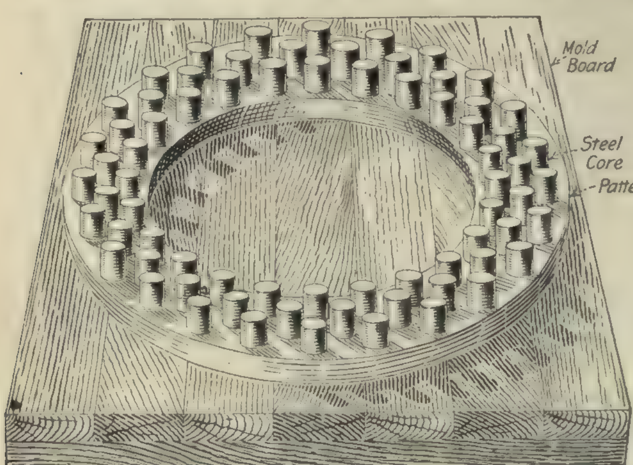


FIG. 2

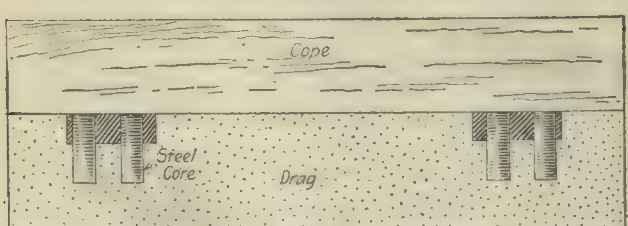


FIG. 3

FIGS. 2 AND 3. THE PATTERN AND A SECTION OF THE MOLD

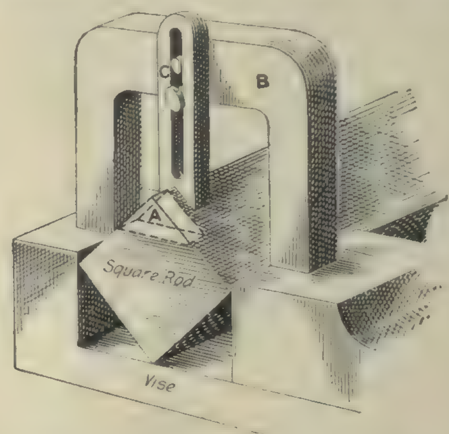
The pattern was regularly made, with the exception that 72 holes, ¾ in. in diameter, were made in it to receive the cores. Laying the pattern on a mold board, the cores were inserted as shown in Fig. 2, and the drag was rammed. Then the work was turned over, the cope was rammed and the pattern removed. The cores remained in the mold, thus saving the molder's time in setting them. Fig. 3 is a cross-section of the mold.

Dexter, Me. E. W. TATE.

Setting Gage for Milling Square Stock

The accompanying illustration shows a small device for setting up square rods for milling.

We had several hundred square rods about 8 in. long to mill flat on one corner, as shown at *A*. The chuck was not deep enough to allow the use of a V-block, so a wrought-metal gage *B* was made to rest on the chuck, with a slide *C* in the center and a V to engage the square rod in the chuck.



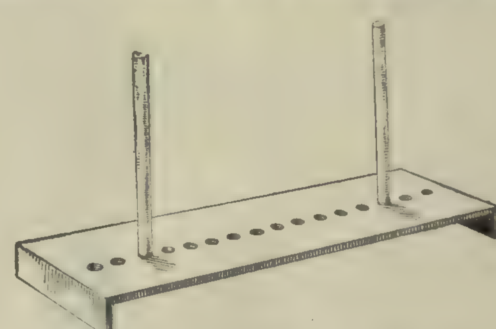
SETTING GAGE FOR SQUARE ROD

This enabled us to set the work up accurately and rapidly for milling. A. E. HOLADAY.

Naugatuck, Conn.

Stock Guide for Punch Presses

The illustration shows a guide for flat sheet stock of various lengths and widths, such as is frequently used in presswork. A piece of iron about 1¼ x ¼ in. and long enough to suit the various sizes of sheets is bent at right angles, as shown. A series of holes are drilled and tapped with ¼ x 24-in. threads, into which studs or uprights are inserted for the required width. By placing two of these stands at convenient distances stock may be guided.



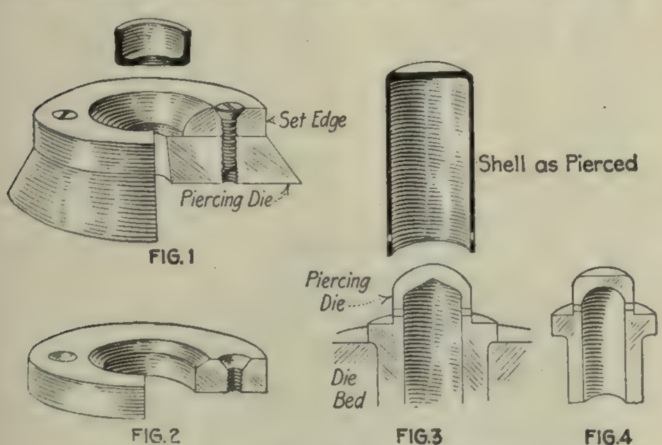
STAND WITH GUIDE PINS INSERTED

East Rutherford, N. J. GEORGE F. KUHNE.

Simple Die-Making Kinks

Herewith are two simple die-making kinks that will help to increase the output of foot- or bench-power presses.

In making the set edge, or "nest," as some die makers call it, for a set of piercing tools the corner of the hole in the set edge that fits the outside diameter of the shell or blank to be pierced should have plenty of bell mouth, as shown in Fig. 1, for the reason that it greatly facilitates locating the shell in the hole in the set edge. Some



FIGS. 1 TO 4. SET EDGES AND PIERCING DIES

die makers shape their set edges as shown in Fig. 2, with the result of making it difficult to locate the work.

The same principle holds good in making a piercing die of the peg type, as shown in Fig. 3. The top is conical and fits inside the shell. A die of this kind is often made as shown in Fig. 4, which makes it difficult to place the work. CHARLES DOESCHER.

Waterbury, Conn.

Index Drilling and Milling Fixture

Our engineering department has designed and built a fixture which I believe would interest some of your readers. It would perhaps be better first to describe the work done with this fixture.

Our special line is manufacturing kerosene-burning carburetors, which use valves and valve levers laid out in various angles that require careful machining. The carburetors are made in comparatively small lots at the present time. To machine these valves would mean thousands of dollars' worth of special tools for the great number of angles that must be taken into consideration, as every size of carburetor would require individual equipment for machining the valves in the different positions. In Fig. 1 is shown the number of angles required for one size of carburetor especially adapted to one car. Figs. 2 and 3 perhaps give a better idea of the actual work re-

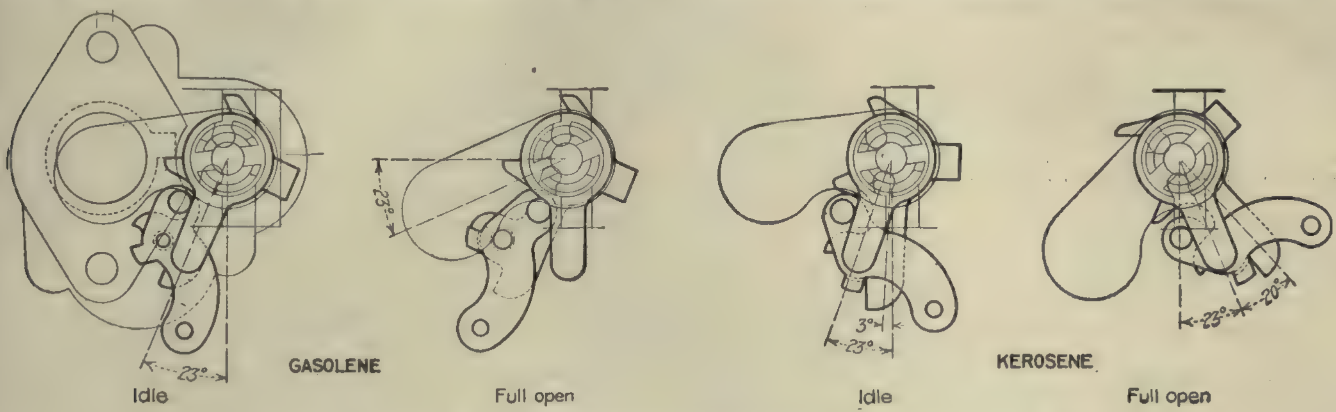


FIG. 1. PARTS OF A KEROSENE CARBURETOR TO BE MACHINED

quired and the number of angles to which our machining department is asked to work.

Owing to the small lots in which these carburetors are manufactured, our engineering department was confronted with the problem of designing, with as little cost as possible, special tools to meet the demand. It is doubtful if any engineering department could have been more successful. The dividing head is illustrated in Figs. 4 and 5.

In Fig. 4 is shown the dividing head set up to mill the slot in the part seen in Fig. 3. The part is mounted on a graduated disk and held in position by means of a bolt with a slot washer that is tightened on the opposite end

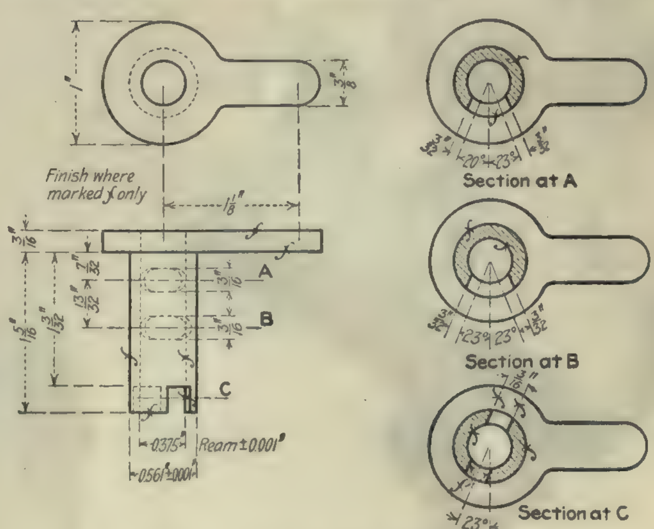


FIG. 2. DETAILS OF THE PARTS

of the spindle on which the plate revolves. It is located on the zero line by means of a lug that is adjustable in a T-slot on the zero line. The ends of the slot are located by an adjustable stop on the periphery of a plate or disk, which is graduated in degrees and has vernier graduations on the side of the two stops. The stops are fastened in position by two screws and a nut inside of a T-slot, which runs around the entire circumference of the grad-

uated disk. The ends of the stops are beveled off 45 deg., so that they will be easily placed to match with the lines indicating degrees. They come in contact with a stop on the frame of the dividing head, which is also 45 deg. on each side. When a segment of a circle is required, if the two stops are set exactly on a degree line and the graduated disk is swung from one stop to another, the stop on the frame will point out the same degree line at which the stop on the graduated disk is set. The slots are milled with a four-fluted cutter with an end similar to that of a flat drill. The cutter is held in position by means of a steel bushing in a block clamped on an arm with a slot for adjustment to height. The arm is adjustable to and from the plate and is clamped in position by means of a bevel-edged clamp, which assures accurate location, the adjustment being governed by a scale that is clamped to the top of the slide and has vernier lines graduated on the guide. The slots in the throttle lever, with the exception of the end slot, are all milled on a drilling machine. The end slots are machined on a miller. The dividing head, which is tipped down so that the face of the disk will be upward and parallel with the table of the miller, is operated in a manner similar to its vertical position. The dividing head is then locked to a fixed position by sliding the two stops tight against the stop on the frame of the dividing head and tightening the screws.

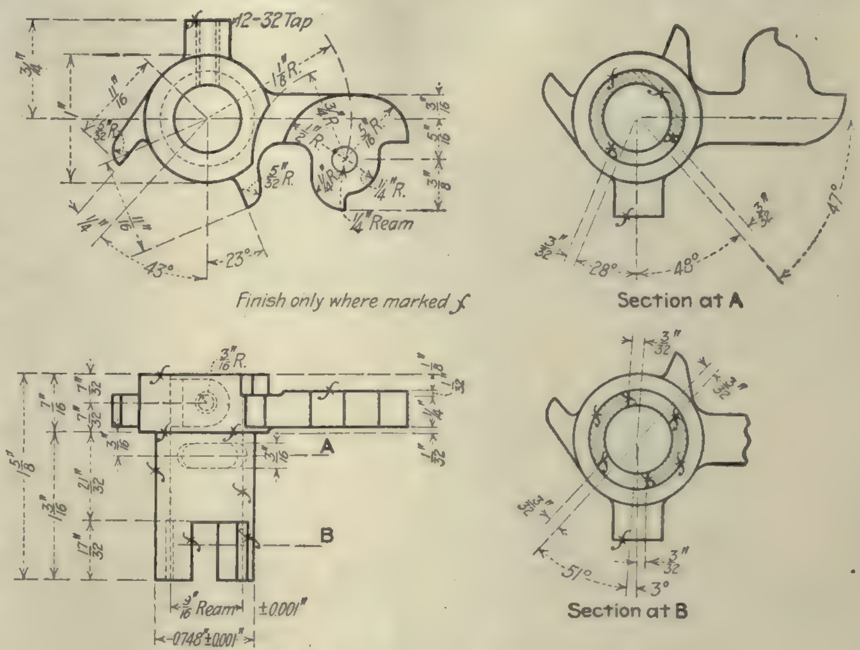
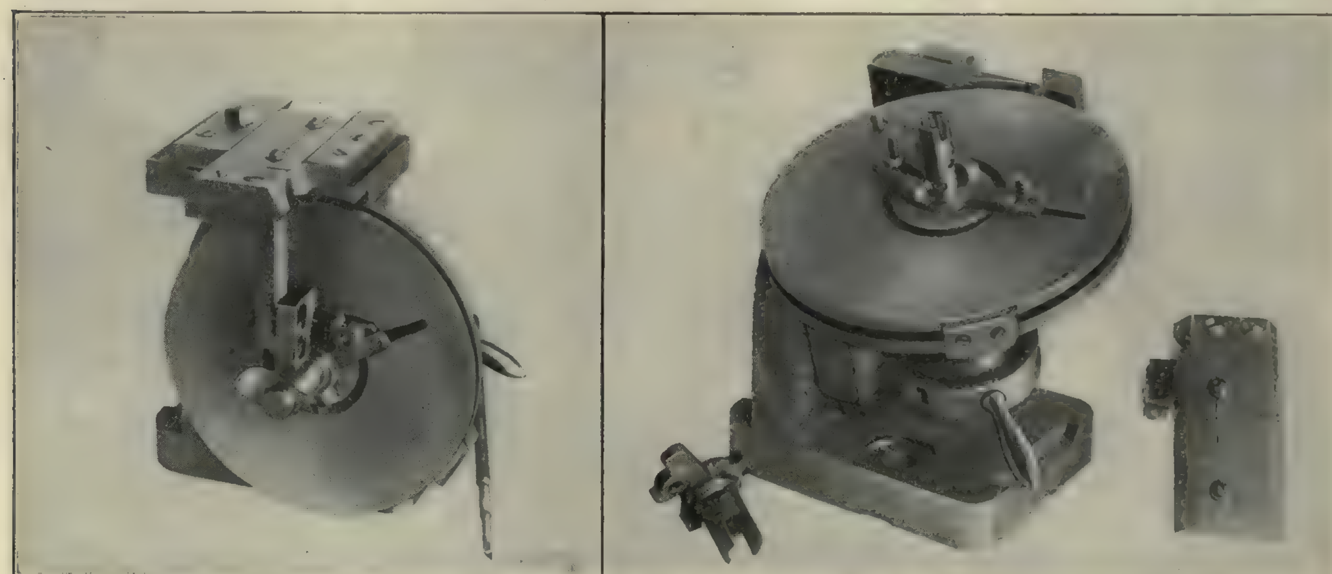


FIG. 3. DETAILS OF THE PARTS

This fixture is used for drilling the holes in Fig. 3.

Detroit, Mich. G. ROGERS.



FIGS. 4 AND 5. MILLING AND DRILLING FIXTURE

John Ericsson Monument

As is probably already known to most engineers, Congress appropriated last fall $35,000 for a monument in memory of John Ericsson, the eminent engineer, to be erected at Washington. A special commission was appointed by the Government to take care of the details in connection with the erection of the monument. This commission met at Chicago, Mar. 10, and it was decided that $25,000 ought to be added to the other appropriation made by the Government, in order that a fitting memorial might be erected. It is proposed to raise this amount by private subscription, and all American engineers, organizations and societies are invited to aid in commemorating the work of John Ericsson, who gave signal service to the country at a time when its very existence hung in the balance.

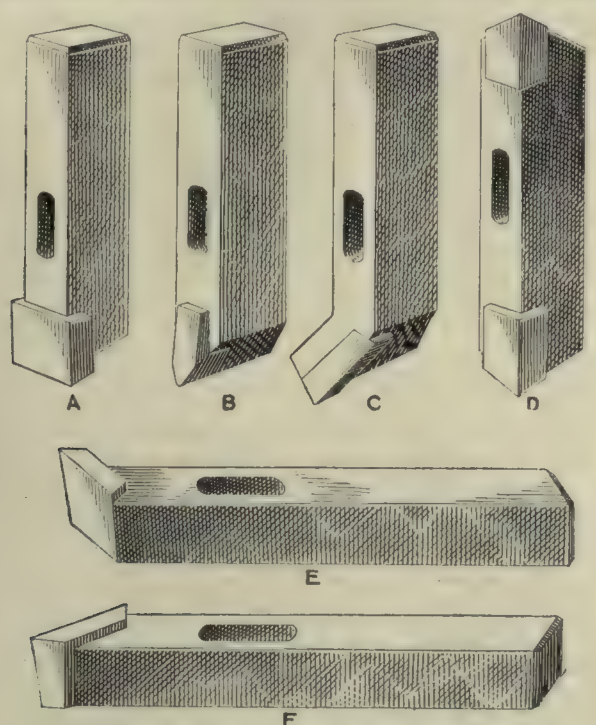
It is the first time that the United States Government has made an appropriation for the erection of a monument to an engineer, and engineers generally will, no doubt, be proud to aid the efforts of the John Ericsson Monument Commission. Subscriptions toward the monument will be received by Erik Oberg, associate editor of *Machinery*, 148 Lafayette St., New York City, who is a member of the commission.

Discussion of Previous Question

Brazing High-Speed Steel Tips to Machine-Steel Cutting Tools

I read with much interest the article by J. Ellis, on page 161, describing a method of brazing high-speed steel inserts to mild-steel shanks. His experience closely parallels my own. We braze a variety of shapes of high-speed steel and "Stellite" tools and have encountered several difficulties, including those mentioned by Mr. Ellis.

For high-speed steel, the brazing and hardening being one operation, I use copper, the only metal that melts at the hardening temperature (1900 to 2000 deg. F.). Spelter and brass at this heat separate into their copper constituent and a dirty dross that breaks the joint. The copper should be quite thick, 0.040 in. or more, and the tool should be withdrawn from the fire as soon as the copper begins to flow and show a green scum. A few light blows struck on the insert expel the excess metal and fill any inequalities in the joint. If made too fluid, the copper cools spongy and makes a weak joint. I use powdered sal ammoniac in preference to any other flux I have tried. With all surfaces ground bright before going into the fire, I have very few failures.



VARIOUS TYPES OF BUILT-UP TOOLS

"Stellite" exhibits even more than high-speed steel the quality mentioned by Mr. Ellis of taking the brass or copper in spots or not at all, but this can be easily overcome by tinning the "Stellite" and sweating to it a piece of thin soft brass bent to cover the surfaces to be brazed. The insert so prepared is then set into the recess in the shank, with the heavier brass intended for brazing and plenty of well-calcined borax, and is brazed in the ordinary manner. The difficulty seems to lie in the corrosive action of the hot gas of the forge on the high-speed steel or "Stellite." The thin brass melts before the insert is hot enough to corrode, and alloys with the solder to coat the insert with a thin protective layer of brass, to which the heavier metal can adhere when melted.

Care should be used in hammering "Stellite," as it remains brittle even when red and crumbles at a little above a bright-red heat. It takes solder with difficulty, but can be soldered with a very hot iron and chloride of zinc as a flux.

We prepare the shanks much as Mr. Ellis describes, leaving an abutment on the shank to take the thrust from the cut. We also set a hard inlay in the shank to prevent the toolpost screw from marring it.

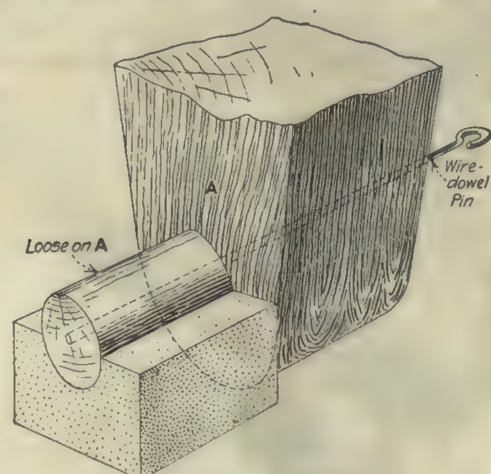
The illustration shows some of the tools and how they are mounted: *A* is a forming tool, *B* a round-nose tool, *C* an offset roughing tool, *D* a straight roughing tool with right- and left-hand ends; *E* and *F* are tangent tools for screw machines; *B*, *C* and *D* have tips of "Stellite," and *A*, *E* and *F* of high-speed steel.

Cincinnati, Ohio. HOWARD BOGART.

Setting a Core Without a Print

The article by Donald A. Hampson, on page 12, which illustrates and describes the making and the molding of the pattern for the grate, is both interesting and instructive.

Mr. Hampson calls attention to "the advantage of coöperation with the foundry." Speaking about this grate pattern, he states, "the matter of casting these grates presented itself when the pattern was nearly finished."



METHOD OF MOLDING THE HUB

It's the old story, What's the use of looking for trouble? The coöperation idea did not strike the pattern maker at the start, when he was planning the construction of the pattern and predetermining the operations of the molder.

Perhaps existing conditions—location of the foundry, shop rules, a fear of displaying a lack of knowledge of the little things pertaining to the molding game—were responsible for this close finish.

The pattern maker mentioned in Mr. Hampson's article "stepped into the foundry and asked the foreman if he knew of a simpler way." He followed the molder's advice and made good—at the finish.

Another simple and practical way for molding the hub on the grate pattern is here shown. Make a saddle core like the one shown, the hub loose on the arm of the pattern; secure it in place by means of a wire dowel pin inserted from the back. The whole pattern—the hub up—is molded in the drag; sand is filled in up to the top of the core; the filling-in of the sand is now stopped, the core is lifted from the mold, the dowel pin drawn out and the hub is lifted. The core is returned to its place in the mold, the filling-in of the sand is continued and the drag completed and rolled over ready for the cope.

Only a small part of the surface of the casting comes in contact with the core, consequently a slight shifting of the core would not effect the appearance of the casting. This is important in the making of stock castings.

Kenosha, Wis. M. E. DUGGAN.

Can Profits Be Shared?

When one of Entropy's reputation asks the question, it is probably presumptuous for a meek and lowly machinist even to attempt an answer. But when he compares the sharing of profits with the wisp of hay on the fishpole in front of a horse's nose, it seems to me he quite misses the point. The horse had given up the chase because the promise was never fulfilled, and promises of profit sharing will certainly have no effect unless they are really kept—and at frequent intervals.

I fail to see how Entropy discriminates, in the fourth paragraph, page 151, between paying stockholders and men out of an accumulated surplus. If no profit is made, how can stockholders share it any more than employees? And if we decide to distribute a profit previously earned, but not distributed, why should not the employee share it as well as the stockholder? It was withheld in one case as well as the other.

Theoretically, every man who works and thereby presumably assists in producing the profit should share in it, just in proportion as his work is of value. And this includes the laborer, whether his period of employment be long or short. Otherwise the man who is hired during a boom and dropped in a short time, through no fault of his own, would never be eligible for his share of the profits.

Practically, it is difficult to share profits with short-term workers or as frequently as desirable. Waiting till the end of the year or even six months does not have a very strong appeal to the man who lives by the week. Profit sharing, to be most effective, must be done at short intervals. There is no more reason why a man who quits, voluntarily or otherwise, during the period should lose his share than that a stockholder should sell without getting his proportion of the dividend that is due at the next quarter.

The last paragraph is full of meat for careful reflection. FRANK C. HUDSON.

New York City.

Metric System Preferred to English

With reference to the editorial about the "Anti-Metric Institute," on page 391, my position is exactly the opposite of that therein expressed. The fact that the founders of this new society admit the need of strengthening and improving the English system weakens their position in the fight against the metric system.

The only way that the old standards and units can be improved is by changing some and dropping others. It can scarcely be doubted that it will be harder to make such changes than to change from the old system to the metric. When two people talk of yards and meters, there can be no question what each one means; but if, for instance, the dry quart is changed to agree with the wet, there will be no certainty when one buys a quart of meal as to the amount to be received.

All the arguments against the metric system, so far as I have seen any that have gone beyond simple assertion, are based on the trouble to be caused by making the change. If the institute is really to improve our present system, it means making so many changes that fully as much trouble will arise as in changing to the metric system; for while the number of changed units may not be so great, the difficulty will be enough greater to make the total just as bad.

Finally, if they should succeed in improving the old system, they will have still missed the two most important points in favor of the metric—that there is a reasonable possibility that it will be adopted by at least a good part of the world, and that it is a decimal system.

Plymouth, Mich. W. B. GREENLEAF.

A Plea for Apprentices

I have read with interest a number of articles on the subject of apprentices, and I differ somewhat with most of the views expressed. This talk about the modern shop not having time for apprentices is inconsistent, as most of them are hiring a good many so-called first-class mechanics who are in reality nothing but apprentices and who must be taught. These men eventually make good and so will an apprentice. In 95 per cent. of the cases the apprentices will be far steadier and stay longer than the others. If these up-to-date shops have time to teach the "would be," they can also take time for the apprentice.

Foremen can find a good many parents who are only too willing to have their boys learn a trade in the proper way—at a moderate scale of wages, which in my opinion is far better than hiring the "would be" and paying him good wages. If foremen would give this method a trial, they would find it profitable to the firm as well as keeping up the supply of skilled labor.

After these boys have learned the rudiments of the shop, they almost automatically work themselves into a good rate of production. I find there is plenty of work for one boy to every 10 or 12 mechanics. A boy can be put on every few months in a shop employing 50 to 60 men. Each boy is made to help the last one until he does what the former has been doing, and so on; each one helps the other up the ladder. A very high percentage of the apprentices will work out well; and as apprentice labor is inexpensive, the experiment is well worth trying. C. CANDER.

Detroit, Mich.

Editorials

Fostering Responsibility in Employees

The average man shrinks from responsibility. It is easy to promote this tendency in the daily routine of the shop, but to do so is certainly no part of scientific management. The opposite effect is plainly the goal to which all organizations should strive, and while divided responsibility may lead to danger, there seems to be a middle course through which beneficial results may be attained.

In the issuance of orders in the shop, there is an opportunity to systematically foster responsibility on the part of subordinates in a way that will maintain discipline and build up a spirit of coöperation—a sort of diplomatic code. Specifically, this procedure can best be explained by the statement made by an eminently successful superintendent: "I never tell a workman that a certain operation must be done in such and such a way, but rather ask if it cannot be done that way."

A suggestion will invariably take firmer root than a mandatory order, which almost as invariably breeds resentment. No matter how subordinate his position, a man prides himself on knowing his part of the job. It is wise to encourage him in that feeling, for there is no greater stimulus to increased effort than implied confidence. In this direction too few executives heed the psychological effect of their orders.

Executive ability does not consist of knowing how to best carry out the details of every piece of work. Details and executive ability seldom harmonize. Otherwise, the best workmen would make the best executives—a theory not often proved in actual practice.

An executive who persists in giving detailed instructions to a subordinate would do well to positively establish that he knows more about the particular work in question than does the subordinate.

Blaming the Other Man for Our Delays

In the desire to free themselves from blame in the eyes of others, many are led to do a grave injustice to an innocent third party. The foreman of one department is sometimes guilty of attempting to shield himself by claiming that delay in another department is to blame for his being behind in his output.

The same thing applies in too many cases to those farther up the line, and we find some machine builders excusing late deliveries by claiming that the motor manufacturers are delaying shipment and by giving similar reasons that too often have no foundation in truth. The injustice lies in injuring the reputation of an innocent party and, in most cases, not giving him a chance to prove an alibi, if indeed he learns of the libel except indirectly and after it has done its damage.

When the truth does come out—and it does at times—the reputation of the one who excuses himself at the expense of others is injured far more seriously than if he had told the absolute truth in the matter. No one gets away with injustice of this kind successfully enough to make it worth while in the long run. It is much safer and leaves one with a better feeling to take his medicine as he goes along, instead of living with the possibility of a revelation that may injure, if not ruin, his reputation for reliability. Shifting the blame instead of remedying the causes of delay is poor business policy.

The Opportunity for Steel Makers

The severe and unprecedented demand for product has made it almost impossible for manufacturers who desire extra-fine alloy steels to obtain the desired quality from our steel makers. Not that it is impossible for the makers to produce such steels, but the great demand for other and lower-grade steel has induced them to choose the easiest way and neglect the opportunity to secure a trade that has hitherto largely gone abroad.

There is still an opportunity to secure and retain this market for high-grade steel forgings, but it should not be neglected too long, in the belief that it can easily be picked up after the rush is over. Anybody having this idea is very likely to be mistaken. Customers are chafing at the scant attention they receive; and it will take much more effort to secure another trial later, when other markets are open, than it does at present.

A little missionary work now, even though it does not pay as well as large tonnage of lower grades, will yield big returns in a steady high-grade trade in the years to come. Now is the time to lay the foundation for a business that will add not only to the total business, but to the reputation of the nation as a maker of high-grade steels.

Keeping Inspectors Out of Temptation

There is one phase of the inspection problem, both for government and for private use, that deserves careful attention, particularly at this time. No inspector should be interested in any way in any apparatus or equipment that passes through his hands.

This is so self-evident that it would seem to be an unnecessary warning, and yet there are many cases where this is being done both in this country and abroad. While it is perhaps natural that a man who is inspecting a certain kind of machine should devise some new attachment for it, he should either refrain from developing his idea or resign as inspector of that particular machine.

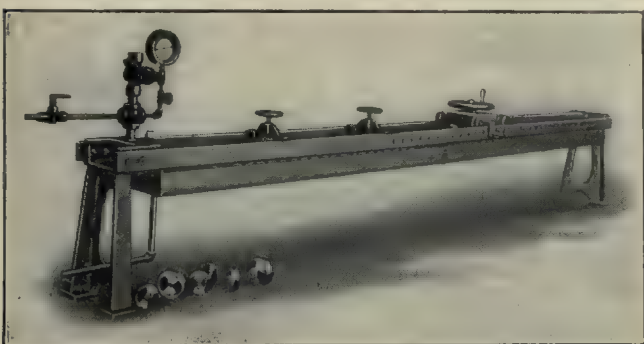
There are cases where the inspectors refuse to pass machines not equipped with their devices, which at once introduces grave suspicions as to the strict ethical honesty of the individual in question. There are many ways of securing financial recompense without actually taking money, yet the result is the same and the practice is to be discouraged in every way possible.

No inspector should pass on a class of machines in which he has any financial interest, any more than a judge should sit in a case in which he is in any way interested. Let us prevent any repetition of the scandals of 1898 by making such things impossible now.

Shop Equipment News

Boiler-Tube Testing Machine

The Watson-Stillman Co., Aldene, N. J., has recently added to its line of hydraulic machinery a testing machine for subjecting boiler or other tubing to internal hydrostatic pressure. As shown, the machine consists of a frame supported by two sets of legs. A stationary abutment is placed at one end, while a second one in the shape of a carriage mounted on rollers moves on the rectangular side bars. This carriage may be set for the desired length of tubing and is held in place by pins



HYDRAULIC TESTING MACHINE FOR BOILER TUBES

passing through the side bars. Two intermediate clamps are used to prevent the tube from buckling while under pressure. The pan under the frame serves as a reservoir for the initial filling of the tubes and to catch all waste water.

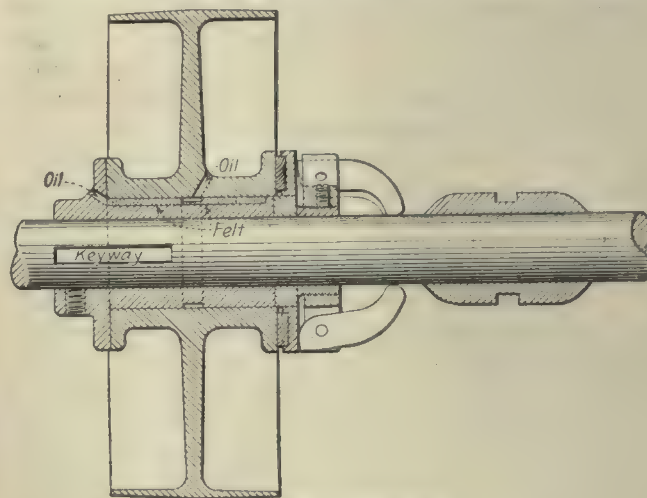
In operation the end of the tube is placed against the fixed abutment; the moving abutment is brought to approximate position and fastened by means of the pins shown. The tube is then made tight by turning the handwheel, which advances a spindle, held in the moving abutment, against the end of the tube. The tube is then filled with water, and a high-pressure pump is used to raise the pressure to the desired point indicated by the gage.

The machine illustrated is for tubes up to 4¼ in. outside diameter and can be used with pressures up to 1200 lb. per sq.in. The minimum length of tube is 5 ft., and the maximum is 15 ft. The weight is 2000 lb. Other sizes of the same general design can be supplied if desired.

Friction Clutch

The friction clutch illustrated is one of a line that has been recently placed on the market. The principal feature of these clutches is the use of friction wedge plates, which are tapered transversely. One, forming part of the hub, is keyed to the shaft, making it the driving part; the other is a fixed part of the pulley proper, which rotates on the hub. When the three fingers are pressed against the compression plate that is a part of the hub, the pulley is moved longitudinally on the hub, thus bringing the two wedge plates together. When the clutch is first engaged, the friction between the plates starts the machine; but as the load is carried, the tendency is for the two wide parts of the wedge plates to come together. This action causes an increase in the pulling power of the clutch.

The hub has three longitudinal grooves and a circular groove to provide for lubrication. Adjustment is taken



FRICTION CLUTCH

care of by screwing the finger carrying spider out or in on the end of the hub. The clutches are built in diameters of from 2 to 20 in. and are the product of the National Clutch Co., Chicago, Ill.

Flexible Metallic Tubing

The Titeflex Metal Hose Corporation, 120 Broadway, New York City, is placing on the market a form of flexible metal tubing known as "Titeflex," in which the

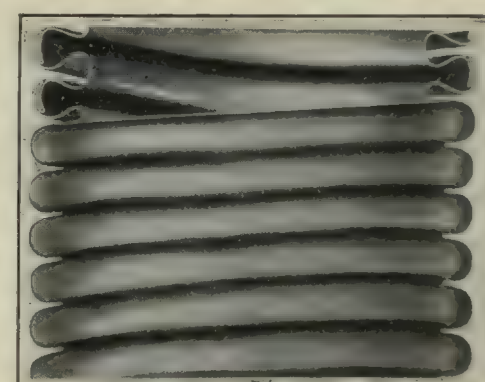


FIG. 1. CONSTRUCTION OF THE TUBING

use of packing is done away with. The flexibility, instead of being obtained by a sliding of the parts of the joints, as is the case with most tubing of its kind, is due to a bending of the U-shaped sections of metal between the joints, which are solidly compressed, making them rigid and tight. The construction is shown in Fig. 1. The degree of flexure of each section is so small

that the limit of elasticity is not reached when the movement of the tube is confined within reasonable limits. The four thicknesses of metal at the joint give the tubing more strength than would otherwise be obtained with metal of a given thickness.

The terminals are threaded in such a manner that they may be screwed into the tubing, as shown in the section, Fig. 2. The threads take the stress due to the pressure in the tube; and unless this is high, the joint need not be soldered. When subjected to pressure sufficient to cause elongation, a series of galvanized steel tapes are braided onto the tube and soldered or brazed to the terminals. The construction of this feature is clearly shown in Fig. 2, while a completed tube is among those illustrated in Fig. 3.

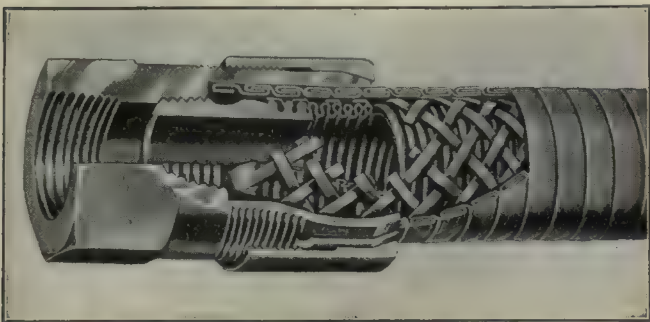


FIG. 2. SECTION SHOWING THE TUBING, TERMINAL AND STYLES OF ARMORING

If the tubing is to be subjected to rough usage or abnormal exterior wear, a third covering is put on consisting of a tube made of interlocking steel ribbon very much resembling the ordinary type of flexible tubing except that no attempt is made to keep this part tight. The construction of this exterior shell, together with the manner of connecting it to the terminal, is shown in Fig. 2. This exterior armoring will also prevent the tubing from being bent to too short a radius.

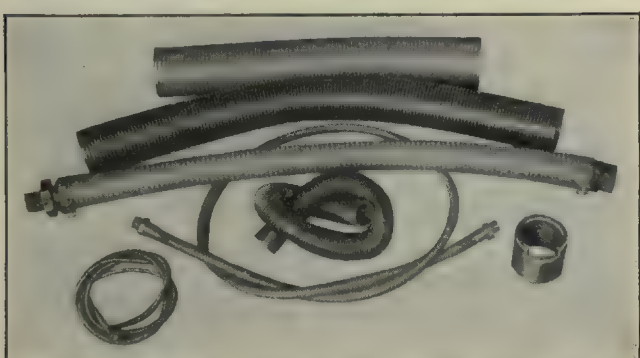


FIG. 3. VARIOUS SIZES AND STYLES OF TUBING

Due to the elimination of all packing material and the substitution of a joint that becomes tighter as the pressure increases, it is claimed that the tubing will carry practically any pressure and is unaffected by heat or cold.

Universal Drafting Board

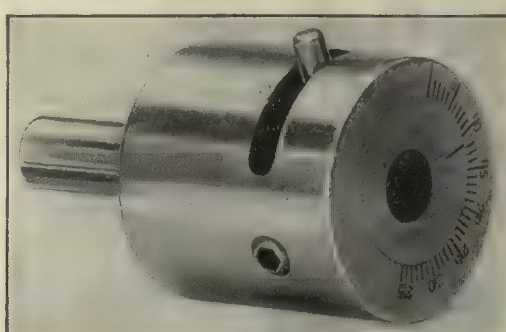
The drafting board illustrated has been recently placed on the market by the Improved Drafting Board Co., Nashua, N. H. The board is of soft pine, is adjustable as to height and may be set at any angle from horizontal to vertical. The frame is of white enameled metal, and the balancing weights for the board are concealed inside the large frame tubes. The feet are provided with felt-covered wood inserts, to prevent the scratching of finished floors.

ADJUSTABLE DRAFTING BOARD

If desired, a cabinet with compartments for the drawing utensils may be attached just beneath the board. The standard-size board takes drawings up to 28 x 40 inches.

Boring-Tool Holder

The boring-tool holder shown has recently been placed on the market by the G. H. Scott Machine Co., Cleveland, Ohio, to meet the demand for a device of compact construction. The desired adjustment of the tool is secured by offsetting the hole with regard to the outside of the inner or adjusting part of the holder. This inner part is of hardened steel and is locked by means of a safety setscrew.

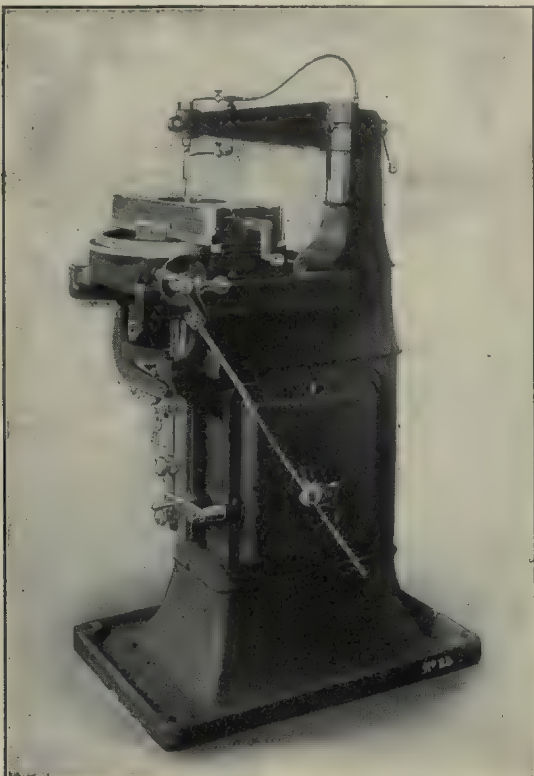


BORING-TOOL HOLDER

The tool may be offset $\frac{1}{4}$ in.; and graduations are provided, as shown, which indicate the amount of offset in thousandths of an inch. The boring tool is held in place by a safety setscrew located in the slot in the outer member. The device has a $\frac{1}{2}$-in. straight shank.

Automatic Profile Shaper

The automatic profile shaper shown is the product of the Luster-Jordan Co., Inc., Norristown, Penn., having been placed on the market to fill the need for a machine for automatic die shaping. A templet, the shape of the die to be cut, is made from sheet steel about ⅛ in. thick



AUTOMATIC DIE SHAPER

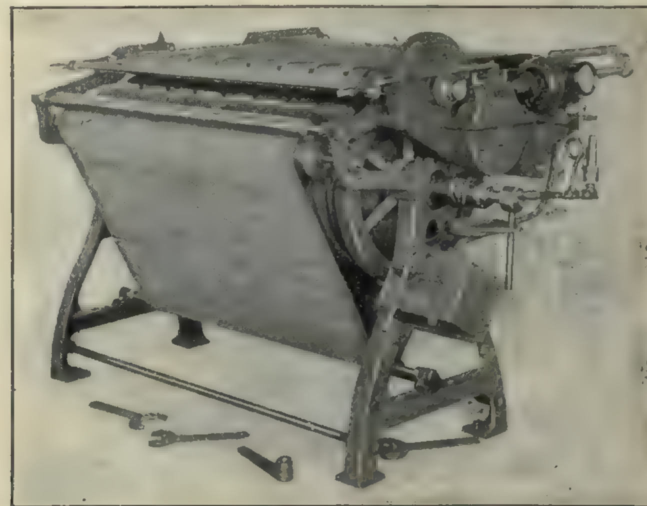
Surface of table, 22 x 8 in.; circular motion of table, 8 in.; oval motion, 12 x 6 in.; distance from center of cutter to supporting arm, 16½ in.; stroke of ram, ¼ to 6 in.; cutting speed, 20 to 35 ft. per min.; distance from floor to table, 48 in.; height, 58 in.; floor space, 28 x 38 in.; horsepower required, 2

and is casehardened on the inner, or working, edge. The die is roughed out and clamped to the machine table with the templet on top. A space of about ¼ in. is left between the die and the templet in order to give the tool clearance.

The tool works up and down in a vertical direction, and the stroke of the ram is so adjusted that at its highest position the cutting edge of the tool is below the templet, thus insuring against cutting. The upper part of the tool bears against the edge of the templet and guides the cutting edge. The table of the machine rests on three self-aligning roller bearings and is counterbalanced. It is automatically locked in position on the up, or cutting, stroke of the ram, thus overcoming any tendency for the work to chatter. The upper supporting arm swings on a hinge, in order to facilitate the removal of the tool. The machine is also adapted for ordinary filing work.

Blueprint Ironer

The blueprint ironer illustrated will iron and dry all types of blue, black-line or Van Dyke prints, taking them directly from the washer. Blue-cloth prints may also be ironed after drying. The machine consists of a heated cylinder 20 in. in diameter, supported by iron end frames held together by means of tie-rods. A fabric apron is used to carry the prints underneath the cylinder and around to the top, at which point they ride over the curved metal fingers and are carried out to the receiving end of the machine. The prints emerge from the machine bone dry; and if a printing machine of the revolving-cylinder



BLUEPRINT IRONER

Floor space for large machine, 68 x 78 in.; gas consumption, 55 cu.ft. per hr.; electric consumption, 11 k.w.; steam consumption, 1½ to 2 boiler horsepower per hour at 6 to 10 lb. pressure; weight, 1825 lb.; capacity allowing for delays, 45 sq.ft. per min.

type is used, the entire operation of printing, washing and drying may be carried out in rolls.

The machine is built in two sizes, 40 and 60 in. wide, and may be gas, steam or electrically heated. Either belt or variable-speed motor drive is used, as desired. The machine is the product of the American Laundry Machinery Co., Cincinnati, Ohio.

Wire and Metal Former

M. D. Kilmer & Co., Cleveland, Ohio, are now manufacturing the wire and metal former shown in the illustration. It is used to form wire into staples, hooks, eyelets, loops, figures, letters, artistic designs, etc., and

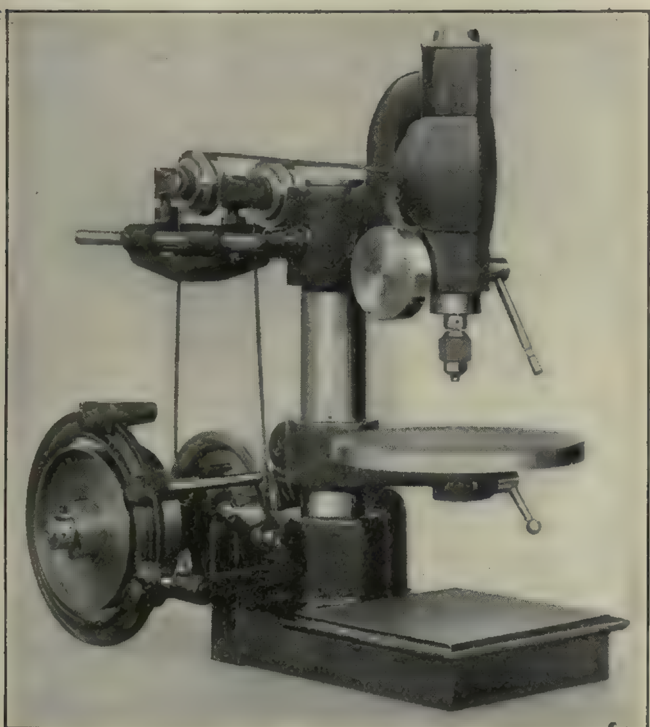
WIRE AND METAL FORMERS

will handle wire in sizes from 26 to 3 gage with only slight changes in adjustment.

Ten separate and distinct adjustments are provided to make possible a large number of finished forms. The part shown in the lower right corner is the adjustable guide through which the wire is fed. The pin around which the bending is done is removable and has shoulders of various sizes, as shown. The figures on the plate are for indicating the length of wire fed and the angle to which it is bent.

Bench Drilling Machine

The illustration shows a bench drilling machine recently placed on the market by the Henry & Wright Manufacturing Co., Hartford, Conn. The machine is of the high-speed type with speeds up to 18,000 r.p.m. and is fully equipped with SKF ball bearings. A round



BENCH DRILLING MACHINE

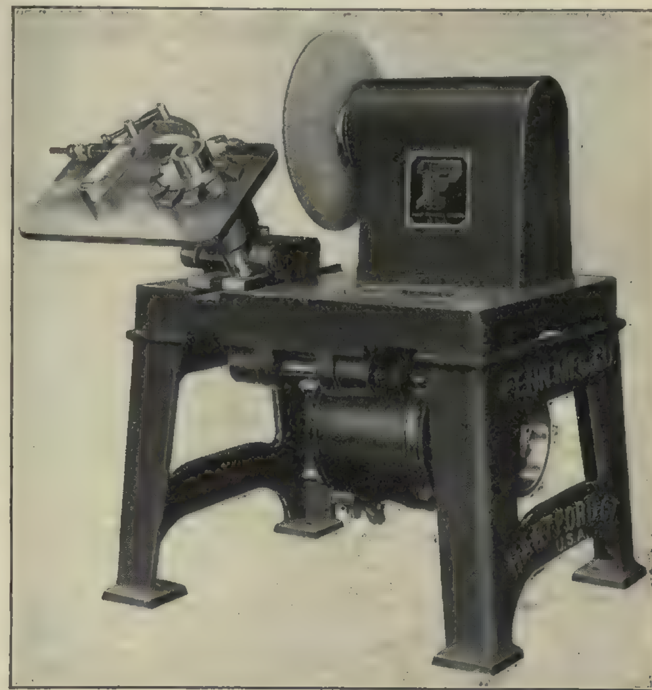
Maximum distance table to chuck, $3\frac{1}{16}$ in.; minimum, 0; maximum distance base to spindle, 8 in.; minimum, $5\frac{1}{2}$ in.; diameter of spindle, $\frac{3}{8}$ in.; spindle-nose taper, 0.9 in. per ft.; spindle movement, $2\frac{1}{2}$ in.; speed of rear shaft, 2700 r.p.m.; maximum speed of spindle, 18,000 r.p.m.; drilling belt, 1 in.; size of lower table, 8 x 8 in.; diameter of swinging table, 9 in.; weight, 135 lb.; floor space, $26\frac{1}{4}$ x 14 in.; height, $22\frac{3}{4}$ in.

driving belt is used, which operates upon two-step cone pulleys.

The work may be placed either on the square base of the machine or on the round swinging table. The tipple is equipped with a No. 1 chuck, which will hold drills up to $^{13}/_{64}$ in. Tight and loose pulleys are placed on the rear shaft, and a belt shifter is provided.

Gear-Cutter Grinder

The grinder illustrated is one that has been put on the market for grinding gear cutters. It is of the self-contained type, the motor being attached to a hinged plate beneath the bed in such a manner that the proper belt tension is maintained at all times. The belt is inside of the head and is thus protected from emery dust. The spindle is mounted on SKF ball bearings and runs at 3000 r.p.m. The table for carrying the cutter and indexing mechanism swings on bearings



GRINDER FOR GEAR CUTTERS

protected from dirt by oil-soaked felt washers, the use of sliding surfaces being thus obviated.

The work table may be raised or lowered on the vertical post, which is adjustable longitudinally, thus making it possible to locate the cutter in the desired position. An adjustable stop finger is provided. The wheel surface is aligned with the table movement by placing a diamond in a V-groove at the back edge of the table and swinging it back and forth across the wheel. Equipment is furnished for handling cutters with $\frac{3}{4}$-, $\frac{7}{8}$-, $1\frac{1}{16}$-, $1\frac{1}{8}$- and $1\frac{1}{4}$-in. holes. The machine is the product of the Fenn Manufacturing Co., Hartford, Conn.

The Salesman and the Shopman

By Robert F. Nowalk

If a man is a poor mechanic, he is usually put on jobs that are relatively unimportant, so that his fiascoes will not endanger the reputation of the house he is working for. On the other hand, many poor salesmen, representing reliable firms, are allowed at large.

Some of the salesmen who call on the shops know almost nothing of what they have to sell. One can often get more out of fifteen minutes with a catalog than he could glean from a salesman's talk in an hour.

Not so very long ago we had occasion to purchase an air compressor. While we knew what capacity we needed, we thought it a good idea to get the confirmation of the compressor companies. In almost every instance the compressor men agreed with the figures we had, although we knew they gave it no thought.

If the average salesman knew his line from A to Z, he could tell the prospect all he wanted to know in a minimum space of time. He would then be a more welcome visitor and would do a great deal to improve his own lot as well as cut down the waste of time.

Depreciation of Plants and Tools

By Charles Piez*

The table of standard depreciation rates adopted by the Conveyor Manufacturers Cost Conference, which appeared in connection with the article on "Perpetual Inventory and Appraisal Values," recently published, was offered as evidence that manufacturers can agree on a schedule of depreciation and can arrange a uniform method of making depreciation a component part of the cost of the product.

The table reproduced herewith offers the choice of two schedules, the first representing a definite percentage of depreciation on the original cost, the second representing a percentage of depreciation computed on the reducing, or depreciated, balance. The two schedules are offered as substantial equivalents based on an assumed life of each class of items. The assumed life was determined by the members of the conference, many of whom had been in active business for more than 25 years and had had considerable experience in the depreciation of buildings and equipment, resulting from wear and tear, from obsolescence, from the development of newer and more economical forms, or from inadequacy to meet the expanding needs of the business. The assumed life is not therefore mere conjecture, but has behind it long experience fortified by actual records. The rates are conservative, because it would be unfair to assess excessive depreciation against costs.

The rates provided under the "Per Cent. on Cost" schedule extinguish the entire cost at the end of the assumed life, while the equivalent rates under the "Per Cent. on Reducing Balance" schedule are supposed to bring the items to a scrap value at the end of the same period.

In the case of small tools, punches and dies, chills and flasks, fixtures and furniture and patterns, only the additions actually made for the purpose of fabricating standard product are to be inventoried; these are to be depreciated as indicated under the "Per Cent. on Cost" schedule and are thereupon to be subjected to no further depreciation. Care must be exercised, particularly in these items, that all replacements are charged to maintenance and that all other obsolete items are charged off entirely.

These items rarely have much cash value upon sale or liquidation, and care must therefore be exercised to prevent inflation of values in their inventory. An occasional check by actual count and a reappraisal of the value of the active items on the basis provided in the schedule of depreciation are strongly advised.

Two Schedules for a Boring Mill

In order to compare the two schedules presented by the table a standard depreciation sheet for a 34-in. boring mill, developed first on a straight rate of depreciation of 4½ per cent. on the original cost and immediately below on a 10 per cent. rate on the reducing balance, is given herewith.

EQUIPMENT INVENTORY

Name of item, 34-in. boring mill, made by Machine Tool Co., Shop No. 183; bought of Machinery Equipment Co., Jan. 1, 1894. Account 40360 Dept. DM

Inventory value computed on per cent. of original cost; rate of depreciation, 4.5 per cent. on tool, 20 per cent. on installation

	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31
34-in. boring mill with turret heads and 3-jaw chuck in table per specifications detailed in purchase order B-2592; cost, $1,318; depreciation, 4.5 per cent.	Net Value*	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value
	1,258.69	1,199 38	1,140 07	1,080.76	1,021.45	962.14	902 83	843.52	784 21	724 90	665 59	606 28
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	....
	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12 31	12-31	12-31	12-31	..
	546.97	487.66	428 35	369.04	309.73	250.42	191.11	131.80	72.49	13 18	0.00	..
	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Cost of installation, $72.59; depreciation, 20 per cent.	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31
	58.07	43.55	29.03	14 51	0 00	...	...	...	...	....	......	..

Inventory value computed on reducing balance; rate of depreciation, 10 per cent. tool, 20 per cent. on installation

	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31
34-in. boring mill as above, $1,318; depreciation, 10 per cent.	Net Value*	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value	Net Value
	1,186.20	1,067.58	960.82	864.74	778.27	700.44	630.40	567.36	510.62	459 56	413 60	372.24
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	...
	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	...
	335.02	301.52	271.37	244.23	219.81	197.83	178.05	160.25	144.23	129.81	116.83	.....
	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
Cost of installation, $72.59; depreciation, 20 per cent.	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31
	58.07	46.46	37 17	29 74	23.79	19.03	15.22	12.18	9.74	7 79	6.23	4 98
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	...
	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	12-31	....
	3.98	3.18	2.54	2.03	1.62	1.30	1.04	0.83	0.66	0.53	0.42	....

* Net value in each instance is given in dollars.

The rates are those provided in the schedule for machine tools. Upon the first schedule the amount of depreciation is uniform for each year; in the second the first year's depreciation is deducted from the original cost, and the second year's depreciation is computed on the remainder, or as it is termed in the table, on the reducing balance.

The amount of the second year's write-off is therefore less by 10 per cent. than that of the first year, and the amount written off each succeeding year continues to decrease by the same percentage. The original cost is never, by this process, wholly extinguished, but the amount of depreciation written off each year by this method approaches more nearly the shrinkage in value that actually takes place. Under normal conditions loss in the selling value of any item of equipment is more rapid in the early years of its life than in the later years. Then too, there is usually some salvage, some scrap value at the end of the period, and this scrap value may be larger or smaller, depending upon the nature of the raw materials of which the item is composed. It is for these reasons that I lean strongly to the method of computing depreciation on the reducing balance and recommend the rates of the second schedule for adoption.

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*President, Link-Belt Co.

As was pointed out in the previous article, the method employed by many manufacturers of charging depreciation to the profit and loss account is wrong; for while this method accomplishes the purpose of bringing the book values of assets in line with actual values, it does not make depreciation a part of the cost of production. To accomplish this all equipment, jigs, templets or patterns especially made for a particular order should be wholly charged to that order, and the reduction in value of all other buildings and equipment, as determined by the schedule of depreciation, must be considered a legitimate expense of the business and charged against the cost of the product. The easiest method of accomplishing this is to estimate in advance the depreciation for each department of the plant for the ensuing year and then assess one-twelfth of these estimates as monthly expense charges, against the departments, making these depreciation charges in this wise components of the departmental expenses and factors in the departmental overheads. Depreciation charges that cannot properly be assessed against any particular department should be assessed against general expense and distributed over the product through the general-expense factor.

Any differences between the estimated depreciation and the actual depreciation as revealed by the final inventory must of course be adjusted before the closing of the books is accomplished.

Two methods of treating the inventory of buildings and equipment can be followed: First, the inventory can be carried at the net figure with depreciation deducted, or second, the inventory can be carried at the original value and a depreciation-reserve account created which will be credited with the amount charged off each year. In the second case the records of original costs are preserved, the total amount charged off to depreciation is always available, and the net value equal to the difference between the two is readily determinable. The second method commends itself, therefore, as a more complete record of actual procedure than the first. In the following tabulation, giving the standard depreciation rates adopted by the Manufacturers Cost Conference, the two schedules are assumed to be substantial equivalents:

Building and Accessories:	Per Cent. on Cost	Per Cent. on Reducing Balance
Reinforced concrete or steel and tile	2	3
Brick and steel with noncombustible roof and concrete floors	2.5	4
Brick, steel and wood	3	5
Brick and wood	3	5
Steel frame, wooden roof and corrugated iron walls	3.5	7
Steel frame, noncombustible roof and corrugated iron walls	3	6
Concrete block, with wooden roofs and floors	3.5	8
All-wood structures, well built (20 years)	4.5	10
All-wood structures, cheap (20 years)	5	12
Sprinkler system (20 years)	4	7.5
Heating and ventilating system (20 years)	4	7.5
Water and sewer piping and sanitary fixtures (where separate)	4	7.5
Tanks and reservoirs, steel	4.5	10
Tanks and reservoirs, wood (10 years), (all repairs and maintenance to be charged to account 8059)	9	20
Machinery and Large Equipment:		
Boilers, pumps, feedwater heaters and air compressors	6	15
Power piping	6	15
Switchboards, main wiring and conduit	6	15
Engines and dynamos	5	10
Machinery, motors, machine tools, traveling cranes, etc	4.5	10
Punch presses, bending rolls, power shears and drop hammers	4.5	10
Machine-tool accessories—boring bars, drivers, key-seating broaches, etc. (all renewals to repairs)	50	.....
Cupolas, converters, melting furnaces and accessories	5	10
Annealing and heating furnaces, ovens, forges, etc	5	10
Motor trucks	20	60
Storage-battery locomotives (battery renewals to repairs)	10	30
Horses and wagons	12	35
Steel shelving, lockers, etc	5	12

For the items below, a single write-off at the rates specified is made and the balance carried as a part of the inventory without further reduction. Only items actively used in fabricating standard product and described in schedule as net items should be so treated, all other items being charged off wholly to expense.

Small Tools:	Per Cent. on Cost	Per Cent. on Reducing Balance
For machines, net additions	50	.....
Hand tools, net additions	50	.....
Punches and dies (standard), net additions	50	.....
Chills, iron and steel flasks and accessories, net additions	50	.....
Fixtures, Furniture and Miscellaneous Equipment:		
Mechanical appliances, net additions	60	.....
Departmental wiring and electric fixtures, net additions	60	.....
Miscellaneous items (wood), net additions	70	.....
Patterns (Standard):		
Metal, net additions	75	
Wood, net additions (all patterns required for a particular order or contract to be charged to the job)	100	.....
Drawings:		
All new standard drawings to be charged to expense; all drawings required for a particular order or contract to be charged to the job.		
Miscellaneous Real-Estate Improvements:		
Pavements, sidewalks, fences, retaining walls, roadways, tracks, yard drainage, general conduits, tunnels, vaults, etc	4.5	10

Cutting a Perfect Gear with a Broken Cutter

By A. E. Burrell

The capacity of the Fellows gear shaper is 35 in., pitch diameter four pitch, and I know from experience that in cast iron this can be handled in one cut. If Mr. Clark, page 68, was cutting three pitch with one cut, as his article states, he either knows so little about the machine as to ignore its limitations or so much about it that he is convinced it has no limitations.

However, for good work even in cast iron two cuts should be taken for either three or four pitch; and when using a cutter with a tooth broken out, four revolutions of the work should be made to complete the gear, two at the roughing depth and two at the finished depth, for the following reason: If the gear is completed in two revolutions, it is very evident that, during the second, 10 of the teeth in the cutter will be taking a light cut, while the eleventh will have to cut a space to full depth out of the stock left by the gap in the broken cutter during the first revolution of the gear. This naturally would give slightly uneven teeth, liable to give trouble if closely assembled; hence, the necessity for making four revolutions of the work. On production work, this of course could not be tolerated, and the broken cutter would be discarded.

Mr. Daiber, page 254, tells about cutting on the same machine some steel gears small enough for instrument work, a very different proposition from three pitch in cast iron. He says that he has trouble in cutting gears within 0.004 to 0.006 in. of concentricity, also with the cutter teeth burning, and inquires what is the best lubricant to use on this work. His cutter trouble must be caused either by his using a carbon-steel cutter instead of one made from speed steel or by an improper annealing of the cast- and tool-steel blanks he is cutting. With a speed-steel cutter and blanks thoroughly annealed, using the best No. 1 lard oil as a lubricant, his 24-26 pitch gears can easily be finished with one cut without burning the cutter. If the lard oil is not entirely satisfactory, there is a heavy-duty sulphonized lard oil on the market, which is good on tough, stringy stock.

Business Items

The J. R. Stone Tool and Supply Co., Detroit, Mich., will act as exclusive sales agents in eastern Michigan for the Greaves & Klusman Tool Co., Cincinnati, Ohio.

The Astra Electric Novelty Works, Inc., has recently been formed to manufacture dry batteries for flashlights. The factory is at 152 Wooster St. and the office at 45 East 17th St., New York City.

The Rider-Ericsson Engine Co. has reorganized, and the new officers are: Samuel Andrews, president; A. W. Christianson, vice-president and general manager; Sanford Abrams, treasurer; D. C. Dominick, secretary.

The Mott Sand Blast Manufacturing Co., Inc., will move to its new plant in Brooklyn, N. Y., some time about the first of April. The new plant has been especially fitted up with facilities for manufacturing sandblast apparatus and allied equipment.

The Vanadium-Alloys Steel Co., Pittsburgh, Penn., has recently made arrangements with the following companies to carry a stock of its various high-speed and carbon steels: E. T. Ward's Sons, Boston, Mass.; George Nash Co., New York City; Field Co., Inc., Philadelphia, Penn.; George Nash Co., Chicago, Ill.

The Reynolds Machine Manufacturing Co., Massillon, Ohio, has recently been organized and the following officers elected: F. C. Snyder, president; O. F. Binford, secretary and treasurer; G. D. Reynolds, general manager. The new company has taken over the plant formerly operated by the Reynolds Pattern and Machine Co.

The Cleveland Brass and Copper Mills, Inc., will have in operation within three or four months the first brass and copper mill in the state of Ohio, in Cleveland. The new company has the following officers: President, Henry C. Osborn, of the American Multigraph Co.; vice-president, B. F. Brusstar, head of the Michigan Copper and Brass Co., Detroit; secretary, B. M. Gardner, head of the B. M. Gardner Co., Cleveland; treasurer, H. P. McIntosh, Jr., of the Guardian Savings and Trust Co. The directors include the officers and S. H. Moore, Chisholm-Moore Manufacturing Co.; E. E. Allyne, of the Aluminum Castings Co.; J. H. Foster, of the Hydraulic Pressed Steel Co.; J. H. Harrison, of the Atlas Bolt and Screw Co.; J. A. House, of the Guardian Savings and Trust Co.; and C. R. Hamilton. All forms of rolled and drawn brass and copper products will be manufactured.

The Charles A. Strelinger Co., Detroit, Mich., has moved to its new store at 43-52 Larned St. The new building is on a plot 100 x 120 ft. and comprises six stories and basement. It is one of the most modern machinery supply houses in the country. The basement is made over into a metal salesroom for heavy storage. The first floor contains small supplies, tools and the sales office. A mezzanine on the east and north sides of the first floor is occupied by the clerical offices—bookkeeping, auditing, filing, etc. Under the mezzanine, in back of partitions, is the shipping and receiving room. The second floor is devoted to machine-tool display, private offices and conference room. The third floor is given over entirely to factory supplies and surplus stocks of tools; the fourth floor to wood-working machinery and surplus general machines, the fifth floor almost entirely to transmission appliances and the sixth floor to general storage supplies and machinery. A feature of the new building is a spiral chute which runs through from the sixth floor to the first floor. It has a capacity of 200 lb. and can take a box or pulley 24 in. in width.

Obituary

Albert Clark Stebbins, a vice-president of the Niles-Bement-Pond Co., 111 Broadway, New York City, died on Feb. 28 at his home in Plainfield, N. J. He was born in Monson, Mass. In the year 1865 he became an apprentice in the machine shop of Lucius W. Pond, Worcester, Mass. He continued as a machinist in this shop until 1870, when he was appointed New York representative of L. W. Pond, with an office on Liberty St. About 1875, when the Pond business passed into the hands of David W. Pond, son of Lucius W., Mr. Stebbins returned to the Worcester shop in the capacity of superintendent. In 1887 the shop at Worcester was taken over by the Pond Machine Tool Co., of Plainfield, N. J., and the shop equipment was moved to new buildings in the latter town.

Mr. Stebbins went to the Plainfield works as vice-president and general manager and directed the construction and equipment of the new shops. He continued in this capacity until the organization of the Niles-Bement-Pond Co., when he was elected vice-president of this company and local manager of the Pond works. He served a term as member of the city council of Plainfield and at the time of his death was vice-president of the Dime Savings Bank of that city. Mr. Stebbins was 73 years of age.

Personals

Carl A. Smarling is now superintendent of the Rider-Ericsson Engine Co., Walden, N. Y.

William Langdon has become assistant purchasing agent of the Willys-Overland Co., Toledo, Ohio.

G. K. Atkinson has taken a position as chief engineer with the Wood Turret Machine Co., Brazil, Ind.

H. B. Ibsen has formed Ibsen & Co., Milwaukee, Wis., to manufacture gage standards. A bulletin of this company is ready for distribution.

J. L. Swayze has been appointed superintendent of the bolt and nut plants of the American Iron and Steel Manufacturing Co.

Sir Robert Hadfield has offered £200 to provide for a prize for a new and accurate method for determining the hardness of various metals.

Alfred H. Bartsch, formerly with the Bosch Magneto Co., has recently taken a position with the McLain-Hadden-Simpers Co., New York City.

L. H. Allen, formerly assistant secretary and treasurer of the Baird Machine Co., Pittsburgh, Penn., has retired and has been succeeded by **W. E. Gnann.**

J. Morgan has severed his connection with the Remington Arms-Union Metallic Cartridge Co. to engage in the banking business with the National Mohawk Valley Bank, Mohawk, N. Y.

E. D. Kilburn, manager of the power department of the New York office of the Westinghouse Electric and Manufacturing Co., has been appointed district manager of the same office.

W. S. Rugg, formerly district manager of the New York office of the Westinghouse Electric and Manufacturing Co., succeeds Charles S. Cook as manager of the railway department, with headquarters at East Pittsburgh.

E. P. Dillon, formerly assistant to the manager of the railway and lighting department of the Westinghouse Electric and Manufacturing Co. at East Pittsburgh, Penn., has been appointed manager of the power division of the New York office.

W. H. Reece, formerly connected with the Northampton Emery Wheel Co. and the Reece & Hamman Co., is now in charge of the grinding and polishing machine department of the Noble and Westbrook Manufacturing Co., Hartford, Conn.

A. A. Templeton, president of the Detroit Seamless Tool Co., is now president of the Detroit Chamber of Commerce. **E. P. Johnson**, of the Detroit Screw Works, and **H. W. Hoyt**, of the Great Lakes Engineering Works, have been elected vice-presidents.

L. K. Berry, district manager in New York for the Warner & Swasey Co., Cleveland, Ohio, has been appointed assistant sales manager with headquarters in Cleveland. **E. R. Gardner** becomes district manager for New York and is assisted by **R. L. Glaser.**

Joseph F. Owens, of the La Pointe Machine Tool Co., Hudson, Mass., has proposed the American Metal Working Foreign Travelers' League. The object of this league is to make arrangements for such machine-tool salesmen as intend to go to Europe after the war to cross on the same boat and keep in touch with each other afterward. Anyone interested should write to Mr. Owens at the above address.

Harrison W. Craver, chief librarian of the Carnegie Library of Pittsburgh since 1908, has tendered his resignation to the Library Committee of the Board of Trustees of Carnegie Institute, to take effect Apr. 1. Mr. Craver has accepted a position as director of the library of the United Engineering Societies of New York and will leave Pittsburgh the latter part of March to assume his new charge. His new position will put him in direction of what is believed to be the largest engineering library in the world, with approximately 150,000 volumes on technological subjects on its shelves.

Trade Catalogs

Geared Circulating Pumps. C. F. Roper & Co., Hopedale, Mass. Circular. Illustrated.

Vises. Prentiss Vise Co., 110 Lafeyette St., New York. Catalog No. 50. Pp. 96, 72; 6 x 9 in.; illustrated.

"Max F" Grinding Wheels. Springfield Grinding Co., Chester, Mass. Catalog. Pp. 6 x 9 in.; illustrated.

Tilted Turret Screw Machines. Wood Turret Machine Co., Brazil, Ind. Catalog. Pp. 32; 8 x 11 in.; illustrated.

Imperial Duplex Dry Vacuum Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3038. Pp. 24; 6 x 9 in.; illustrated.

Milling Cutters, Counterbores, Reamers, Mandrels, etc. Advance Tool Co., Cincinnati, Ohio. Catalog. Pp. 38; 5 x 7½ in.; illustrated.

Electric Fans. Sprague Electric Works, 527-531 West 34th St., New York. Booklet No. B-3409. Pp. 22; 3½ x 6 in.; illustrated.

Ingersoll-Rogler Straight Line Dry Vacuum Pumps. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3037. Pp. 24; 6 x 9 in.; illustrated.

Single-Phase Variable-Speed Motors. Sprague Electric Works, 527-531 West 24th St., New York. Bulletin No. 41,514 Pp. 12; 8 x 10½ in.; illustrated.

Calipers, Dividers, Punches, Steel Rules, Gages, Hacksaw Frames, Toolholders, etc. Union Tool Co, Orange, Mass. Catalog. Pp 54; 6 x 9 in.; illustrated.

The Revolvator—Portable Elevator or Tiering Machine. New York Revolving Portable Elevator Co, Jersey City, N. J. Catalog. Pp. 24; 4 x 9 in.; illustrated.

Ball Bearings in Machine Tools. Hess-Bright Manufacturing Co, Front St. and Erie Ave., Philadelphia, Penn. Pamphlet. Pp. 28; 6 x 9 in. This pamphlet contains photographs and line drawings showing applications of ball bearings.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The National Metal Trades Association will hold its next convention on Apr. 25 and 26 at the Hotel Astor, New York City. A meeting of the administrative council of the association will be held on the day preceding that on which the convention opens.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The Society of Automobile Engineers, whose name will be changed next month to Society of Automotive Engineers, has been arranging for the most elaborate summer meeting in its history, including events and presentation of technical matter connected with aircraft, watercraft and farm tractors as well as motor cars. The various committees, including the meetings committee, of which David Beecroft is chairman, and the papers committee, which is conducted by H. G. McComb, have well-advanced plans that can be put into final effect quickly as soon as it shall be known whether it will be possible or advisable to hold sessions of the scope intended. Meantime, announcement of the time and place of the meeting is being withheld pending development of international conditions, with the thought that in the event of untoward results in this respect the society shall be as untrammeled as possible with plans interfering in any way with direct work for the nation.

Ammunition for American Merchantmen

By Lieut. A. G. Dibrell*

SYNOPSIS—The necessity that has forced us to either arm our merchantmen or give up our rights to sail the seas makes necessary the manufacture of shells for the guns to be used on merchantmen. The sinking of the numerous vessels without warning of any kind emphasizes the necessity for arms and ammunition with which to protect our commerce and the lives of American seamen. This article gives in detail the methods used by the navy yard at Puget Sound for making 6-in. common naval shells.

Owing to the great demand made upon this country, many shops are now thoroughly familiar with the process of manufacturing British, French and Russian shells. The United States Navy projectiles differ radically from the army shells of foreign countries and require a departure from the methods of manufacture of foreign shells. As the time for shops to get started on this work may be short in case of war, it is believed that a description of a successful method of machining the navy projectiles will make it possible for contractors to equip their machines by the time forgings can be obtained. Furthermore, the ideas here set forth may enable mechanics in the United States to improve on this method, thereby decreasing the cost and increasing the output. There are three essentials in the machining of projectiles: (1) They must be of a certain weight within a very small tolerance, because a standard weight, or charge, of powder is used and undue variation in the weight of the projectiles affects the range; (2) the center of gravity must be maintained or the projectile will "tumble" in flight; (3) the projectile must be concentric or it will give an erratic flight, causing wide dispersion. These ballistic qualities a shell must have; but just how to obtain them and keep within all the small tolerances allowed in the dimensions is the mechanical problem to be solved. From experience gained at the Puget Sound navy yard, and in other shops visited, it may be stated as a general rule that the ordinary three- and four-jawed lathe chucks cannot be successfully employed in the manufacture of shells. Draw-in, or pot chucks, collet chucks and expanding mandrels must be used. To save the cost of handling, as many operations as possible should be performed at one chucking; and where engine lathes are employed turret heads should be fitted to the crossfeed.

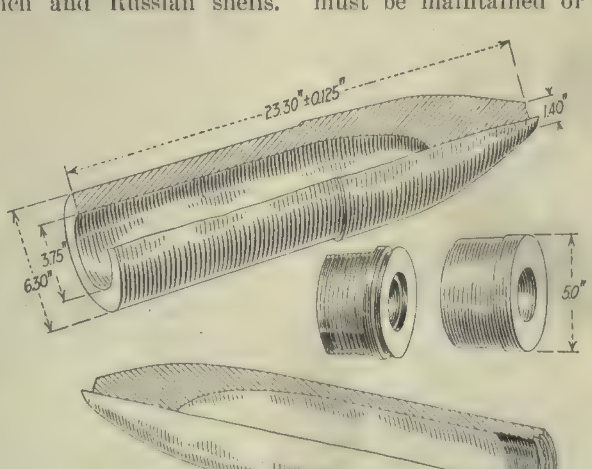
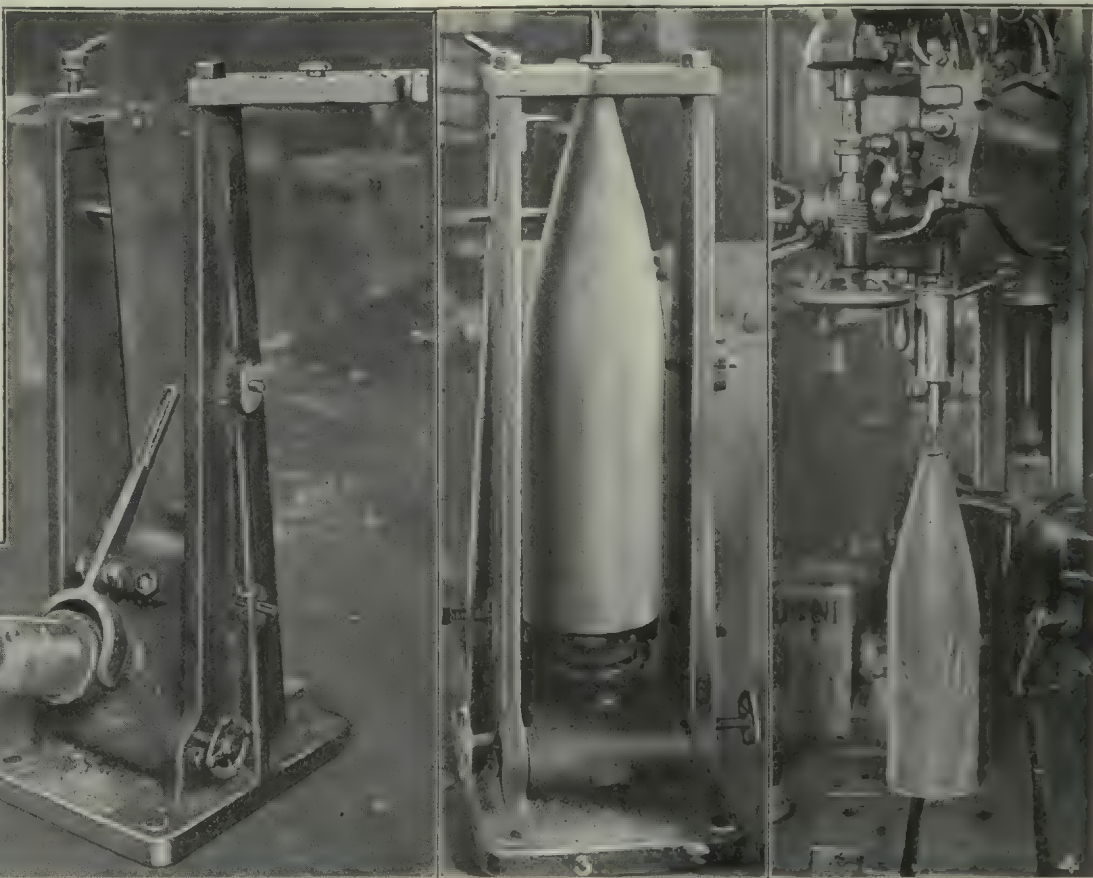


FIG. 1. ROUGH-FORGING AND FINISHED UNITED STATES NAVY 6-IN. COMMON PROJECTILE

*United States Navy, Submarine Division.

Fig. 1 gives the dimensions of the rough forging furnished the navy yard, but not the dimensions of the finished projectile. It was assumed that the steel billets would be punched in the forming dies at one stroke. In that case allowance must be made for the punch running out of true in a great many forgings. Fig. 2 shows the centering and gaging machine. This machine serves two purposes: First, centering the outside of the forging true with the cavity, for rough-turning the outside, and second, determining whether or not there is sufficient stock in the forging for finishing. If insufficient stock is found, or the forging is pierced too much out of center or flat on the radius, it is marked and no machine work is wasted on it. The machine consists of a cast-steel stand with two columns between which the forging is placed for centering and gaging. On top of the column is a swinging arm secured by a handle nut, containing the centering bushing. The stop on the back allows the spindle to tilt about 65 deg. for slipping the rough forging over the spindle.



FIGS. 2 TO 4. CENTERING GAGE AND THE METHOD OF DRILLING THE CENTER
Fig. 2—View of centering and gaging rig, operation 1. Fig. 3—Six-inch projectile forging in centering and gaging rig. Fig. 4—Drilling center in 6-in. forging, operation 1

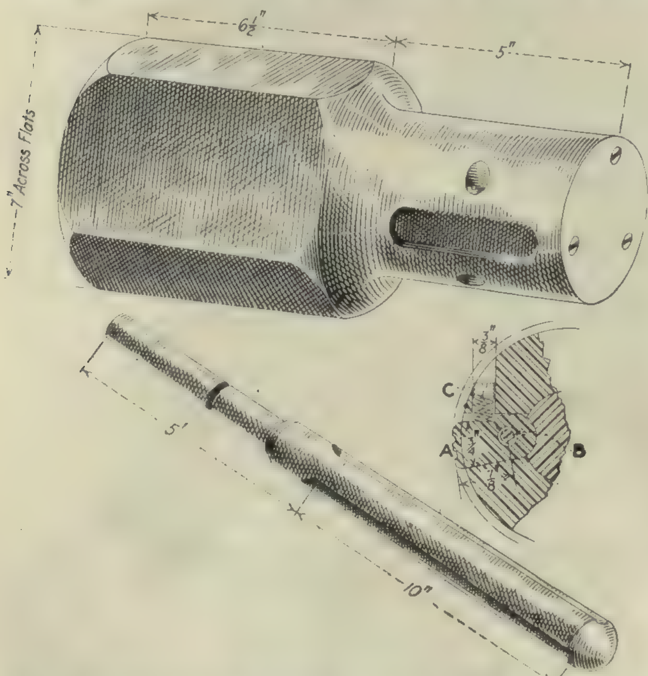


FIG. 5. EXPANDING MANDREL FOR HAMILTON LATHE. OPERATION 2

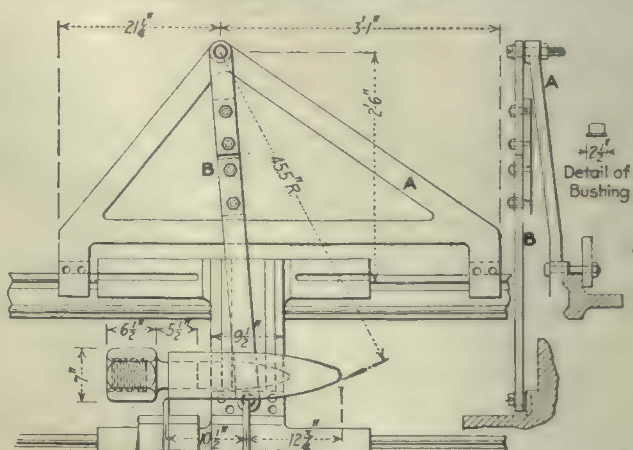


FIG. 6. RADIUS-TURNING ATTACHMENT FOR HAMILTON LATHE. OPERATION 2

The weight of the shell on the cone forces the three rollers out against the base of the forging, firmly holding the forging true with the cavity. The forging is thrown back into the frame and the top plate closed. The forging is removed by the forked handle shown.

A later development was fitted to offset the forgings when too much out of center for the machine. This consists of handwheels on threaded stems operating the base of the spindle and giving an offset of $\frac{1}{16}$ in. Each forging is revolved on

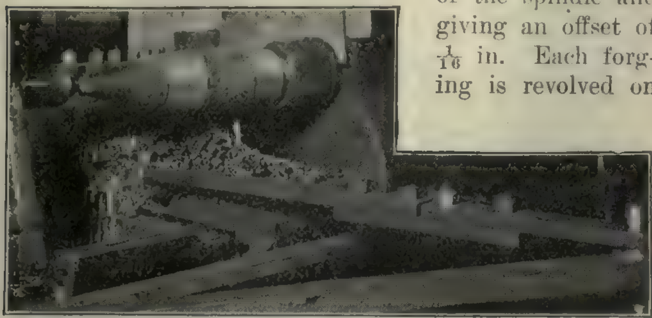


FIG. 7. ROUGH-TURNING 6-IN. FORGING, OPERATION 2

the centering spindle while the movable indicator pins are held against the forging. Should the stock pins, Figs. 2 and 3, show insufficient stock for finishing, the lines on the indicator pins pass beyond the established marks. If the forging is good, it is center-punched through the bushing, as shown in Fig. 3, and the bench mark is established on the base of the forging. The forging is then removed and the center drilled in a radial drill press, Fig. 4. The bushing in the swing lever has recently been enlarged, and the base of the casting is bolted to the press table so that the drilling is done without removing the forging from the centering machine. This operation has been found necessary, as the points of many forgings dropped in cooling. For operation 2, an old 32-in. by 8-ft. Hamilton engine lathe was fitted with an expanding mandrel and a radius-turning attachment. The outside having been centered with the cavity, the forging may be held on a mandrel for rough-turning. The mandrel was designed to grip the inside of the forging firmly, so that it would be rough-turned the entire length concentric with the cavity. The mandrel is made of cast steel and fits over the lathe spindle. The forging is gripped by three dog wedges of tool steel, shown at *A* in Fig. 5, which are held in place by pins and springs, shown at *B* and *C*. These dog wedges are forced out by the medium-steel taper spindle shown. The rod screwed into the taper spindle runs through the hollow spindle of the lathe and is operated by a handwheel. The grip is over a length of 3 in., and the shell is further supported by the tailstock in the center drilled in operation 1.

In order to obtain a heavy cut and prevent chattering of the tool a positive radius-turning attachment was made for the roughing machine, in accordance with Figs. 6 and 7. The frame consists of two arms of cast iron secured to the back of the lathe bed, shown at *A*. The radius arm *B* is of medium steel on a radius of 45.5 in. and is secured to the tool carriage by a composition G-bolt. In order to remove the metal on the roughing cut as quickly as possible, two tools were fitted; one to take the straight cut and the other to begin at the bourrelet and take the radius. Marks are established on the lathe face-

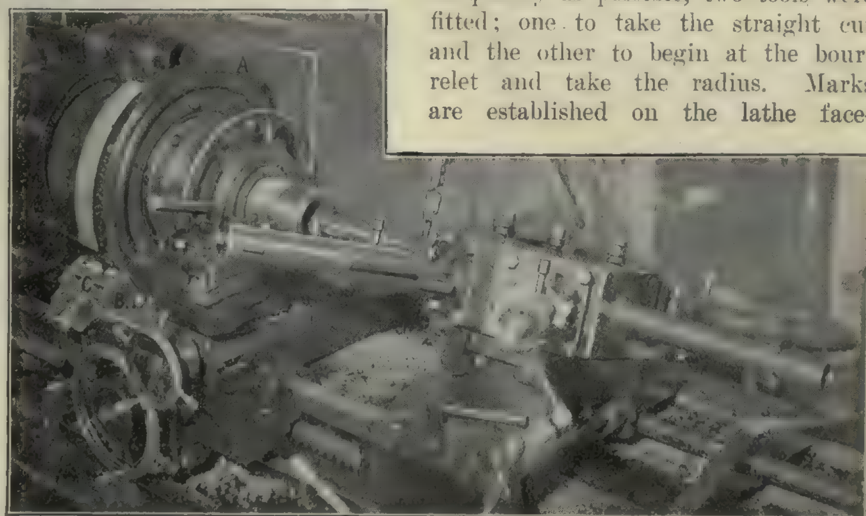


FIG. 9. GISHOLT LATHE FITTED FOR PERFORMING OPERATION 3

plate and a carriage indicator is used for setting each forging correctly. A shell is accurately gaged from this machine once each day to determine whether the tools are properly set and that the forgings are leaving the machine in accordance with instructions.

The forging is chucked on an expanding mandrel and accurately set with the tram in the bench mark and the established mark on the mandrel nut. The center line of the radius-turning bar is set 7.02 in. from the bench mark established in operation 1; at this point the indicator on the lathe carriage coincides with the established gage on the lathe. With the carriage set in this position, the

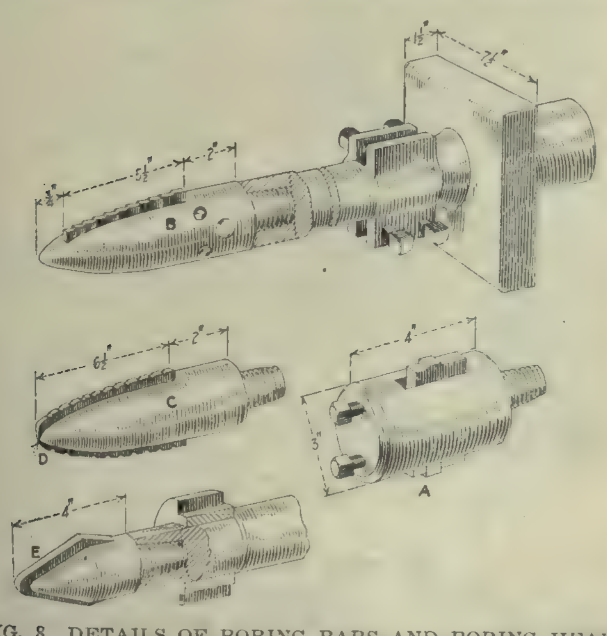


FIG. 8. DETAILS OF BORING BARS AND BORING HEADS FOR GISHOLT LATHE, OPERATION 3

FIG. 10. CUTTING AIR VENTS IN SINUSOIDAL RIBS, OPERATION 4

radius-turning tool is accurately set with gages. The tool for turning the straight body is set 10.5 in. behind the radius-turning tool. The base of the forging is then faced off to the bench mark.

The forgings are $6\frac{1}{2}$ in. in diameter in the rough, and to turn to $6\frac{1}{16}$in. requires a cut of $\frac{7}{32}$ in. on a side. This gives $\frac{1}{16}$ in. to finish. No cutting compound is used in this operation. The cutting tools are made of $\frac{1}{8}$ x $1\frac{1}{8}$-in. tungsten tool steel. A speed of 47 ft. per min. with a feed of $^1/_{28}$ in. is used, and it is necessary to sharpen tools about every sixth shell. This operation is also shown in Fig. 7, which is a view taken from the back of the lathe to show the radius attachment.

The outside having been rough-machined concentric with the cavity, the forging can now be chucked in a universal pot-chuck for boring the cavity. Gisholt turret lathes were the most available for the boring, operation 3, a universal chuck, bolted to the faceplate flange being used. This is a draw-in chuck with a 20-in. wheel, the collet being made in six segments carefully machined. The segments are separated by small springs, which release the forging when the nut is backed off the taper.

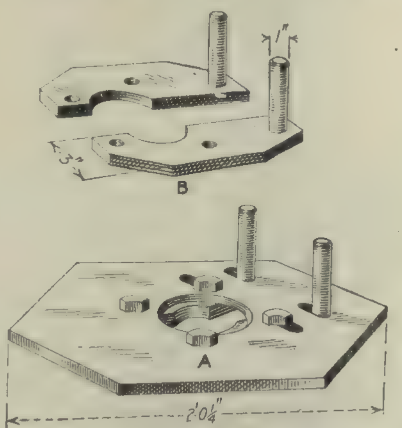


FIG. 11. DETAILS OF PLATE

Fig. 8 shows the special boring bars and cutting heads for the Gisholt turret lathe. The straight head *A* carries the cutting tools for boring, these being made of $\frac{1}{2}$-in. square tungsten tool steel. Two heads were made for each bar, so that the cutting tools could be changed

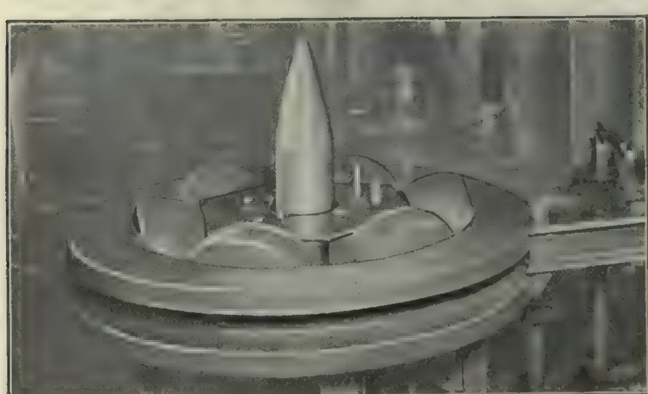


FIG. 13. SIX-INCH PROJECTILE FORGING IN BANDING PRESS, OPERATION 5

and a reserve head remain always available. The rough-boring bar removes $\frac{7}{32}$ in. of metal, finishing a hole to $3\frac{31}{32}$ in. and leaving $\frac{1}{32}$ in. to be removed by the finishing tool. The forgings are received with an inside diameter of $3\frac{3}{4}$ in. and must be finished to an inside diameter of 4 inches.

The roughing radius head is shown at *B*. The cutters are made of $\frac{1}{2}$ x $\frac{1}{2}$-in. and $\frac{1}{2}$ x 1-in. tungsten tool steel and the lengths of cutters vary as shown in the illustration. These cutters are designed to remove the maximum amount of metal that the machine will pull. The finishing head is shown at *C* and the finish cutters at *D*. These cutters leave a clean, smooth surface. The point of the shell is finished by the cutter *E*.

The Cutting Compound

In order to obtain cutting compound on the point of the cutting tool $\frac{3}{8}$-in. holes (not shown in the drawing) were drilled through the bars, the discharge opening be-

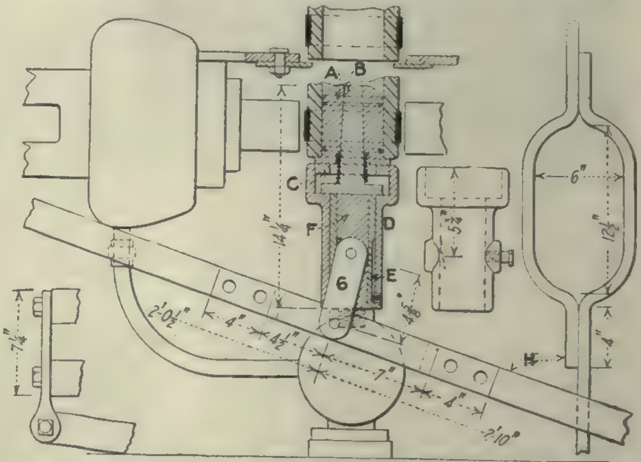


FIG. 12. DETAILS OF MANDREL AND EJECTOR FOR BANDING PRESS, OPERATION 5

ing in the heads. A plug was fitted to each bar and the flexible hose connection made by means of a bayonet joint. This is shown in Fig. 9. The cutting compound is a mixture of 2 lb. of borax dissolved in 10 gal. of boiling water, to which is added 2 gal. of boiling lard oil. The tools require changing about once a day or about every tenth forging. Each bar is fitted with an independent stop and these are tested and adjusted once daily. A boring speed of 30 ft. per min. with a feed of $^1/_{40}$ in. per revolution is used. In addition to the boring operations a turret head is fitted on the tool carriage of these lathes to carry tools for cutting the copper band groove, undercutting, cutting the sinusoidal rib and rounding the base. The band score is first rough-cut to a diameter of 5.8 in.; then the sinusoidal cam is thrown in and the groove finished to 5.7 in. at the bottom. The undercutting is done next and finally the base of the shell is rounded. This requires four tools on the turret head of the tool carriage, these operations being completed during the boring. The sinusoidal rib-cutting cam arrangement is shown in Fig. 9. The cast-iron camplate *A* is bolted to the faceplate of the lathe, and the cast-iron plate *B* is fastened to the lathe carriage. The medium-steel arm *C* con-

FIG. 14. MARKING BASE, OPERATION 6

nects the two pieces, the cam motion being positive, by means of casehardened rollers on each side of the camplate.

Operation 4 consists in cutting air vents in the sinusoidal ribs, Fig. 10. The copper band is slipped over the

in about 0.015 in. in banding. To prevent this a special mandrel was designed, Figs. 11, 12 and 13. A large hexagonal ½-in. plate A, Fig. 11, was fitted inside of the rams of the press. Through this plate a hole was cut 7 in. in diameter. Underneath this plate are fitted two

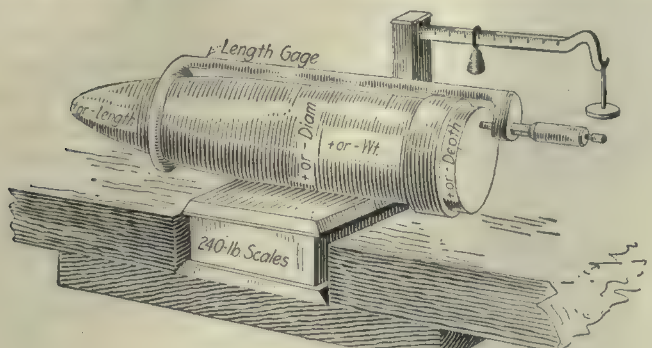


FIG. 15

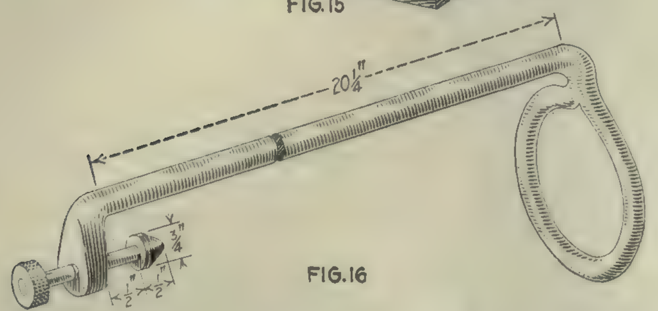


FIG. 16

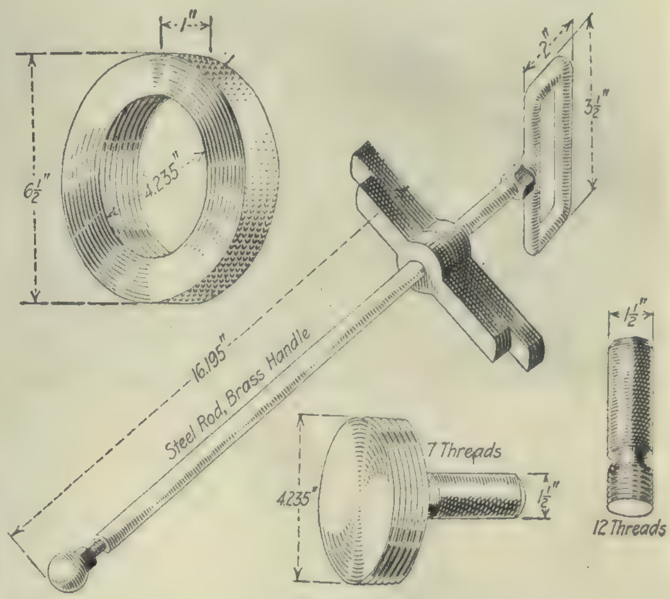


FIG. 17

FIGS. 15 TO 17 GAGES AND METHOD OF WEIGHING FOR OPERATION 7
Fig. 15—Measure weight and gage, operation 7. Fig. 16—Details of gage for operation 7. Fig. 17—Depth gage used in operation 7 and gages for base and base plug

base and struck a blow with a wooden mallet to seat it in the groove, operation 5.

Experiments conducted after the arrival of the banding press indicated that the base of the forging was crushed

hinged plates B with lugs sliding in slots cut in the upper plate A. The diameter of the plate B is 5⅜ in. A spring slips over the lugs to hold the plate in place while the shell is being put in and taken out of the press. The spring and the lugs are better shown in Fig. 13.

In Fig. 12, A is an expanding mandrel of medium steel which slips into the base of the forging and is forced out against the inner walls by the taper spindle B. C

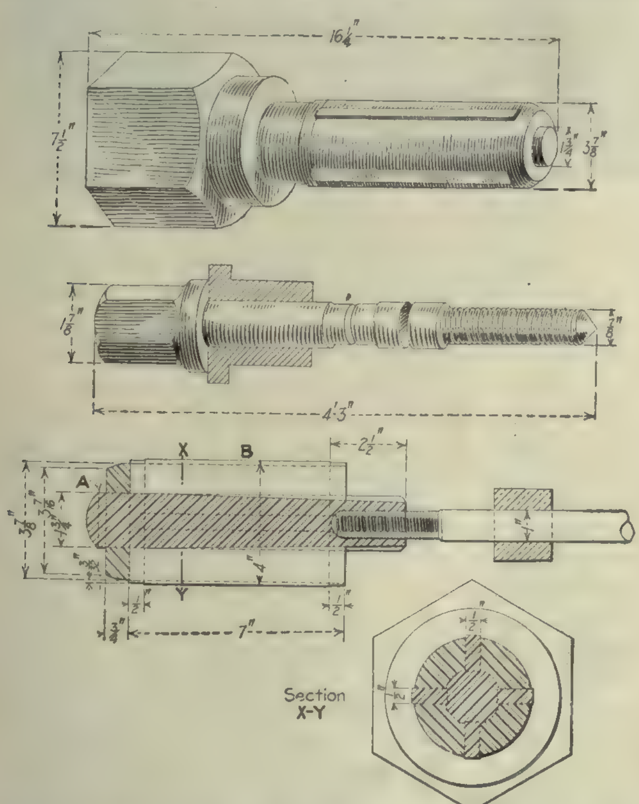


FIG. 18. EXPANDING MANDREL FITTED TO LE BLOND ENGINE LATHES FOR FINISH-TURNING, OPERATION 8

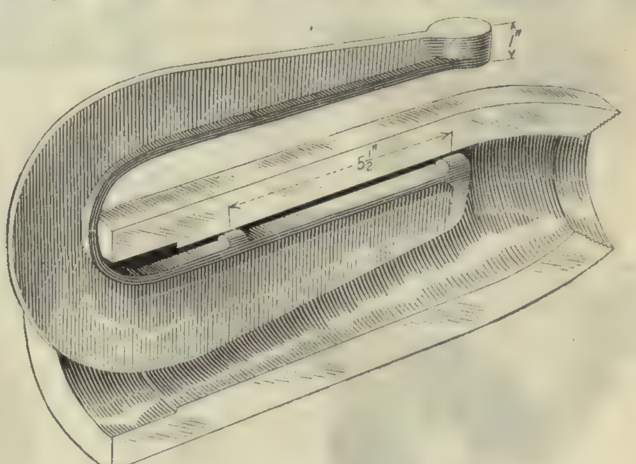


FIG. 19. GAGE FOR DETERMINING ECCENTRICITY OF WALLS, OPERATION 8

is a screw bushing which screws into the telescopic sleeve D. The guide for the mandrel is operated by a hand lever. This guide works in the inner sleeve E of the telescope. The action is as follows: The plates B are closed and locked by the spring. The forging is set on its base on this plate and the mandrel handle lifted, forcing the mandrel into the cavity. The plates B

are thrown out and the forging lowered to the banding position, which is determined by a stop. The band is given four squeezes of the press, the forging being slightly

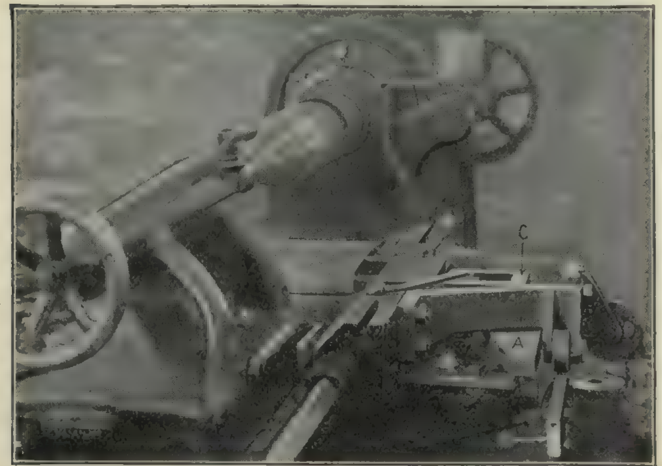


FIG. 20. FINISH-TURNING, SHOWING RADIUS ATTACHMENT, OPERATION 8

rotated after each squeeze. A gage pressure of 2500 lb. is applied, which gives a total pressure of 100 tons on the copper band. The hand lever is again lifted, the plates B thrown under the base of the forging, and the mandrel withdrawn. The device for marking the base, operation 6, consists of a cast-iron base to which are secured the two uprights, Fig. 14. The dieplate containing the letter die slides up and down on the uprights. The dieplate is secured to the base of the shell by means of a setscrew. The counterweights lift the die and plate after marking. On the base of the marker is mounted a conical chuck for taking the nose of the forging, which is protected from burrs by thin copper sheets. On top of the uprights is a yoke supporting the airhoist cylinder, which lifts the weight after the blow has been delivered. The weight, when released by opening the air-exhaust valves, drops by gravity. The letters shown in the pocket at the right are for marking the lot and serial numbers by hand. The forging is taken from the banding press and set nose down in the chuck shown. The letter die in the dieplate is placed over the base of the shell and the weight of 550 lb. dropped from a height of 2 feet.

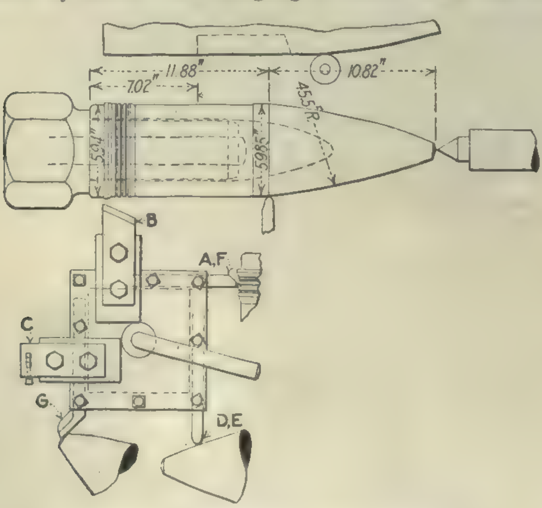


FIG. 21. FINISHING, OPERATION 8

The forging is next weighed and gaged in accordance with Fig. 15. The length is taken by the gage shown in Fig. 16 and the depth of cavity by the gage shown in Fig. 17. The diameter is taken with micrometers and all the dimensions are marked on the forging as indicated in Fig. 15. The forging, therefore, goes to the finishing lathes, operation 8, with the necessary information for an accurate finish. The man in charge of the job checks the gaging, operation 7, before the finish-cuts are taken.

Fitting 24-in. LeBlond lathes for finishing the forgings, operation 8, was one of the most difficult and costly equipments made. Referring to Fig. 18, the mandrel block was first made of cast steel; but the castings would either take a set or be so porous that they would spring. The block, as fitted at present, is made of forged steel. This block screws over the hollow spindle of the lathe. Through the hollow spindle from the back of the lathe runs a forged steel rod that screws into the expanding mandrel A, which is made of forged steel casehardened. The jaws B are of tempered tool steel and are 7 in. long, thus giving a grip practically the entire length of the cylinder cavity.

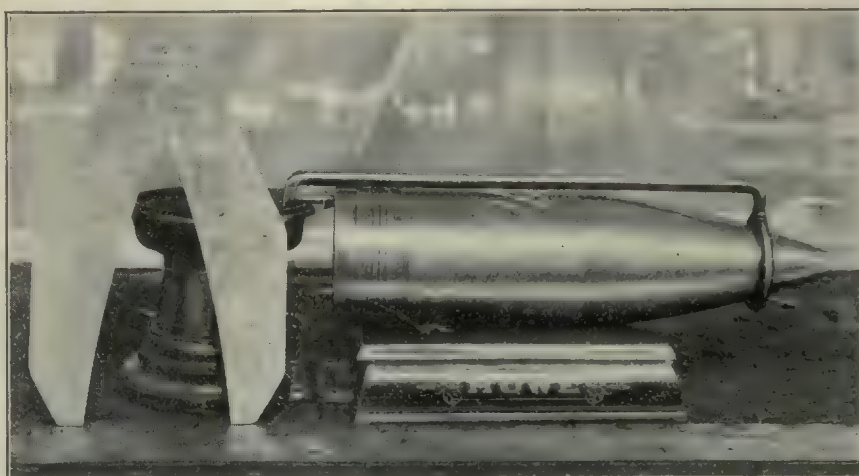


FIG. 22. WEIGHING AND GAGING, OPERATION 8

The diameter of the jaws is slightly less than 4 in., enough to enter the forging, and is accurately ground to size. A handwheel at the end of the lathe fits the mandrel nut. By turning this wheel the mandrel A is drawn back, the taper forcing the jaws B hard out against the cavity of the shell and giving a good grip. The mandrel is tested daily for trueness; a few forgings are tested daily for eccentricity by means of the gage, Fig. 19. The maximum eccentricity obtained was 0.015 in.; the average is about 0.005 in. This small eccentricity is due to the spring in the turret head when an exceptionally hard forging is being machined. The cutting tool being at the corner of the turret does not give the required stiffness when working on hard forgings.

These lathes were not large enough to fit a positive-acting radius-turning arm similar to the one fitted to the Hamilton lathe for the rough-turning, so the profiling attachment shown in Fig. 20 was designed. The cast-iron radius form A is bolted to the taper attachment at the back of the lathe. A cast-steel guide bracket is bolted to the tool carriage. Other brackets are bolted to

the bedplate at the back of the lathe and support the bar *B*, which acts as a trolley for the rollers of the guide bracket. The cast-steel roller bracket *C* inside the guide bracket is bolted to the crossfeed screw. A ⅜-in. wire cable is attached to the roller bracket, is led over the pulley *D* and made fast to a 200-lb. weight at the back of the lathe. The base-plug forgings shown in the photograph were added to increase the weight. The design works perfectly on ordinary forgings, but some of the forgings are so hard that the pull is insufficient to hold the tool to a full cutting depth. This tendency of the tool to leave the shell has been overcome by using a second plate and roller below the one shown, with the curve away from the lathe. When the roller tends to leave the radius form the second form takes the pressure. A spring was tried out, and it worked well when the tension was maintained, but some operators were careless and the form was substituted for the spring. The turret head fitted to the tool carriage of these lathes is an ordinary square turret head made of cast steel and is secured in the desired positions by means of the lock screw. The wide copper cutting tool and gang tools for cutting the grooves in the copper band are secured near the middle of the side, while the steel cutting tools are secured at the corners. Referring to Fig. 21, the sequence of operations and tools used is as follows: Cut groove in rear of copper band, tool marked *G;* shape copper band, tool *B;* cut grooves in copper band, tool *C;* remove burrs and finish copper band to size, tool *B;* turn bourrelet and radius, tools *D* and *E;*

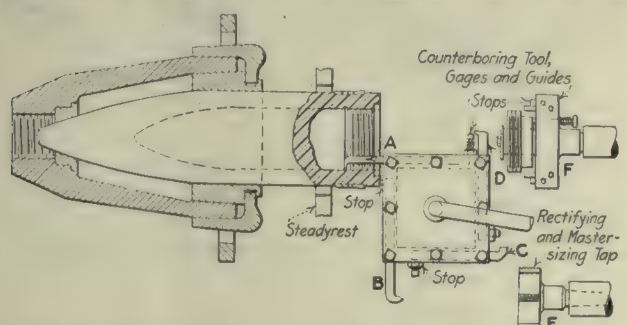


FIG. 24. TOOLS USED IN THREADING THE BASE OF 6-IN. PROJECTILES, OPERATION 9

remove shell, weigh and gage as per Fig. 22, correct weight by turning cylinder of shell between copper band and bourrelet, tools *A* and *F;* turn point of shell, tool *G*, reweigh and mark weight on shell. Turning tools *D, E, A, F* and *G* are of ¾ x 1⅛-in. Midvale tool steel; *B* is of carbon steel 2¼ x 1 in.; the gang tools *C* are of tungsten special. The cutting compound previously described is used in these machines. The speed of each machine is 80 r.p.m. and the feed $^1/_{40}$ inch.

The 18-in. by 8-ft. LeBlond lathes were fitted with collet chucks for cutting the threads in the base of the forging, operation 9. These chucks are similar in design to those fitted to the Gisholt turret lathes. The chuck head screws on the lathe spindle instead of bolting to the faceplate, as with the Gisholts. The other features

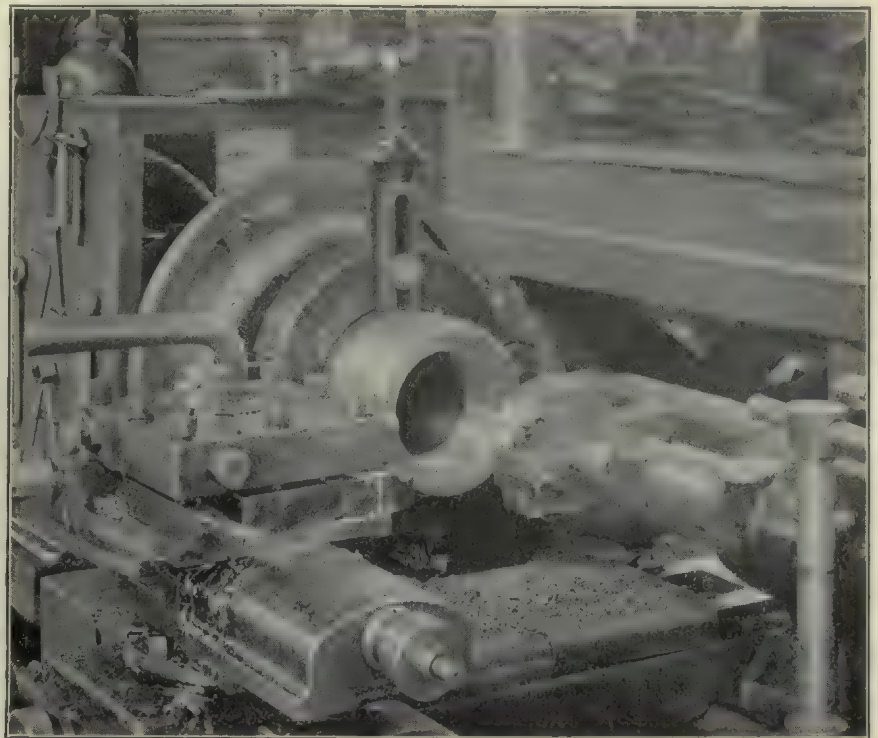


FIG. 23. THREADING THE BASE IN A LE BLOND LATHE, OPERATION 9

of the design are similar in all respects to those described for the Gisholt machines. On account of the weight of this chuck and the great overhang (17 in.), the steadyrest shown in Fig. 23, is used. The turret head for holding the tools is similar to the one used in operation 8. In this design, however, all the tools are held at the corners and the head is bolted to the crossfeed for working in the cavity of the shell.

Fig. 24 shows how the shell is held and how the turret head is fitted with cutting tools and stops, also the sequence of operations in threading. A chasing tool with six chasing threads has been substituted recently for the single-point thread-cutting tool *B*, and tool *C* has been fitted with a lip that cuts the counterbore for the base plug, so that the counterboring tool on the tailstock is more of a forming tool. These changes were made to increase the production. The tool *A* is shown in the shell;

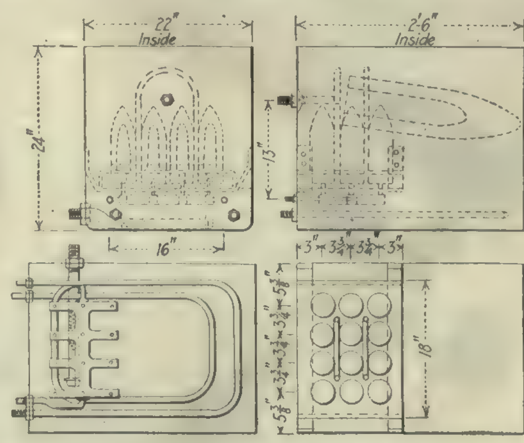


FIG. 25. TANKS AND NOZZLES FOR WASHING 3- AND 6-IN. PROJECTILES, OPERATION 10

the head revolves clockwise. The sizing tap E and the master rectifying tap are inserted in the tailstock. The sizing counterboring tool is shown at F.

The projectile is next thoroughly washed in a boiling solution of soda and lye water to remove all oil and grease, operation 10. Fig. 25 shows the tanks fitted for both 6- and 3-in. projectiles. The pump shown on the column in Fig. 26 forces the boiling mixture through the spraying nozzle shown for washing the cavity. This illustration also shows a forging in the tongs just lifted from the washing tank by means of the air cylinder. This air cylinder travels on an overhead trolley. The shell is next suspended in the second tank, which contains clear, boiling water for rinsing.

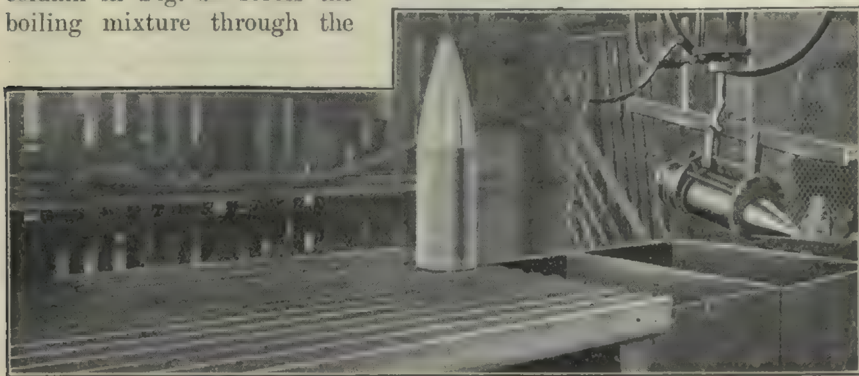


FIG. 26. VIEW OF WASHING TANKS AND DRAIN BOARD, OPERATION 10

The lacquering, operation 11, as originally designed was to be done on a tipple. A thread guard bushing was screwed in the base, the lacquer poured in hot, the shell revolved and the lacquer poured out. The guard did not prevent the lacquer running into the threads. Also the time required for screwing the bushing in and out was as much as was required when using a brush and painting by hand. No time is lost, because another shell is being washed while the lacquering is being done.

The base plugs are next installed, operation 12, the projectile is dropped into the swinging chuck shown in Fig. 27 and the base plug screwed in by means of a special wrench which fits the two holes. Fig. 28 shows the layout of these tables and the sequence of operations. After the plug is installed, the forging is weighed on the scales shown and the final weight is stamped on the base by hand. The number of the plug is also stamped by hand to agree with the number of the projectile. This illustration also shows the painting rig, operation 13, at the left. Briefly, it consists of a constant-speed motor which runs at 1200 r.p.m. and is geared down to drive a conical disk at 88 r.p.m. A swinging arm carrying a cast-iron cone on each end is so centered that when revolved by hand, these cones will alternately engage the driving disk. A spring stop is provided for holding the arm in place while the shell is being painted. While one shell is being painted, the shell that has already been painted is removed from the idle disk by the tongs, Fig. 29, and a fresh shell put on. From here the shell goes out to the shipping station, where it is given its final inspection and stamped before being racked. The only special equipment made for machining the base plugs was a mandrel for finish-turning the outside of the plugs; this mandrel was fitted to the engine lathe. Operation 14 consists in rough-turning the face and body of the base plug. The forging is held by the flange in a four-jawed chuck of a 2-in. Jones & Lamson turret lathe. The inside face of the base plug is first turned to about $1\frac{23}{32}$ in. from the inner face of the flange. Next the thread space is turned the entire length, leaving the diameter of the forgings about $4\frac{1}{4}$ in.; 100 forgings are finished in this operation and the machine is then changed for operation 15. The forging is chucked on the thread space and the flange and the fuse hole finished.

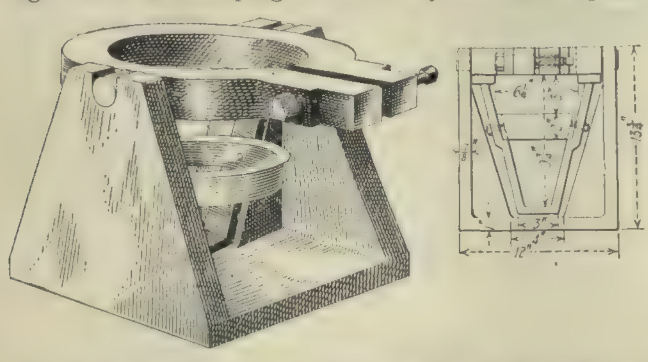


FIG. 27. TRUNNION STANDARD CHUCK FOR INSTALLING BASE PLUGS, 6-IN. PROJECTILES, OPERATION 12

A small drill press is used for drilling the holes in the base plug for the spanner wrench, operation 15. The forging is bolted to the table and two $\frac{1}{2}$-in. holes drilled, stops for depth being used.

The base plugs are threaded, operation 16, in a Le Blond engine lathe, a special mandrel being employed.

FIG. 29. DETAILS OF TONGS USED IN HANDLING FRESHLY PAINTED 6-IN. PROJECTILES, OPERATION 10

The flange is turned to 4.748 in. in diameter and faced to a thickness of 0.35 in. The thread relief and the threads are then cut 7 thread, left hand, U. S. S. form, each plug being tested with a ring gage. The plugs are fitted in projectiles in operation 8. The cost of equipping all the machines was less than $5000, including labor and indirect and material charges. All the special equipment was installed and the machines ready to start work when the first shipment of forgings was received.

The manufacture of projectiles at the Puget Sound navy yard is secondary to the regular routine repair work on ships and only a few machines were utilized. The output of eleven machines is 18 projectiles per 8-hour day and the average cost for direct labor $1.75 per shell.

In view of the large amount of detailed information already published in these columns on the making of pro-

jectiles of various sizes, it has not been considered necessary to go into the minute details of each and every operation. The operations described and the equipment shown will, however, give sufficient information to enable anyone to proceed with the work with very little delay and with comparatively slight modifications of his present equipment. With these methods as a basis and the information as to cost as a guide in making estimates, there should be no delay in getting contracts started, should a large supply of shells become necessary, as now seems likely to be the case. By carefully studying the needed modifications of standard machines, it will be found that these changes can probably be made before forgings can be obtained.

FIG. 28. WASHING, LACQUERING, INSTALLING BASE PLUGS AND PAINTING

Safety Honors Awarded

President Arthur Williams, of the American Museum of Safety, has made public the report of the jury of award, covering the award of four of the five gold medals that are given annually by the American Museum of Safety for noteworthy achievement in the realm of safety. The jury has not yet completed its deliberations relative to the award of the E. H. Harriman memorial medals, which are given annually to the American steam railroad that during the preceding year has been the most successful in protecting the lives and health of its employees and of the public. The awards for the year 1916 are as follows:

The Anthony N. Brady memorial medal, awarded to that American electric-railway company which for the year of the award has done the most to conserve the safety and health of the public and of its own employees, is awarded to the Connecticut Co., with headquarters at New Haven, Conn. On recommendation of the president of the Connecticut Co., the silver replica of the medal is awarded to S. W. Baldwin in recognition of his campaign to impress upon the public the need for the more careful use of the highways and more caution in the use of street cars, as well as for obtaining coöperation among all departments of the company. For similar reasons the bronze replica is awarded to W. J. Flickinger, secretary to the president. Honorable mention goes to the Pacific Electric Railways, of Los Angeles, Calif., and the Interstate Public Service Co., of Indianapolis, Indiana.

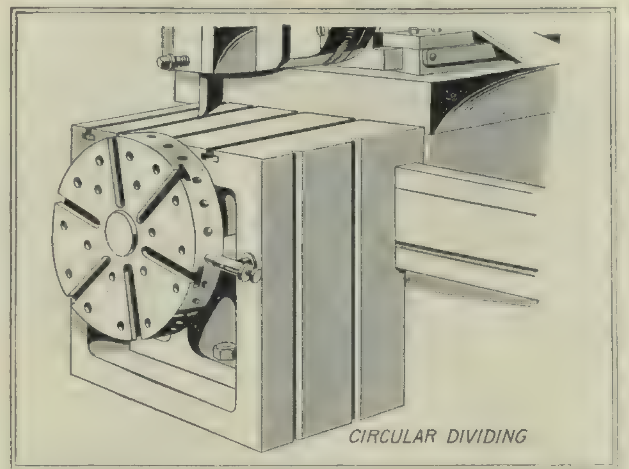
The *Scientific American* medal, awarded for the most efficient safety device invented within a certain number of years and exhibited at the museum, is awarded to the Pullman Co., for originating the "Dean" end frame for passenger cars. This device is a reinforced 8-in. channel beam, bent in an inverted U-shape, to form the side of the vestibule connecting door between cars. This heavy structural beam is then carried under the car platform to a union with the steel underframe of the car. Most of the fatalities in train wrecks have been due to telescoping. The Dean end frame practically armors the end of the car against this occurrence and thus effectively prevents telescoping. Service tests and actual experience in train wrecks have demonstrated the value of the device in protecting passengers from injury in the event of train wrecks.

The Louis Livingston Seaman medal, awarded for progress and achievement in the promotion of hygiene and the mitigation of occupational diseases, is awarded to the Julius King Optical Co., of New York City, as a recognition of its scientific investigation of the effect of colored lenses worn by workmen whose eyes are exposed to the blinding glare of metal melting and refining operations, oxyacetylene welding and electric-arc welding. An effective color has been devised for lenses, which will completely interrupt the ultra-violet and infra-red rays of the spectrum and allow only the most valuable rays of the natural spectrum to pass, thus giving the workman the maximum of illumination and complete protection against retinal irritation. This award is also for the work done by the company in perfecting safety goggles for chippers and sanitary and efficient helmets for workers.

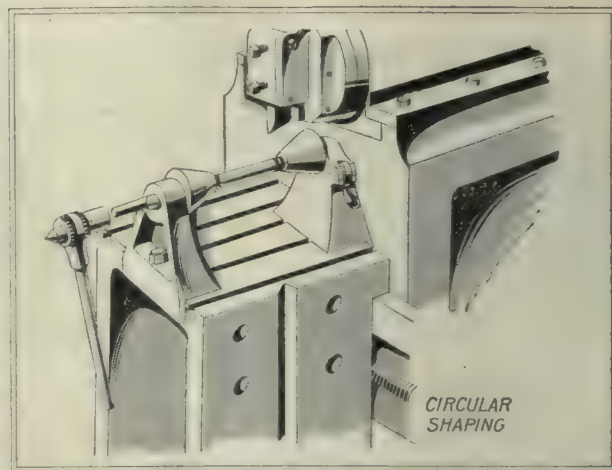
The Travelers Insurance Co.'s medal, awarded to the American employer who has achieved greatly in protecting the lives and limbs of workers, is awarded to the Commonwealth Steel Co., of St. Louis, Mo., for its splendid safety system and protective devices, the sanitary methods applied throughout the plant and for the fellowship work among its employees.

From a Small-Shop Notebook

By John H. Van Deventer



CIRCULAR DIVIDING



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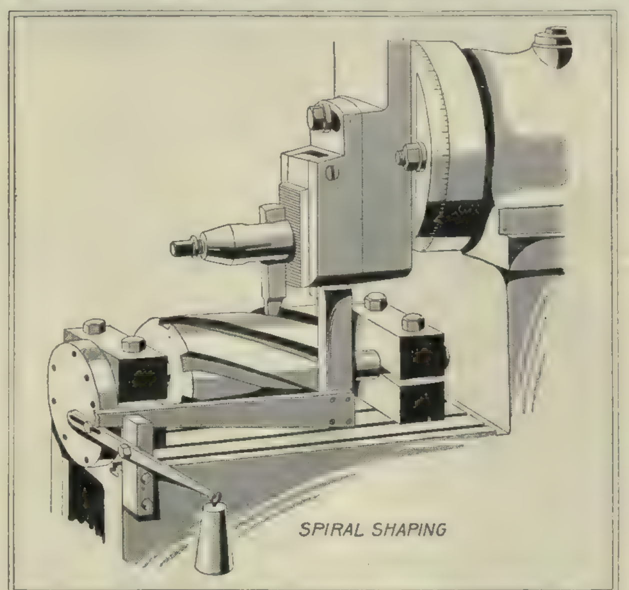
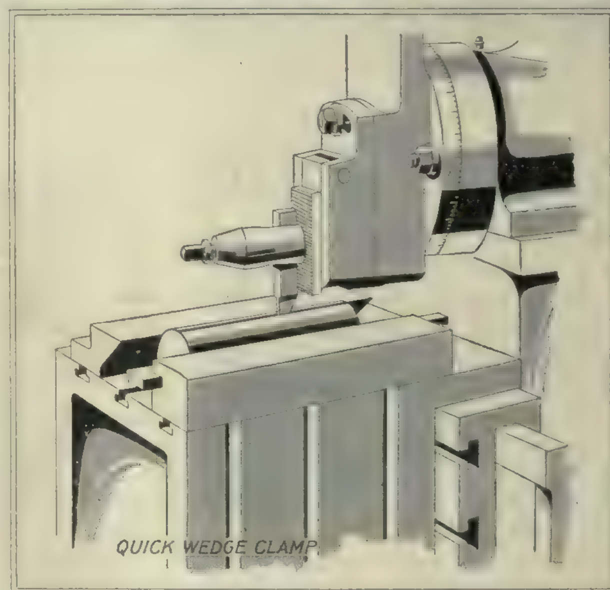
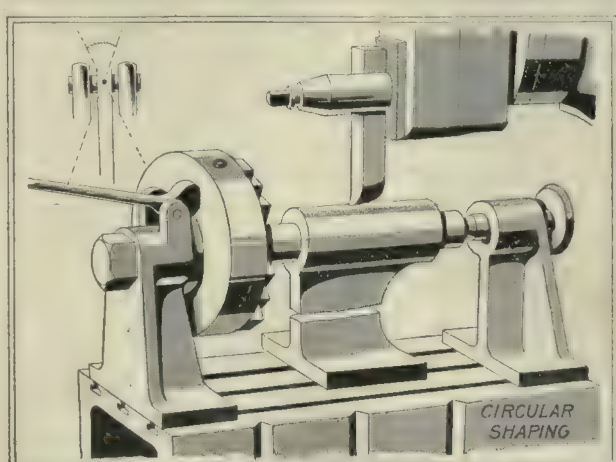


SPIRAL SHAPING



QUICK WEDGE CLAMP



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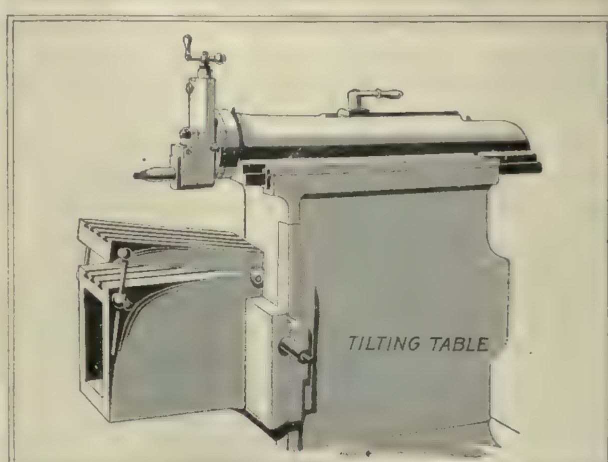


TILTING TABLE

STUNTS THAT MAKE SHAPERS EARN PROFITS AND PAY DIVIDENDS

ADD THESE BENCH AND VISE KINKS TO YOUR COLLECTION

Time Studies on Automatic Machines*

By Dwight V. Merrick†

SYNOPSIS—As the use of automatic machinery increases, it becomes more necessary to determine what constitutes a proper output. This article takes up in detail every step in the time study of automatic machines and leads up to the ultimate assignment of the base rate and task for daily or hourly production.

The time study of automatic machinery differs from that of ordinary, non-automatic, in that in the latter the time required to perform the component parts of the complete operation is taken, while in the former the time lost by stoppages and delays to continuous operation of one kind or another is noted. For instance, with a drawing press with a magazine feed, the production could be absolutely predetermined by multiplying the speed of the machine in revolutions per minute by the number of minutes that it would be in operation per day, provided there were to be no stoppages of any kind. But it is impossible to operate presses, or any other machine, with an assurance that there will be no interruptions. Tools will become dull and require changing, the supply of material may fail, the operator will need a certain amount of time for his personal necessities which will involve stopping the machine, parts of the equipment may require adjustment; any one of a number of causes may operate to delay or stop the work.

It is the function of time study to ascertain what these delays are, what is the probable interval of their recurrence and the duration of each. From these data a factor can be determined that may be applied to the ideal capacity of the machine to give with reasonable accuracy the production that normally should be obtained. At the same time, information is acquired regarding delays that are unnecessary and provision made for their elimination. Improvements in equipment that will minimize the unavoidable delays, such as are necessary concomitants of machine operation, may also be indicated by the study.

PRODUCTION OBSERVATION SHEET P. M. 814-2M-6-16

OBSERVER'S NAME L. K. F. DATE Aug. 10 1916

OPERATORS NAME AND QUALIFICATIONS

PART 44 Caliber Shell — 44 Caliber Shell

OPERATION Head #3 — Head #4

TIME OF DAY	COUNTER READING	REFERENCE	REMARKS MACHINE SYMBOL 56	TIME OF DAY	COUNTER READING	REFERENCE	REMARKS MACHINE SYMBOL 57
P.M. 1.00	88132				89637		
1.15	89594		R.P.M. 100 R.P.M.		91116		
1.30	91085				92614		
1.45	92555				94104		1.48.9 P.D. 1.58.4 F.C. / 1.50.3 1.4 1.58.6 .2
2.00	94042				95463		2.19.5 P.D 2.21.8 A 2.26.5 A 2.28.7 / 2.21.8 2.3 2.22.8 1. 2.27.4 .9
2.15	95515		2.28.7 F.C. / 2.29 .3		96966		
2.30	96989		2.41.8 P.P. / 2.44.2 2.4		97916		2.28.7 U 2.31.5 N.P. 2.32.3 A / 2.31.5 2.8 2.32.3 .8 2.34.2 1.9
2.45	98234		2.47 F 2.52.6 A / 2.47.2 .2 2.52.8 .2		99014		
3.00	99698		3.02.8 O 3.06.9 F.C. / 3.03.8 1. 3.07.1 .2		00503		3.01.4 O 3.04.6 N.B. 3.08.4 A 3.09.1 P.B. 3.09.8 A / 3.02.1 .7 3.08.4 3.8 3.09.1 .7 3.09.8 .7 3.10.5 .7
3.15	01070				01268		3.11.12 P.B 3.12.0 A / 3.12.0 .8 3.12.2 .2
3.30	02549		3.05 F / 3.05.3 .3 100 R.P.M.		02762		
3.45	04051				04250		101 R.P.M.
4.00	05506		4.01.7 U 4.07.3 N.B. 4.08.1 A 4.08.3 P.B. 4.09.3 A / 4.07.3 5.6 4.08.1 .8 4.08.3 .2 4.09.3 1. 4.13.3 .4		05735		4.07.2 F.C. 4.11.8 F.C. / 4.07.5 .3 4.12.0 .2
4.15	05680		4.13.3 P.D 4.14.2 A 4.15.0 P.D. 4.15.6 A / 4.14.2 .9 4.15.0 .8 4.15.6 .2 4.17.8 2.2		07213		
4.30	06900				08703		
4.45	08370		4.48.1 F.C. / 4.48.4 .3		10185		
5.00	09864		5.00.0 F 5.22.2 F.C. / 5.00.3 .3 5.22.5 .3		11683		
5.15	11302		R.P.M.		13186		
5.30	12793				14659		
5.45	14288				16153		
6.00	115285				117156		
	88132				89637		
	27153				27519		

FIG. 1. THE ORIGINAL OBSERVATION SHEET OF A TIME STUDY ON AN AUTOMATIC HEADING PRESS

In short, time study of non-automatic machinery concerns itself only with useful, productive operations. Time study of automatic machines concerns itself not at all with productive time, except incidentally, but is vitally interested in the time expended in useless or inefficient operations. The first examines, in detail, the production of the individual piece. The second looks after production in the mass and determines the time required to produce a quantity of pieces.

It is therefore evident that time study of automatic machinery must be carried out on a somewhat different basis than the time studies that have previously been de-

 This is one of several articles by the same author on the general subject of time study. The other articles appeared in the "American Machinist" on pages 171, 221, 269 and 407.

†Consulting engineer, New York City.

scribed. Such studies must extend over a relatively long period of time, usually at least two days and often ten days. This is necessary in order that the observer may be sure, through the recurrence of delays of the same character, that he has made observations of every class of interruption that is likely to take place in the usual course of work. It is also necessary to ascertain the average rate of production of the particular equipment under study. It is well known that the speed of lineshafts will vary from hour to hour and that the speed of the machine itself will vary independently of lineshaft variations, owing to belt slippage and other causes. The study must be of sufficient duration to take into consideration all of these variations.

Studies of automatic machinery may be divided into two classes: (1) Where the individual pieces are produced so rapidly that there is an insufficient interval between them to record the time of production of each separate piece, and (2) where the interval between the individual pieces is sufficiently great to permit the production of each piece to be noted and recorded separately. In the latter case, the study partakes largely of the nature of the production study described in a previous article, and the difficulties of analysis are no greater than those of the production study. In the first case where the production is extremely rapid, it is necessary to take the average production and apportion all delays to this average production. The method of taking time studies of this character is considered in the present article.

Studies of automatic machinery comprise the following divisions:

1. A preliminary study and analysis of the work and of all the influencing conditions, in order that the observer may obtain a clear conception of the work of the machine and the duties of its attendant. This study gives him a general knowledge of the operation as a whole and of all the factors that contribute to delay it, including the physical and mental condition of the operator.

2. Observation of the machine or group of machines and their attendants under working conditions for a considerable period of time. During this observation, which is the time study proper, note is made of the production, speed of the machine, time of interruptions and the duration of all delays, together with notations of the cause of such delays. These observations should be started at the beginning of the day and should be continued until the observer is satisfied that the delays are repeating themselves. The production—that is, the quantity of pieces made by the machine—should be noted at regular intervals. Fifteen-minute intervals will usually be found satisfactory for most classes of work. The speed of the machine should be noted at least twice during each half-day and more often if the conditions seem to make it advisable.

OBSERVATION SHEET 1449A 15M-8-16

OBSERVER'S NAME L. K. F. MACHINE NO. 56 DATE 8-14 1916

WORKMAN'S NAME AND QUALIFICATIONS 1240 G

PART 44 Caliber Shell

OPERATION Head

	DETAILED OPERATIONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	AVERAGE	MINIMUM TIME
1			AM		AM		PM		AM		PM		AM		Total		Per Day			Per Piece			
2	Number of pieces done	27	441	27	129	27	153	23	444	28	054	24	320		157	540	56	250					
3	Time with all delays		300		300		300		225		300		255		1	680		600		0.0	165		
4																							
5	Necessary delays																						
6	Punch trouble	1.	0^{-1}	–			–		–		1.9^{-1}					2.9^{-2}		1.03	.715	103/.715	=1.44		
7	Die trouble	–			3.0^{-2}		.9^{-1}		–		–					3.9^{-3}		1.39	1.07	139/1.07	=1.30		
8	Bunter trouble	–			1.5^{-2}		.8^{-1}		–		–					2.5^{-3}		.82	1.07				
9	Tool and Mach. Adjust.	3	9		2.5		7.4		.6		6.8					2.2		7.17		.82/1.07	=.766		
10	Wash	5.	0		5.0		5.0		5.0		5.0					25.0		8.93					
11	Oil Machine		7		.9		1.0		–		1.3					3.0		1.39					
12	Personal	7	9		–		–		–							79		2.82					
13																							
14	Unnecessary delays																						
15	Feed trouble	1.	5		.3		.8		.2		1.6		.5			4.9		1.75					
16	Feed clogged	5.	0		3.1		1.1		2.3		1.1		1.4			14.0		5.0					
17	Polish punch	–			2.1^{-1}		3.0^{-2}		2.5^{-2}		–		–			7.6^{-5}		2.71	1.78				
18	Polish bunter	–			1.7^{-2}		1.0^{-1}		–		.7^{-1}		1.1^{-1}			4.5^{-5}		1.61	1.78				
19	Wait for adjuster	–			–		–		–		–					–		–					
20	Unnecessary	8	6		7.1		5.6		–		.4					21.7		7.75					
21	Straighten punch	–			–		–		–		–		7.7^{-2}			7.7^{-2}		2.75	.715				
22									Total Delays						12	7.5		45.12					
23							Time without Delays								554	88				.00985			
24																							
25																							
26	Average Speed 101.4																						
27	Time per Stroke 0.00985																						
28																							
29																							
30																							

FIG. 2. THE ANALYSIS OF A SERIES OF TIME STUDIES ON AN AUTOMATIC HEADING PRESS

3. Repetition of item (2) for several groups of machines having the same features in common, such as the type of machine, type of work, etc.

4. Summation of the various delay items, production, etc., for the total period for which the machines were under observation and the reduction of these items to a basis of one day.

5. Study and analysis of the time records leading to the selection of a governing factor that runs through all the studies and by means of which they can be compared. As a result of this analysis and study, curves can be plotted for each item for which a delay allowance should be provided.

6. The selection from the curves or records of fair values for each of the items for which delay allowance should be made.

7. The preparation of instruction cards on which the items are listed and allowances made for fatigue, washing, etc., for the guidance of the operator.

A Typical Automatic-Machine Study

The accompanying illustrations show the features of a typical time study made on a series of heading presses performing one of the operations of manufacturing brass shells. The production is ascertained by the reading of the counter on the press at the beginning and end of the operation and at 15-min. intervals between. The object of the counter readings at 15-min. intervals is that if an extraordinary delay occurs during the course of the study, the counter reading at the end of the 15-min. period preceding and at the beginning of the 15-min. period succeeding the delay can be taken and the study between those points omitted altogether. This will prevent a relatively minor accident vitiating a study that has already extended over several days. The delays, as they take place, in any 15-min. period are entered in the space headed "Remarks" and opposite the figure denoting the beginning of the 15-min. period. Thus delays occurring between 7 and 7:15 are entered in the 7 o'clock space. Those between 7:15 and 7:30 are entered in the 7:15 o'clock space, etc. The time at which each delay starts and ends is entered in this column, together with the symbol showing the cause or nature of the delay. The following have been used as symbols for delays in connection with the press operations illustrated:

A, adjust machine; B, belt trouble; CT, change ticket; BS, bad shells; F, feed trouble; FC, feed clogged in pipe; ND, new die; NB, new bunters; NP, new punch; NO, operator not on hand; NW, no work; PD, polish die; PB, polish bunters; PP, polish punch; WA, wait for adjuster; U, unnecessary; O, oil; W, wash; SP, straighten punch; P, personal; PPDB, polish punch, die and bunter.

Separate observation sheets are used for morning and afternoon observations, these being identical except that the 15-min. intervals on the morning sheet run from 7 a.m. to 12 o'clock noon, while on the afternoon sheet they run from 1 until 6 p.m. Space is provided on each sheet for two independent sets of observations, so that two machines can be studied at one and the same time by means of a single observation sheet.

Referring now to Fig. 1, it will be observed that the first notation in the "Remarks" column for machine No. 50 is 2.28.7 FC. This signifies that at 28.7 min. past 2 o'clock the feed pipe clogged. The next notation, directly underneath, 2.29, indicates that the trouble was remedied at that time, and the time lost by the interruption is denoted by the circle drawn around it. In the next space is the notation 2.41.8 PP, signifying that at that time the operator stopped his machine and polished the punch, losing 2.4 min. in the operation and resuming work at 44.2 min. past two. The time lost in all cases is shown by a circle drawn around the figures indicating the differences, to draw attention to them. Throughout the study, delays are similarly noted and recorded.

At the conclusion of the study, the production and the delays are summarized as shown in Fig. 2. On this sheet the various columns each represent a separate half-day study. The various causes of delay are listed in the column entitled "Detailed Operations," and the several delays of each character on separate production observation sheets are totaled and entered in the proper space and

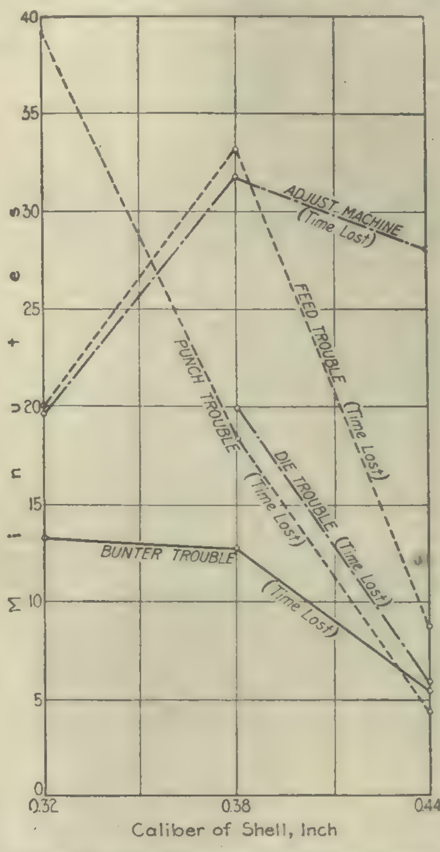


FIG. 3. GRAPHIC REPRESENTATION OF TIME LOST IN HEADING-PRESS OPERATION

column on the summary sheet, Fig. 2. Thus, in Fig. 1, there was trouble due to the feed pipe clogging in many of the 15-min. periods represented by the symbol FC. If these several items FC in Fig. 1 are totaled, they will be found to be numerically equal to 1.1 min., which figure is entered in column 6, line 16, of Fig. 2. Similarly, the time lost unnecessarily is totaled and found to be 5.6 min., while 7.4 min. was consumed in adjustments. It is also shown that it was considered necessary to polish the punch twice during the period represented by the study in Fig. 1 and that 3.0 min. was consumed. This is entered in line 17, column 6, and the exponential figure 2 is written alongside to indicate two changes.

In analyzing the observation sheets, delays that are considered as necessary accompaniments to the manufacture are separated from those that are on their face unnecessary, as shown in the illustration.

TABLE A. ANALYSIS OF DELAYS IN TIME STUDY OF AUTOMATIC HEADING PRESSES

	Total						Per Day					
	0.32 Caliber Shell		0.38 Caliber Shell		0.44 Caliber Shell		0.32 Caliber Shell		0.38 Caliber Shell		0.44 Caliber Shell	
Pieces made	118,292		121,636		281,651		47,441		43,838		51,205	
Time required, min	1,485		1,665		3,330		600		600		600	
Delays	Changes	Min.	Changes	Min.	Changes	Min.	Changes	Min.	Changes	Min.	Changes	Min.
Feed trouble	....	48.0	....	92.8	....	46.58	....	19.37	....	33.4	....	8.47
Punch trouble	6	96.5	6	51.75	5	23.20	2.4	39.02	2.2	18.6	0.91	4.22
Die trouble	....	......	4	55.40	4	31.70	....	......	1.4	19.9	2.62	5.76
Bunter trouble	7	32.8	4	35.35	5	29.10	2.8	13.25	1.4	12.7	1.18	5.28
Adjust machine	....	49.9	....	88.30	....	153.4	....	20.16	....	31.8	....	27.90
Wait for adjuster	....	45.2	....	......	....	26.0	....	18.26	....	......	....	4.74
Oil machine	....	1.5	....	......	....	6.3	....	0.61	....	......	....	1.14
Unnecessary	....	19.7	....	108.05	....	42.9	....	7.86	....	38.95	....	7.80
Wash	....	10.0	....	20.0	....	50.0	....	4.04	....	7.25	....	9.10
Belt trouble	....	......	....	......	....	37.1	....	......	....	...	....	6.75
No operator	....	......	....	......	....	7.2	....	......	....	......	....	1.32
Tools needed	....	......	....	15.40	....	....	....	......	....	5.55	....	......
Gaging	....	......	....	7.50	....	....	....	......	....	2.70	....	......
Machine repairs	....	......	....	21.20	....	....	....	......	....	7.65	....	......
Polish punch, die and bunter	....	9.6	....	......	....	9.0	....	3.88	....	......	....	1.64
Unavoidable	....	......	....	3.55	....	....	....	......	....	1.28	....	......
Bad shells	....	......	....	10.5	....	1.6	....	......	....	3.78	....	0.29
Change job ticket	....	......	....	......	....	7.8	....	......	....	......	....	1.42
Total delays		313.2		509.8		471.8		126.5		183.56		85.83
Net productive time		1,171.8		1,155.2		2,828.2		473.5		416.44		514.17

A similar analysis is made of each of the production study sheets, the number of pieces produced during each study being determined by subtracting the first counter reading from the last. The productive time consumed and delay for a single day. Thus, in Fig. 2, the study required 1680 min. for its completion, giving a factor of 0.357, which reduced the 14.0 min. total delay due to clogging of the feed pipe to 5.0 min. delay for one day.

OBSERVATION SHEET 1449A 15M-8-16

OBSERVER'S NAME Tyler MACHINE NO Vert Hd DATE 10-19 1916
WORKMAN'S NAME AND QUALIFICATIONS (Operator & Tool Setter) one man
PART 44 Caliber Shell .... 110 R.P.M.
OPERATION Heading - Vertical Machine

COMPUTED BY L. K. Y. DATE 10/19/16
CHECKED BY A. F. DATE 10/19/16
PASSED BY D. O. M. DATE 10/19/16
SIGNED BY J. DATE 10/19/16

	DETAILED OPERATIONS		
1	Oil machine at start of each 5 hour interval	2.00 mins. for 56,660 pcs.	.000035
2	Start machine		------
3	HEAD SHELL 110 R.P.M.		.009091
4	Bunter, set and adjust	1.75 MINS. for 43,600 pcs.	.000040
5	Die, set and adjust	2.75 " for 24,400 pcs.	.000113
6	Punch, set and adjust	1.2 " for 41,000 pcs.	.000029
7	Adjust tools and machine	15.0 " for 56,660 pcs.	.000265

Mach. Adjuster's UNIT BASE RATE .03	BASED ON 12 MACHINES	DAY RATE GUARANTEED
TIME PER 100 10.589 MINS.	Production Per Hour of 4,720 AND OVER UP TO 5,660	BONUS RATE PER 1000 $.00145
	Production Per HOUR AND OVER 5,660	BONUS RATE PER 1000 $.00175

TOTAL SELECTED TIME .009573
.009091 MACHINE TIME, POWER FEED at 5 % .000455
MACHINE TIME, HAND FEED at %
.000482 HANDLING TIME at 25 % .000120
Personal Allowance 15 min for 56,660 pcs. .000265
Washup Allowance 10 min. for 56,660 pcs. .000176
TIME FOR PIECES
TIME FOR ONE PIECE .010589
TIME FOR 1000 PIECES 10.589
HOURLY PRODUCTION 5,660
UNIT BASE RATE .1425 RATE PER THOUSAND $.0335
OPERATOR OPERATES 2 MACHINES ON OPERATION NO.
Two Vertical Heading Machines

Old Rate .0293 Eff 85.8%

FIG. 4. SUMMARY SHEET OF THE TIME STUDY OF HEADING. 44 CALIBER SHELLS

during the studies and the time of the various delays are all totaled and entered in the proper column, as shown. The total time with all the delays is divided into 600 min. (the number of minutes in a working day in the establishment in which the study under consideration was taken) to obtain the factor that will reduce the totals of production and delays to a standard of production

Similar studies were made on machines doing work of the same character but of different size—namely, 0.38 and 0.44 caliber—in which the same character of delays would probably take place, and the analyses are tabulated as in Table A. It will be noticed in Table A that the following delays are common to all sizes of shells: Feed trouble, punch trouble, die trouble, bunter trouble, ad-

just machine, oil machine, personal. It might be assumed, therefore, that such delays are necessarily a part of the manufacturing process and are more or less unavoidable. Forming, as they do, a large percentage of the total delay, they should be examined carefully to ascertain, first, if they can be wholly or partly avoided, and second, what proportion each, when reduced to its minimum, bears to the net productive time. The remaining classes of delays are obviously due to accident or carelessness and need not be considered in the setting of tasks. In fact they need not be considered at all except to see that provision is made to prevent their recurrence.

Plotting the delays, as has been done in Fig. 3, is an excellent method of studying the relation that the several delays in the different sizes of work bear to each other. The curves reveal some valuable facts: (1) There is an evident relation between the punch, die and bunter trouble and the size of the work, the trouble being less serious with the larger sizes. (2) There is no apparent relation between the size of the work and the adjustment of the machine or the feed trouble. (3) There is apparently a very definite relation between the time lost due to feed trouble and the time lost in adjusting the machine. (4) On account of the steep slope of the curves it is evidently impossible to select a factor for delays that will apply to all sizes of shells alike, but it will be necessary to select different factors for each class of work.

TABLE B. SUBDIVISION OF DELAYS

	0.32 Caliber Shell		0.38 Caliber Shell		0.44 Caliber Shell	
	Total Delay, Min.	Delay per Day, Min.	Total Delay, Min.	Delay per Day, Min.	Total Delay, Min.	Delay per Day, Min.
Charge punch	86.3	34.9			7.1	1.29
Polish punch	10.2	4.12	51.75	18.6	19.9	3.62
Straighten punch	....	.....			2.1	0.38
Change die	....	.....	55.40	19.9	4.3	0.78
Polish die	....	.....			27.4	4.98
Change bunter	....	.....	35.35	12.7	9.2	1.66
Polish bunter	32.8	13.25			19.9	3.62

The fact that the delay due to feed trouble is irregular in character indicates that it is due to conditions that are not inherent in the manufacturing process, and that they, therefore, probably are subject to correction which would eliminate this source of delay altogether. As a matter of fact, an investigation of the equipment after the time study had indicated the irregularity of the feed revealed that the feed pipes through which the shells were fed to the presses from the magazines were too small and clogged easily. The substitution of larger feed pipes removed practically all trouble from this source and automatically eliminated this particular item of delay. There are, then, left for consideration the items of punch, die and bunter trouble, and such machine adjustment as does not relate to the feed mechanism. To do this, it is necessary to examine the delays somewhat more closely than has been done in Table A.

Reference to the original observation sheets will show that the delays charged to punch, die and bunter, and to adjusting machines, can be further subdivided. Such a subdivision for shells of 0.32 caliber and 0.44 caliber is given in Table B. Unfortunately, the observer who was assigned to the study of the 0.38 caliber shells failed to subdivide the delays as finely as did the observer on the other jobs, but lumped the delays under the heads of punch trouble, die trouble, etc., as given in Table A. However, the information given by the time studies on the other two sizes is sufficient to enable a judgment to be formed regarding the delays on the third size.

Table B shows that punch, die and bunter troubles divide themselves mainly into two classes—change equipment and polish equipment. The one exception is the straightening of the punch in the 0.44 caliber shell, which might properly be included in the time for changing, inasmuch as it is an adjustment incidental to the improper setting of the punch. It is now necessary to determine if all the delays listed in Table B are necessary and unavoidable. An investigation of the polishing of punch, die and bunter showed that this was more or less of a tradition in the work and that it was largely unnecessary. Any polishing that might be needed to put these items of equipment in condition for work could be done at the time they were changed, and the stopping of the machine at irregular intervals for this purpose was wholly unnecessary and a waste of time and effort. These items were therefore discarded from further consideration in the formulating of the task.

The analysis thus far has eliminated as unnecessary all the delays noted in the observations except those of changing the punch, die and bunter, adjusting and oiling the machine, and the usual flat allowances for personal delays and washing. It is now only necessary to determine what the ideal production of the presses should be and what percentage of this production should be deducted for each of the several allowable delays noted above.

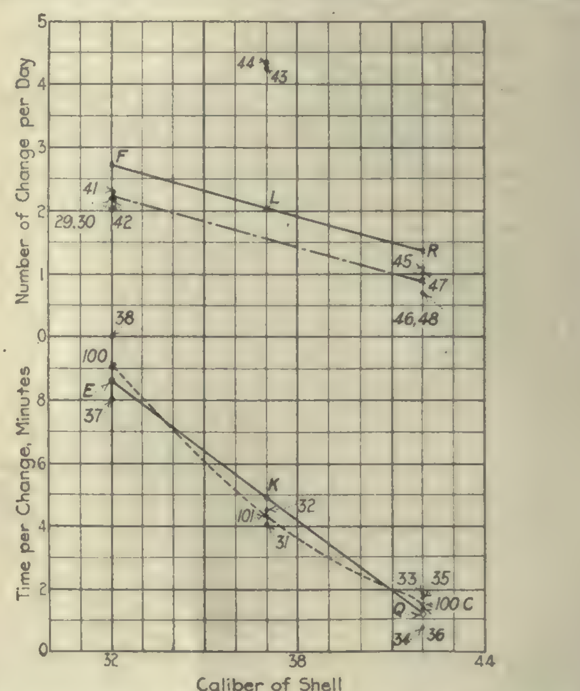


FIG. 5. GRAPHICAL ANALYSIS OF NECESSARY DELAYS

Determination of Ideal Production

Referring now to the summary sheet, Fig. 4, it will be observed that the delays enumerated in the preceding paragraph are the only delays allowed in determining the production required. It will also be observed that the speed of the machine is set at 110 r.p.m., although the time studies showed an average speed in the neighborhood of 100 r.p.m. The higher speed was determined by means of an independent investigation carried on to ascertain the maximum speed at which the operation could be performed, taking into consideration the effect of the process on the material being worked, the frequency

of breakdown of equipment at the several speeds investigated, the life of punches, etc. Such an investigation is highly desirable, but not altogether necessary from the standpoint of time study. The delay allowances could be fixed just as accurately without such an investigation, although there then would be no assurance that the presses were delivering their maximum capacity. This investigation is of a mechanical character and should be made to supplement the time study whenever possible.

The higher speed having been determined by a separate investigation, it may be found necessary or desirable to take new time studies if rates have been fixed as the result of studies made at the original operating speed. The reason for this is that the higher speed may introduce new conditions in handling the work that do not exist at the lower speeds and thus vitiate the studies under which the rates were set.

18179 5M 1-17

PIECE WORK
INSTRUCTION CARD

NO.	DETAIL INSTRUCTIONS	FEED Amount	FEED Sym	SPEED R.P.M.	SPEED Sym	Preparation Time	Time Work Should Take
1	Oil machine at start of each 5 hr. interval, 2.0 mins. for 56,660 pcs.						.000035
2	Start machine						-----
3	HEAD SHELL			110			.009091
4	Bunter, set and adjust, 1.75 mins. for 43,600 pcs.						.000040
5	Die, set and adjust, 2.75 mins. for 24,400 pcs.						.000113
6	Punch, set and adjust, 1.2 mins. for 41,000 pcs.						.000029
7	Adjust tools and machine, 15.0 mins. for 56,660 pcs.						.000265
							.009573
	.009091 mins. (machine time) at 5%						.000455
	.000482 mins. (handling time) at 25%						.000120
	Personal Allowance, 15 mins. for 56,600 pcs.						.000265
	Washup Allowance, 10 mins. for 56,660 pcs.						.000176
	Time for one piece						.010589
	Time for 1000 pieces						10.589
	Man operates two machines on operations head shell.						

When work cannot be done as shown, report must at once be made to the man who signed this card. Date 10-21-16 Signed DVM

Sketch

Name or symbol of part: 44 CALIBER SHELL
Operation: HEAD 110 R.P.M. Oper. No. 15
Kind of material: BRASS Mach. symbol: 1HV
Unit: 1,000
Time per unit: 10.589 Preparation time: Production per hour: 5,660
Rate per unit: $.0335 Rate for preparation: Operators base rate per machine: $.1425
Rate per unit: Rate for preparation: Attendants base rate per machine:

FIG. 6. INSTRUCTION CARD ISSUED TO MACHINE OPERATOR

THE APPORTIONMENT OF DELAYS

We now come to the problem of determining how often punches, dies and bunters should be changed and the length of time that should be allowed for each change. Unless there are a great many observations available—many more than will ordinarily be found to be the case—it is unwise to attempt to formulate a particularly severe task for this portion of the work. Changes come at such irregular and relatively infrequent intervals that no regular rate of speed can be established, nor is there any chance for the operator or adjuster to obtain a rhythm in his work, which always tends to diminish the time required for any operation. In the case of a series of studies on a single type of machine it is probably safe to take the average value, both of the number of changes and of the minutes required per change, and to use this average as a base upon which allowances for delay, fatigue, etc., are figured.

Where several machines are involved, however, or several sizes of work, it is often profitable to plot curves from the results obtained from the time studies and from these curves select more or less arbitrary values for the delays which are permissible for the various sizes of work and the several sizes of machine. Fig. 5 shows the plotting of one such set of curves in regard to changing of punches. Points 37 and 38 represent the average time per change as determined by two separate studies on 0.32

1808 5M 9-16

INSTRUCTION
CARD

NO.	DETAIL INSTRUCTIONS	SPEED R.P.M.	SPEED Sym	Time Work Should Take
	MACHINE ADJUSTER. Should adjust, maintain, inspect and see that machines are properly oiled and are kept in good operating condition. He is to secure and prepare tools for twelve machines; to make every effort to keep the machines running, and to eliminate lost time. He is paid a piece work bonus, based on the output from the twelve machines in addition to the regular day rate.			

When work cannot be done as shown, report must at once be made to the man who signed this card. Date 10-21-16 Signed DVM

Sketch

Name or symbol of part: 44 CALIBER SHELL
Operation: HEAD 110 R.P.M. Oper. No. 15
Kind of material: BRASS Mach. No. 1HV
Machine adjuster's base rate per machine: $.03 Day rate guaranteed
Time per 1000: 10.589 mins.
For production per hour of 4,720 and over, up to 5,660: Rate per 1000 $.00145 Bonus
For production per hour and over 5,660: Rate per 1000 $.00175 Bonus

FIG. 7. INSTRUCTION CARD ISSUED TO MACHINE ADJUSTER

caliber shells; 31 and 32 represent similar points for 0.38 caliber shells, while 33, 24, 25 and 36 represent the average times for changes for 0.44 caliber shells, as determined by a corresponding number of studies. Points 100, 101 and 102 represent respectively the mean of the several plotted points for 0.32, 0.38 and 0.44 caliber shells. A curve drawn from these three points will, it is recognized, be quite flat, and a straight-line approximation of it would probably be sufficiently correct for all practical purposes. Accordingly, a straight line has been drawn through it in such a position as to divide the error equally on either side of it. Values selected for the delay allowances for changing punches are the points of intersection *EKQ* of the straight line with the ordinates representing the several sizes of shell. Were there intermediate sizes other than the three, the given delay allowance taken from this straight line would be sufficiently correct for the setting of tasks.

Similarly, the curve *FLR* is laid out to give the average number of changes of the punch per day. Approximate curves are drawn in the same manner to obtain

values for all of the necessary and allowable delays—namely, die and bunter trouble and machine adjustment.

These values having been determined, we can now ascertain the production per day by means of a convenient formula as follows:

$$Production = \frac{Q}{1.05}(M - 1.25H - W - P)$$

where

Q = Production in pieces per minute, or revolutions per minute of the machine when the production is one unit per revolution;

M = Number of minutes in the working day;

H = Sum total of all adjusting, oiling and tool-setting allowances in minutes per day;

W = Washing allowance, in minutes per day;

P = Personal allowance, in minutes per day.

The denominator 1.05, of the factor, and the coefficient 1.25 represent respectively the allowance for the machine work and for handling time.

The statement in the first article of this series will be recalled, that a flat allowance of 5 per cent. was made on all machine time and that an allowance for handling time was determined by means of the curves illustrated in that article. Reference to those curves will show that when the period exceeds 10 min. the curves are practically straight and range in value from 20 to 30 per cent. An average allowance of 25 per cent., therefore, has been considered ample for this class of work. Translated into the terms of a 10-hour day, on machines running 110 r.p.m. and delivering one unit of product per revolution, the above formula would read

$$Production = \frac{110}{1.05}(600 - 1.25H - W - P)$$

When the production has been found by means of the formula, the various quantities that can be made by each portion of the equipment between changes are ascertained by dividing the production per day by the number of changes per day. The quotient so obtained is divided into the time allowed per change, to apportion the delay to the individual piece, and the results are entered in the summary sheet, Fig. 4, as shown. These delays and the prorated allowance for machine and handling time, together with the personal and washing allowances, are added to the machine time per piece to give the total time to produce a single piece, with all delays and allowances figured in. The hourly production and unit piece rates are then calculated, as shown in Fig. 4, and instruction cards written and issued. The steps are all clearly indicated in the illustrations and further description is unnecessary.

While the above detailed explanation applies to time studies of automatic-press work, nevertheless the principles involved apply to practically every class of automatic machinery. The procedure may be summarized as follows:

1. Take a study of one or several machines of the same character, extending over several days, noting the production at regular intervals and recording the time of the beginning and ending of each interruption or delay, together with a notation of the nature of such interruption or delay.

2. Analyze the delays and interruptions, noting the number, total and individual times of each class of delay for each size of machine or size of work.

3. Examine the delays to ascertain which are avoidable by correction of existing improper conditions and discard these from consideration, after taking steps to have the improper conditions rectified.

4. Plot the remaining delays to ascertain whether or not any relation exists between them and also to ascertain what effect one character of delay has upon another.

5. Subdivide as minutely as possible these delays and examine them to see if any portion of them can be avoided. If so, discard these items from further consideration.

6. Plot the average time, in minutes, of each class of delay and draw a smooth curve that will represent the average performance of the group of machines or several sizes of work under consideration, and read from the curves the allowable time per delay.

7. Plot in a similar manner the average number of delays per day for each class and determine the allowable number of delays per day.

8. Multiply the number of allowable delays per day by the time per delay, to ascertain the total length of each class of delay per day.

9. Determine the required production per day by means of the formula,

$$Production = \frac{Q}{1.05}(M - 125H - W - P)$$

10. Divide the production per day by the number of delays per day of each class (as found in 7), and divide the quotient into the allowable time per delay (as found in 6), to prorate the total delay to the individual piece.

11. Ascertain the machine time per piece by dividing the total production per day into the number of minutes in the working day.

12. Add the machine time per piece to the total of all the delays per piece, and add to the sum an allowance of 5 per cent. of the machine time per piece and of 25 per cent. of the sum of all the delays per piece.

13. Add to the sum obtained in (12) the prorata allowance per piece for the various personal necessities and washing.

14. Divide the sum obtained in (13) into 60 to find the hourly production required.

15. Fix base rates and task for daily or hourly production.

A Remarkable Accomplishment by Shop Journalists

A publication that is perhaps the most attractive of its kind has found its way to the editor's desk. It is the annual called "Knots," published by the employees of the Barber-Colman Co. Bound appropriately in a cord-tied cover, its one hundred and sixty-eight 9 x 12-in. pages are full of clever writing and illustrations. The avowed objects of this annual published by the Barber-Colman Association are to further the interests of coöperation between employer and employee, serve as a memento for the members and friends of the association, and as a demonstration to others of what loyalty, energy and unity of effort can accomplish.

The Barber-Colman Co. is to be congratulated on having employees endowed with the good taste and ability necessary to get out a work of this kind. It is equal, if not superior, to many university and college annuals.

Electric Arc Welding in the Pennsylvania Railroad Shops

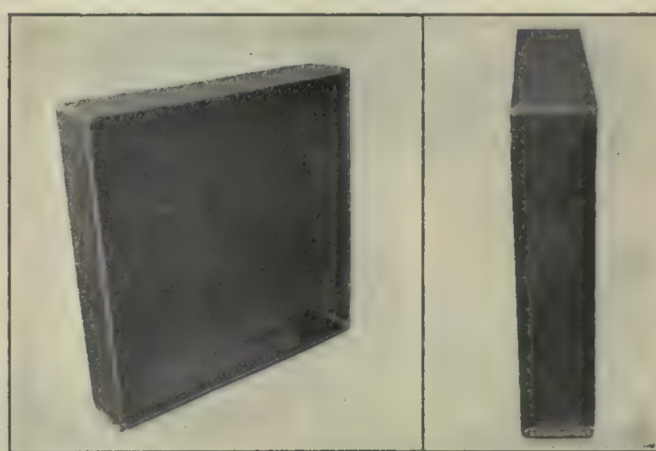
By Robert Mawson

SYNOPSIS—Seven jobs of electric arc welding on locomotive and car parts are shown in detail, and the time is given for each operation. The jobs include welding in boiler tubes, assembling a valve spool, finishing a steel-plate tank, building up a rod end, repairing a cab saddle and filling up holes in a steel plate and a casting.

There are two kinds of electric welding—arc and incandescent—and the latter is again subdivided into spot and butt welding. In the arc-welding process the necessary joining material is a metal welding rod that is melted by the heat from the current passing through the tips, or contacts. This is allowed to flow on to the pieces being welded, until a homogeneous weld is produced. This method in practice it somewhat similar to oxyacetylene, or flame, welding. On many parts the preparation for the weld is similar for the two processes, and care is necessary to obtain the desired successful results.

At the Juniata and Altoona shops of the Pennsylvania R.R. arc welding has been used for the past five years on many manufacturing and repair jobs. Arc welding of parts that are under stresses or that carry loads is not permitted, so the application has been carried on somewhat slowly. Yet with these limitations many uses are found on everyday jobs for the arc electric welding machine outfits that are employed in these machine shops.

FIG. 1. WELDING TUBES IN A LOCOMOTIVE BOILER



FIGS. 5 AND 6. WELDED BABBITT TANK

FIGS. 2 TO 4. WELDING OPERATIONS ON A VALVE

Fig. 2—Assembling a valve. Fig. 3—Second operation on the spool. Fig. 4—Completely welded spool

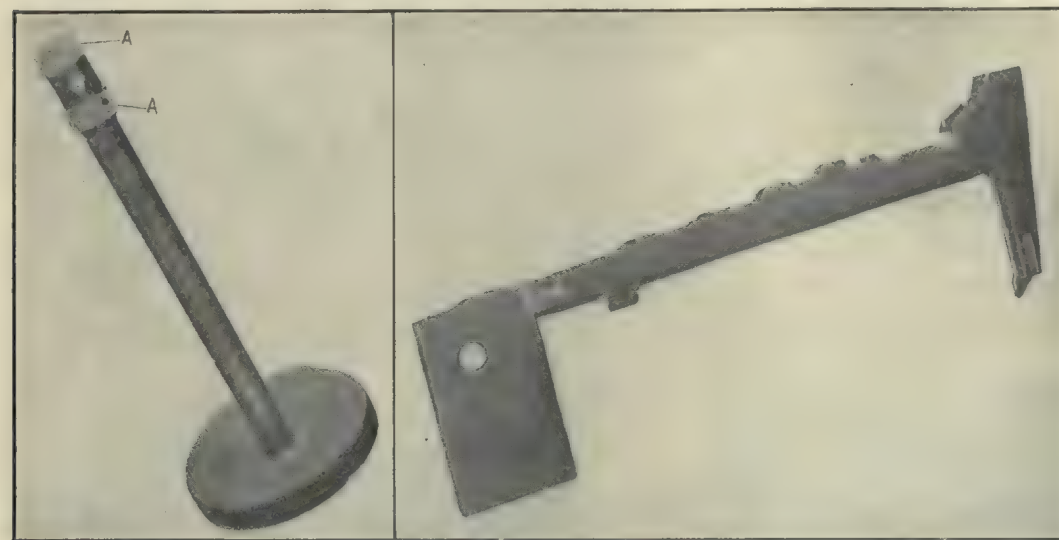
One of the uses is for welding the tubes in the sheets of boilers, and now all locomotive boilers are assembled in this manner. In service it has been found that, if the welds are correctly made, they scarcely ever give

trouble through leaks. Some engines with boilers so assembled have been kept in service for two years, and when tubes were removed the welds were found to be as good as when originally made. There is, however, this to say for the operating practice of the Pennsylvania R.R.: The water used in the locomotives, with the exception of that found in one or two localities, is of a very good quality and does not tend to injure the tubes or the welds.

Two makes of arc-welding outfit are used at the shops mentioned—those made by the Siemund Wenzel Electric Welding Co., and by the General Electric Co. The current pressure is from 60 to 65 volts and the flow about 150 amp.

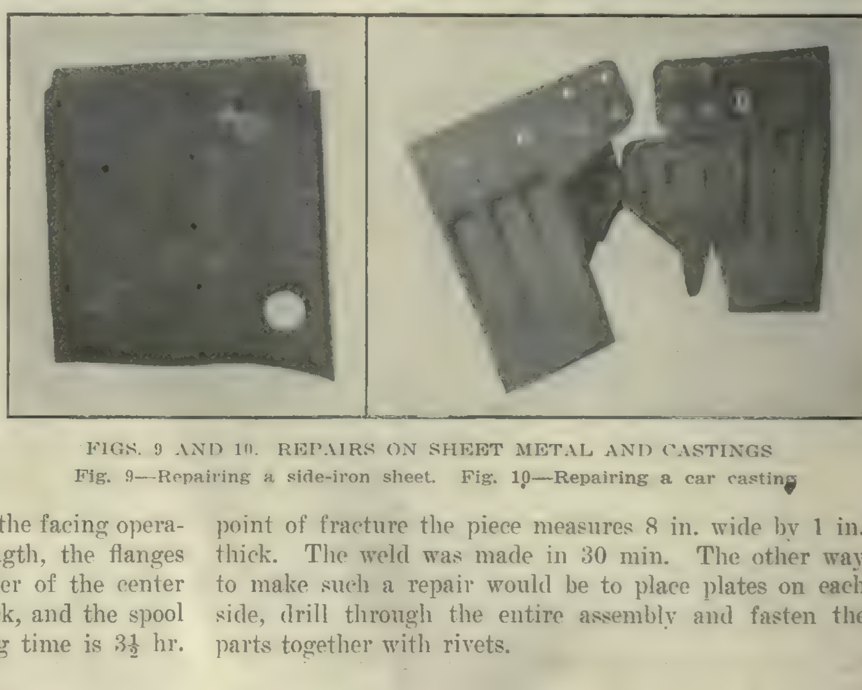
In Fig. 1 is shown the boiler of a locomotive with some of the tubes welded and others prepared ready for welding. In number there are two hundred and sixty-five 2-in. and thirty-six 4⅝-in. tubes. These tubes are placed through the machined holes in the sheet and allowed to project $\frac{3}{16}$ in. The projecting end is then beaded down as far as possible against the outside surface of the sheet. The tubes shown at the right of the illustration have been treated in this manner. The ends of the tube are then welded to the sheet. Those shown at the left in the illustration have been thus welded. The welding rate for the smaller tubes is 15 per hr. and for the larger 8 per hr. The spools used for the engine valves are also built up with the aid of the welding machine. These spools are made in four parts—two bell-mouthed ends and two center pieces, as shown in Fig. 2. The parts of the spool, which are held together by a bolt through the inside and by straps at each end, are welded in three places A, Fig. 3. Metal is then added to the two outer surfaces A of the flanges, Fig. 4, so that the spool will be sufficiently long for the facing operation. The piece measures 24 in. in length, the flanges are 11⅝ in. in diameter, and the diameter of the center part is 5½ in. The wall is 0.148 in. thick, and the spool is made from steel tubing. The welding time is 3½ hr.

A special welding job done in the shops is a tank used to hold babbitt. See Fig. 5. It is shown as the next example. This tank is 36 in. square and 8 in. deep, made from ½-in. steel plate. Welds are made along the four corners to form a tight receptacle. The corners are assembled with butt joints and simply "tacked"; afterward the welds are completed. By this method the plates do not require to be bent at the corners, and riveting is avoided. The time required for the tacking and welding of the four corners is 3 hr. In Fig. 6, an end view of the tank, the appearance of the welds may be better seen. Another use of the apparatus is for what was at one time considered an impossibility—a putting-on tool. Not many years ago, if a part was undersize either through wear or a mistake in the shop, it was scrapped. Sometimes it was made usable by another machining operation. In Fig. 7 is shown the result of a putting-on operation on the end of a piston rod. This rod end was worn down considerably in service, and it was necessary to enlarge it to effect a repair. The enlarged end A measures $5\frac{3}{16}$ in. in diameter and 9 in. long; the undercut surface B is 4⅝ in. wide. Metal was added to the surfaces A to a depth of ½ in. The time necessary for the operation was 3 hr. The rod is ready for the lathe, where the surfaces to which metal has been added will be turned to the required dimensions.



FIGS. 7 AND 8. PISTON-ROD AND CAB-SADDLE REPAIRS
Fig. 7—Putting on metal on a piston rod. Fig. 8—Repairing a cab saddle

The electric-welding outfit is suitable for other kinds of repair work. In Fig. 8 is shown a broken cab saddle, made of cast iron, which has been welded at A. At the point of fracture the piece measures 8 in. wide by 1 in. thick. The weld was made in 30 min. The other way to make such a repair would be to place plates on each side, drill through the entire assembly and fasten the parts together with rivets.



FIGS. 9 AND 10. REPAIRS ON SHEET METAL AND CASTINGS
Fig. 9—Repairing a side-iron sheet. Fig. 10—Repairing a car casting

Sometimes a part having a hole through which a shaft or stud passes wears so that the shaft is loose. Here is another opportunity for the welding outfit. Such a part, with a worn hole filled up, is shown in Fig. 9. The steel plate is 5/8 in. thick, and the hole was 2 in. in diameter. The worn hole was first completely filled, as shown at A, and then another hole was machined in the correct location and to the proper dimension. The time required to fill up this 2-in. hole was 20 min.

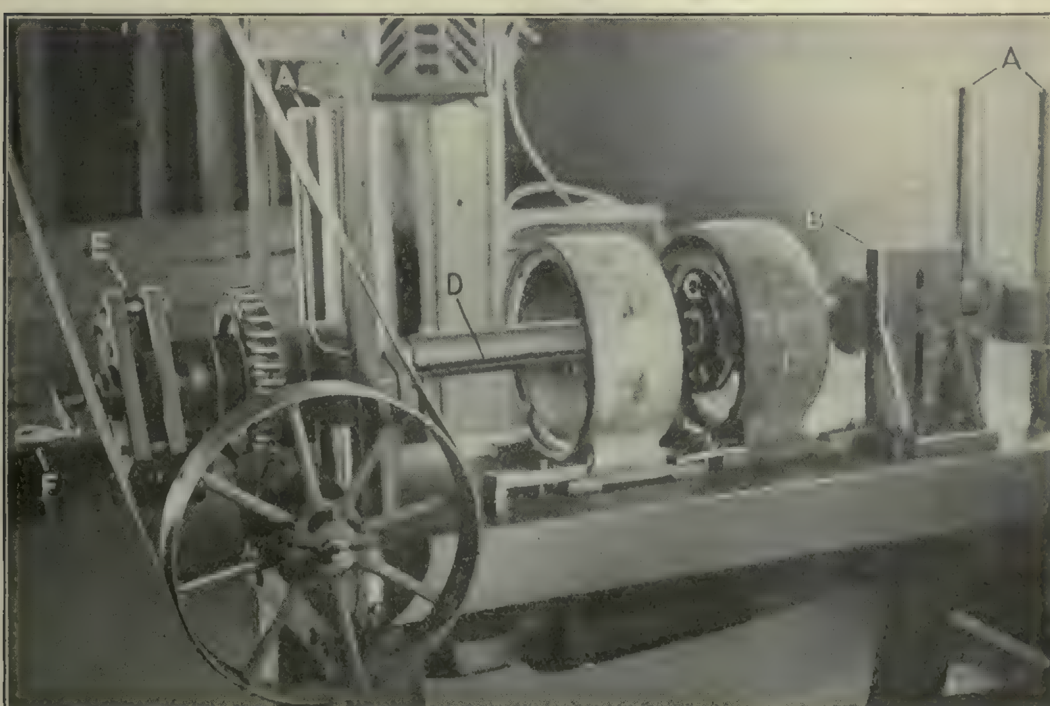
Another use of the arc-welding outfit is for the correction of mistakes that happen in the foundry or the shop. Under the best of control, errors will occur. Where formerly parts were scrapped, the welding outfit now saves them.

The part shown in Fig. 10 is a side-frame and end-rail connection for a car. The holes seen in the piece A are drilled wrong. They are 4 7/8 in. in diameter. In the similar part B are shown holes that have been filled up. By drilling new holes in the correct position the casting can be saved. The time necessary to fill up the four holes with the arc-welding outfit was 20 min.

Quick and Easy Methods of Boring Motor Frames

A horizontal boring machine, ordinarily used for boring out motor frames, but which may be utilized for other purposes, is shown in the illustration. This machine was made by the Reno-Kaetker Co., Cincinnati, Ohio.

The bed is a heavy piece of cast iron 24 in. wide and 5 ft. long. Four posts A, 3 in. in diameter, are set into this bed as supports for the bar mechanism. The pairs of posts are 4½ ft. center to center and 18 in. high. Two motor frames are shown strapped to the bed, but the number varies with the size to be bored. Besides the two bearings on the posts for the bar, a steady bracket B is used where it will do the most good.



MACHINE FOR BORING OUT MOTOR FRAMES

The bar is driven through a worm and worm gear by means of a 2-hp. variable-speed motor placed above and belted, as shown. The boring head C is fed along as the bar turns, by means of a screw D, in a slot in the bar, which is operated by the feeding mechanism at E. For quickly setting the boring head the handle F is used. This machine will bore work up to 36 in. in diameter, which covers the ordinary sizes of motors made by this concern.

Apprenticeship Reduces Labor Turnover

By Fred H. Korff*

In previous years the main thought of almost every boy upon entering business was, "What trade shall I learn?" The main idea was to obtain a future "accelerative policy" on one's earning capacity. Now the prevalent idea seems to be to obtain a large salary from the day of employment, entirely losing sight of what future developments the position may bring forth.

I believe that two factors in the scarcity of modern apprentices are improper home influence and absence of control or coördination of the work and the apprentice on the part of the company.

I have in mind an instance which most forcibly illustrates the above conditions.

Every successful manufacturer carries on his books the item of depreciation as applied to machines and buildings. Why not apply a similar depreciation to his yearly turnover of labor? This turnover is one of the largest financial leaks that can occur in a factory, and yet in the majority of cases it is accepted as a matter of course. Economists have compiled statistics which show that each time an employee who has been employed not less than four months leaves, the company actually loses from $40 to $50. This loss can be traced indirectly as a cause of the scarcity of apprentices. There are few concerns which hold forth inducements in the way of apprenticeship systems. In some factories boys are placed in the various departments and permitted to learn by themselves and not coached as they should be. I have in mind at the present writing a factory whose yearly labor turnover is less than 2 per cent. and which in my opinion has developed the apprentice system in con-

*Assistant superintendent, Stromberg Motor Devices Co., Chicago, Ill.

junction with a betterment propaganda to a high state of perfection. They do not require a contract that the apprentice will stay for a certain length of time, but rely entirely on the opportunities offered to keep their men.

A boy upon entering their factory as an apprentice is first placed in the "shop school." The school is taught by an expert mechanic, a graduate of this shop's apprentice system. In the school there are the lathe, shaper, miller, drill press, universal grinder and boring mill. These can only be run by the instructor.

The pupil upon entering the school is assigned to one machine for a short period of time, and each detail is thoroughly explained to him, descriptive methods, colored charts, photographs, etc., being used to forcibly impress upon him the range and class of work which can be done by the machine. At the end of this preliminary instruction period he is required to take an examination, the questions of which pertain to the machine which he has been studying. Having successfully passed this examination the apprentice then enters what is known as the "machine probation period."

He is placed in one of the factory departments and assigned to a machine similar to the one which he has been studying. The simplest work is given to him at first, and as he becomes proficient the work becomes more complicated. One entire day of each week is spent in the shop school, the time being spent in studying the next machine to which he will be assigned.

At the end of his first six months' shop experience he is required to take two examinations. One relative to the machine and the work he has come in contact with while running the machine, and the other relative to the machine he has been studying in the shop school. If he passes both of these examinations, he is transferred to the machine he has been studying, and repeats his first period of training spending one day each week in the shop school in preparation for his next advancement.

From September till April of each year the shop school is kept open three nights each week, and furnishes gratis instruction in elementary and intermediate mathematics, mechanical drawing and machine design. When the apprentices have finished their four-year course they are given a bonus of $100 and assigned positions as tool- or diemakers, receiving the standard rate paid to the other mechanics. Such a system produces an endless chain of men trained in the methods of the factory and firmly impressed with the ideals and standards of the company.

When this system was first put into operation a get-together club was organized, all men in the factory being eligible for membership. This in turn evolved the idea of a betterment department whose duties consisted of investigating all cases of discharge, leaving on account of being dissatisfied, working and home conditions, etc.

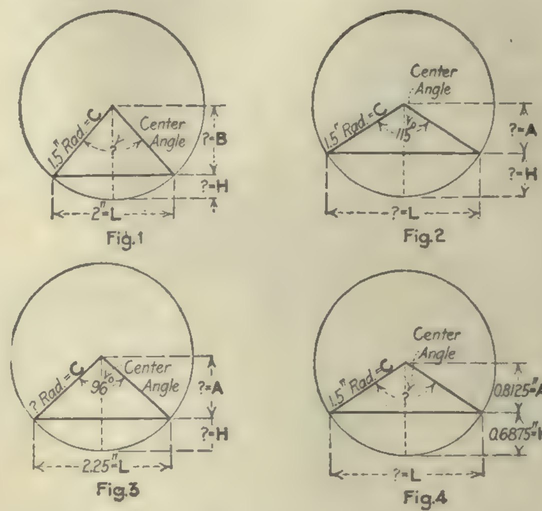
A Few Examples in Shop Trigonometry

By Edward J. Rantsch

Tool makers and draftsmen are confronted by many problems when laying out jigs and fixtures and the accompanying illustrations are intended to show how simple problems in shop trigonometry are handled with a saving of much valuable time.

If in working up jigs, tools, fixtures or dies the different lengths of the lines or angles, with reference to a right-angled triangle, had been given on the blueprints, a considerable saving in time could have been effected. In Figs. 1 to 4 are four problems to be worked out.

In the first problem we must calculate the center angle, length B and height of arch H, shown by "?."



FIGS. 1 TO 4. SOME TOOL-ROOM PROBLEMS

Distance L = length of chord, is given. In Fig. 5 will be found the rules for calculating the unknown quantities. This sketch shows one-half the center angle, from which all calculations are made. Figs. 6, 7 and 8 give the solution of the problems in Figs. 2, 3 and 4.

I make no reference to "side adjacent" and "side opposite" or "hypotenuse," but call these lines lengths A, B and C and the angles X, Y and Z, in which Z = 90 deg.

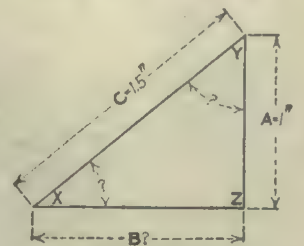


FIG. 5

Sine of angle X = A ÷ C = 1" ÷ 1.5" = 0.66666. Corresponding angle of sine 0.66666 = 41° 49′. Angle Y = 90° — 41° 49′ = 48° 11′. Length B = C × cosine angle X = 1.5" × 0.74528 = 1.1179". Distance H = 1.5" — 1.1179" = 0.3821". Center angle = 2 × 41° 49′ = 83° 38′

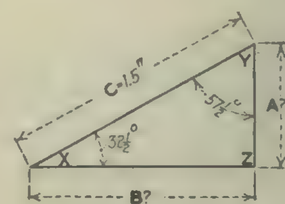


FIG. 6

Length A = C × sine angle X = 0.80595". Length B = C × cosine angle X = 1.26508". Distance H = 1.5" — 0.80595" = 0.69405". Center angle = 2 × 57½° = 115°. Length of chord L = 2 × 1.26508 = 2.53016"

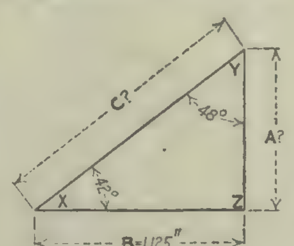


FIG. 7

Length A = tangent angle X × B = 0.9004 × 1.125" = 1.01295". Length C = A ÷ sine angle X = 1.01295" ÷ 0.66913 = 1.5138". Distance H = 1.5138" — 1.01295" = 0.50085". Center angle = 2 × 48° 96′

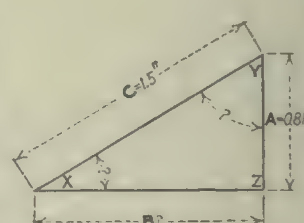


FIG. 8

Sine angle X = A ÷ C = 0.8125 ÷ 1.5" = 0.54166. Corresponding angle of sine 0.54166 = 32° 48′. Angle Y = 90° — 32° 48′ = 57° 12′. Length B = C × cosine angle X. Cosine angle X = 0.84057 × 1.26085. Center angle = 2 × 57° 12′ = 114° 24′. Length L = 2 × B = 2.5217"

FIGS. 5 TO 8. THE WAY THEY ARE SOLVED

An Unusual Metal Pattern for a Typewriter Frame

By Frank A. Stanley

SYNOPSIS—This is a case where costs were lowered 75 per cent. by making a frame in sections instead of solid, the cost of machining being much less than the former cost of casting. It also reverses the usual foundry practice and uses a green sand core in a baked mold.

The accompanying illustrations show an interesting metal pattern and a core box for a typewriter frame originally made in a single casting, but later, owing to difficulties in securing solid castings, built up in sectional construction. This proved satisfactory in all respects and led to improvements in shop methods that enable the sectional form of frame to be produced better and more economically. This pattern, while no longer in service in the factory where it originated, is well worthy of study, in that it embodies certain features of interest to metal pattern makers and molders; features that are applicable to pattern work other than for typewriter frame castings.

The pattern itself is of brass, in several sections, and is shown assembled in Fig. 1. It will be seen that there is a heavy brass frame in the form of a rectangular ring to the inner sides of which are fitted two brass side plates, shown more clearly in the view in Fig. 2. These plates carry on their inner faces numerous hubs, bosses and flanges, which are to be reproduced on the inner faces of the typewriter frame castings. The side-plate patterns fit snugly against the interior walls of the main body of the pattern and are located in position by short tongues that slide into corresponding vertical grooves in the pattern body. The sloping front end of the side-plate patterns is beveled to 45 deg., as shown, and these beveled faces form a clean joint with similar faces on the end of the pattern members for the front rail of the typewriter frame.

This beveled end front pattern member will be seen in Fig. 2 lying immediately in front of the side plate at the left. The other longitudinal pattern member seen in the group in Fig. 2 in front of the right-hand side pattern is shown in position in Fig. 1 where, as will be seen, it is adapted to form in the mold the channel for the cross-bar that ties together the two sides of the typewriter frame casting. At the back and lower inner face of the assembled pattern is another longitudinal strip for the molding of a rear crosstie in the frame casting. The two cylindrical plugs in Figs. 1 and 2 are arranged to be inserted under the pattern for molding the frame feet, which are cored out in the casting to receive the rubber inserts or feet proper.

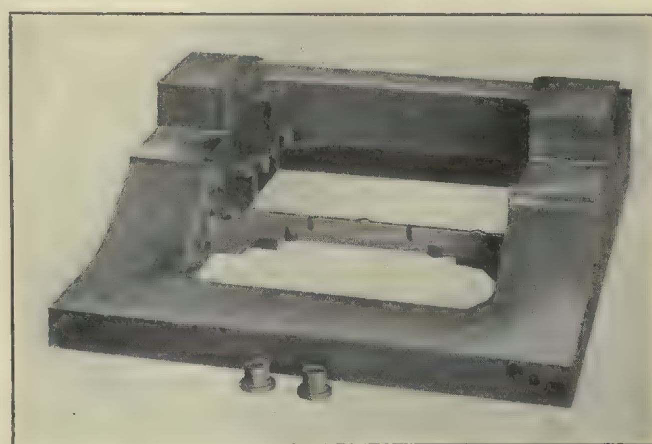


FIG. 1. THE ASSEMBLED BRASS PATTERN

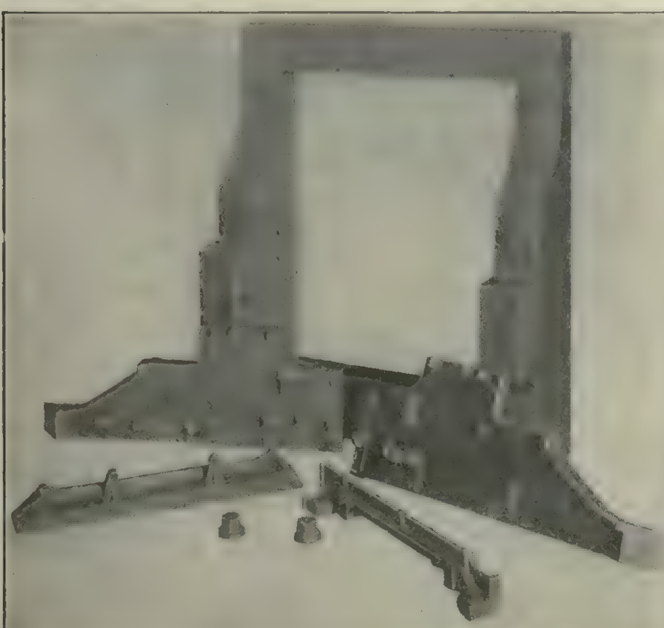


FIG. 2. VARIOUS PARTS OF THE PATTERN

FIG. 3. CORE BOX OF WOOD AND BRASS

When this pattern is placed in the sand in a two-part flask, the parting line for the greater portion is along the lower edges of the pattern sides, although at one or two points this line drops to a point sufficient to follow the outline of certain ribs and bosses. This means that very little of the pattern is rammed up in the cope, and when the flask is turned over and the body of the pattern is pulled out of the drag, the side plates and the front bar and crosstie remain in the sand. The walls of the pattern body are of such thickness as to form a wide enough channel in the sand to allow the side plates to be drawn out into the cavity and removed from the mold, the other sectional parts also coming out readily.

Reversing Usual Core Practice

The core box seen in Fig. 3 has a wooden frame, but the central portion is of brass with a convenient hand hold at the center, so that it is easily lifted out of place. This box forms what is really an outside core, which after being properly baked is placed in the mold with its outer faces fitting into the rectangular channel formed when the brass pattern body is removed from the drag. The interior of this square core ring is, of course, accurately sized by the brass central member shown in the core box. This brass center is larger in length and breadth than the interior opening in the assembled frame pattern by an amount sufficient to provide for the desired thickness of the walls in the typewriter frame casting; that is, the core ring when set in the mold leaves a channel all the way around just wide enough for the necessary thickness of metal in the casting. The purpose of the sectional plates in the construction of the pattern proper is to form the indentations in the mold for inside bosses and ribs. Here is a reversal of the usual practice in general foundry work, in that the real core for the interior of the typewriter frame is rammed up in green sand while the baked sand core is placed around the outside and constitutes the real side walls of the mold.

Reducing Casting Cost 75 Per Cent.

After a thorough test of this pattern in the foundry and in machining the frames in the shop, it was finally decided to adopt a sectional construction for the typewriter frame. This new frame has already been described in detail in the articles on the Noiseless Typewriter Co.'s methods at Middletown, Conn., and extended reference to it at this point is not necessary. It was found with the pattern for the solid frame that the foundry output was small and the cost of castings very high. The old frame in one piece weighed 7 lb. and the foundry charge was 30c. per lb. After the casting was received, a rear brace had to be welded into the frame to take the place of a cast tie that was included in the casting to stiffen it during foundry operations and afterward cut out to admit the welded brace: this further added to the cost of the frame proper, so that it ran to about $2.25 per casting. When the sectional frame was adopted, the foundry costs were reduced to 7c. per lb., the weight then being about 8 lb., giving a total cost for the frame casting of 56c., or less than one-quarter that of the former one-piece frame.

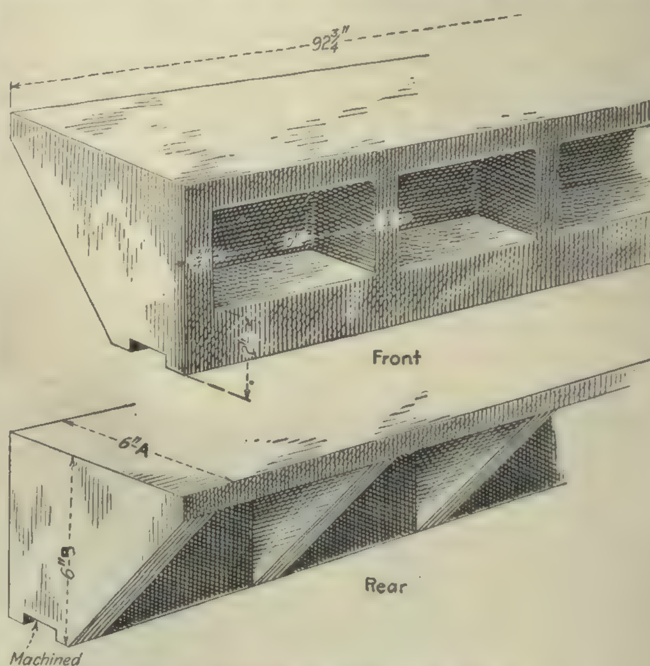
So far as concerns subsequent machine operations in the shop, it may be said that while in the new form of sectional frame certain machining cuts have to be made in fitting in the rear brace, these cuts are about the same as were necessary for the brace put into the solid casting as originally made; and as certain other facing operations are completed at the same pass of the work under the cutters as is required for the brace seat cuts these additional machine cuts add no labor cost to the process. Certain other operations in the finishing of the frame members in sectional form are much more readily accomplished than was possible when the frame casting was produced in a single piece.

What Are the Correct Sizes for This Pattern?

By Jan Spaander

The accompanying illustration gives the main dimensions of a wooden pattern of a punch holder for a gang punch press practically 8 ft. long and only 6 in. high and 6 in. wide. It is machined top and bottom and vertically along the sides of the slot, which though only ¼ in. high have to be considered anyhow, in my opinion.

When the pattern came from the pattern maker the dimension A had been left 6 in., with the proper shrinkage and the width above the slot similarly treated. The height B, however, had been increased to over 6½ in., and the pattern maker insisted that his was the right pattern, because he had to allow for bending, the pattern being so slender.



THE PATTERN UNDER DISCUSSION

I had no objection but asked in wonder if he should not also allow ½ in. to the 2-in. bead at the bottom—or do anything to allow for the bending in the vertical direction. His emphatic "No!" stopped the argument till the pattern reached the foundryman, who also had to machine it. The latter condemned the pattern and insisted that I state which side up he was to cast it. I made a guess at it and the casting came out so straight that the extra ½ in. on the one side seemed nearly superfluous.

It might be interesting to hear the opinions of more experienced readers as to the correct size for the economic pattern and which side should be cast up.

United States Munitions*

The Springfield Model 1913 Service Rifle

Leaf II—Slide and Cap

SYNOPSIS—This completes the leaf and covers the slide and slide cap of the rifle sight. These are small parts but require many operations.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 18

Number of Operators—One. Description of Operation—Removing burrs from operation 18. Apparatus and Equipment Used—File. Production—Grouped with operation 18.

OPERATION 20. HAND MILLING REAR END OF JOINT

Transformation—Fig. 1563. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held upright in vise jaws, Fig. 1564. Tool-Holding Devices—Standard arbor. Cutting Tools—Form milling cutter, Fig. 1565. Number of Cuts—One. Cut Data—600 r.p.m.; hand feed. Coolant—Cutting oil, ⅛-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1566; A, contour of end; B, squareness with hole. Production—175 pieces per hr.

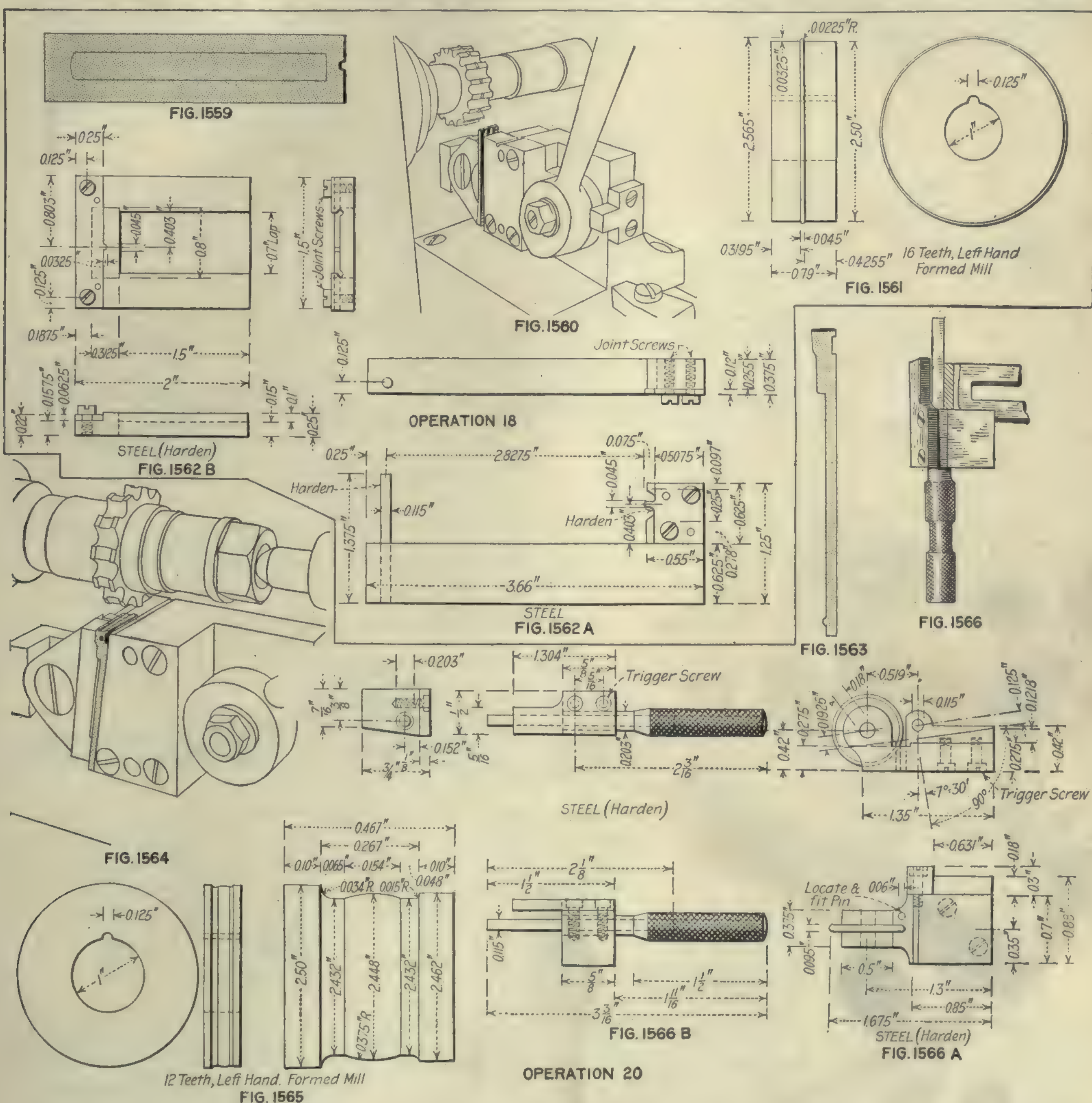


FIG. 1559. FIG. 1560. FIG. 1561. FIG. 1562 B. OPERATION 18. FIG. 1562 A. FIG. 1563. FIG. 1564. FIG. 1565. FIG. 1566. FIG. 1566 A. FIG. 1566 B. OPERATION 20

OPERATION 18. HAND MILLING SIGHTING NOTCH

Transformation—Fig. 1559. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held upright in vise jaws, Fig. 1560. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1561. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1562; A, location from side; B, location from hole. Production—350 pieces per hr.

OPERATION 15½. FILING GRADUATIONS

Number of Operators—One. Description of Operation—Filing burrs from graduations. Apparatus and Equipment Used—File. Production—350 pieces per hr.

OPERATION 16. PROFILING DRIFT-SLIDE NOTCH

Transformation—Fig. 1567. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws, Fig. 1568. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter, Fig. 1569. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1570; A, size and angle of slot; B, angle of drift slot with sides. Production—45 pieces per hr.

OPERATION HH. REMOVING BURRS LEFT BY OPERATION 16

Number of Operators—One. Description of Operation—Removing burrs from operation 16. Apparatus and Equipment Used—File. Production—Grouped with operation 16.

OPERATION 19. COUNTERBORING JOINT

Transformation—Fig. 1571. Machine Used—Sigourney 16-in. three-spindle upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1572. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed.

Holding Devices—Pushed to stop, clamped by jaws A, cam B and knock-out C, indexing fixture, Fig. 1577. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1578. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—5000 pieces. Gages—Upper edge of joint. Production—350 pieces per hr.

OPERATION 23. COUNTERSINKING AND REAMING JOINT PIN HOLE

Number of Operators—One. Description of Operation—Countersinking and reaming pin hole. Apparatus and Equipment Used—Countersink, Fig. 1579, reamer and bench lathe. Gages—Pin. Production—450 pieces per hr.

OPERATION 24. FILING TO GAGE FOR THICKNESS, WIDTH, WIDTH OF STRAIGHT SLOT, WIDTH OF JOINT AND GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing thickness to gage and width of slot, joint and general cornering. Apparatus and Equipment Used—File and gage. Gages—Width. Production—13 pieces per hr.

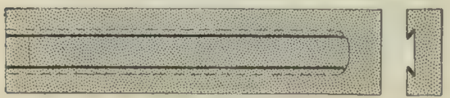


FIG. 1567

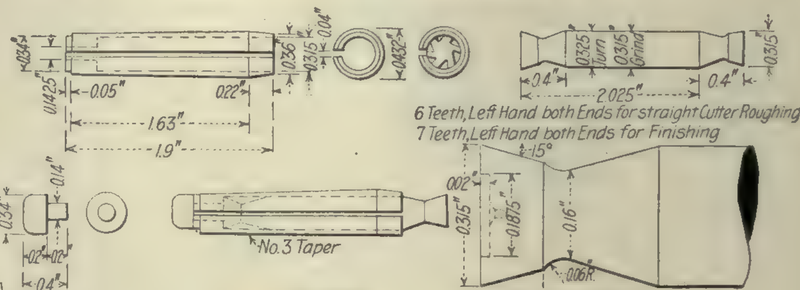


FIG. 1569

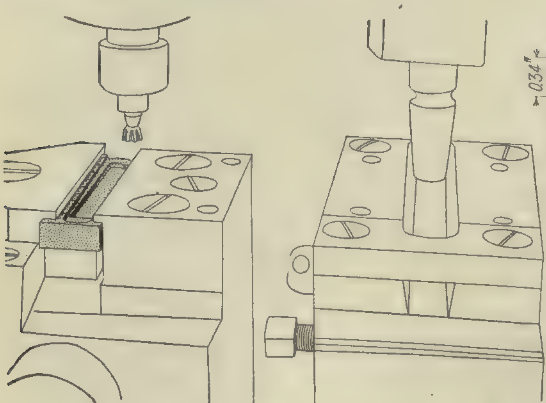


FIG. 1568

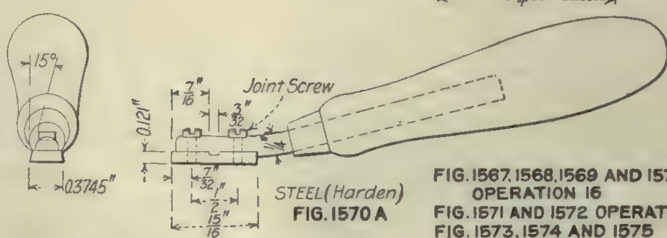


FIG. 1570 A

FIG. 1567, 1568, 1569 AND 157´ OPERATION 16
FIG. 1571 AND 1572 OPERATION 19
FIG. 1573, 1574 AND 1575 OPERATION 21

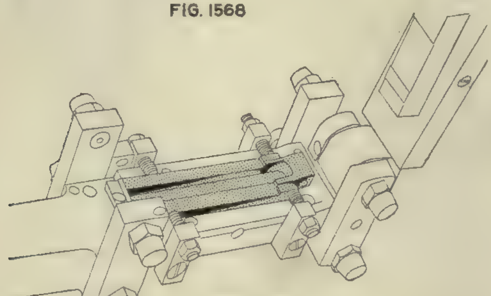


FIG. 1572

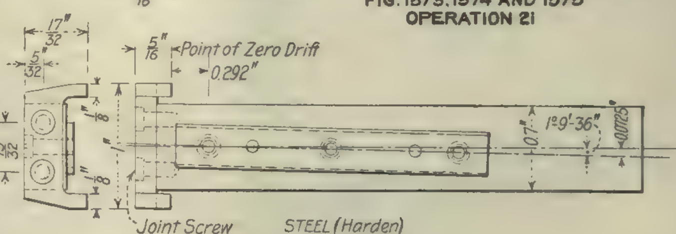


FIG. 1570 B

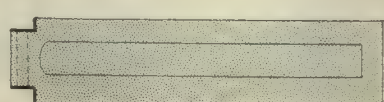


FIG. 1571

FIG. 1573

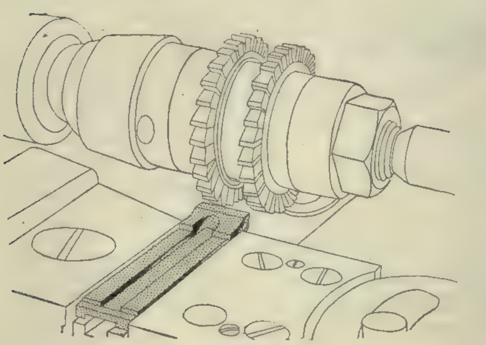


FIG. 1574

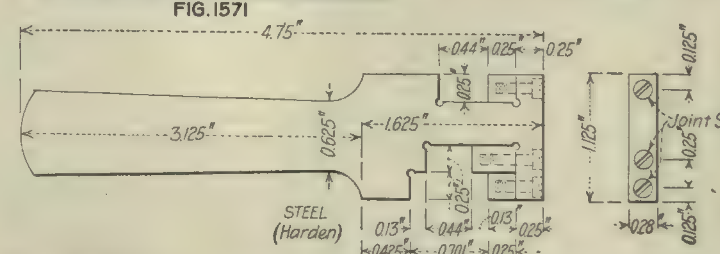


FIG. 1575

Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Diameter of counterbore. Production—55 pieces per hr.

OPERATION 21. HAND MILLING STRADDLE JOINT

Transformation—Fig. 1573. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Pushed to stop, clamped by vise jaws, Fig. 1574. Tool-Holding Devices—Standard arbor. Cutting Tools—Straddle mills. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1575; width of joint, and also its relation to the leaf; thickness. Production—175 pieces per hr.

OPERATION 22. HAND MILLING JOINT, SWING FIXTURE

Transformation—Fig. 1576. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-

OPERATION 25. CLEANING GRADUATIONS

Number of Operators—One. Description of Operation—Cleaning graduations. Apparatus and Equipment Used—Hand pick. Production—35 pieces per hr.

OPERATION 26. FILING EDGES OF DRIFT SLOT TO REMOVE BURRS

Number of Operators—One. Description of Operation—Removing burrs from drift-slot edges. Apparatus and Equipment Used—File. Production—350 pieces per hr.

OPERATION 27. CASEHARDENING

Number of Operators—One. Description of Operation—Pack in ¾ bone, ¼ leather; heat to 750 deg. C. (1,382 deg. F.) for 2½ hr.; quench in oil. Apparatus and Equipment Used—Same as for all other casehardening.

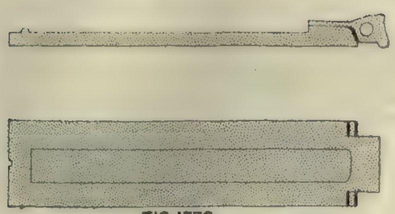


FIG. 1576

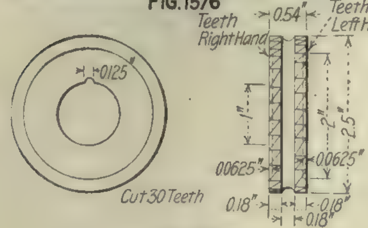


FIG. 1578

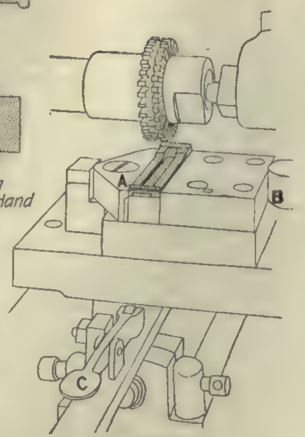


FIG. 1577

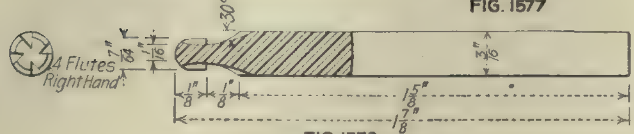


FIG. 1579
OPERATION 22

OPERATION 28. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening after hardening. Apparatus and Equipment Used—Lead block, hammer and straight-edge. Production—350 pieces per hr.

OPERATION 29. POLISHING GRADUATIONS WITH EMERY CLOTH

Number of Operators—One. Description of Operation—Polishing graduations. Apparatus and Equipment Used—Emery cloth, 000 grit. Production—350 pieces per hr.

OPERATION 30. ASSEMBLING WITH MOVABLE BASE

Number of Operators—One. Description of Operation—Assembling with movable base. Apparatus and Equipment Used—Hand and light hammer. Production—90 pieces per hr.

OPERATIONS ON THE SLIDE—FIG. 1580

Operation	
A	Forging from bar
B	Annealing
B–1	Pickling
C	Trimming
1	Grinding bottom
AA	Removing burrs left by operation 2
3	Drilling capscrew, binding-screw and pin holes
BB	Removing burrs left by operation 3
4	Reaming capscrew and binding-screw holes
CC	Removing burrs left by operation 4
2, 5, 6	Milling front and rear and both ends
DD	Removing burrs left by operation 5
EE	Removing burrs left by operation 6
7, 8	Milling top and leaf slot, rough and finish
FF	Removing burrs left by operation 7
GG	Removing burrs left by operation 8
9, 12	Tapping binding-screw holes
10, 11	Profiling cap slot
13	Tapping capscrew holes
13–A	Reaming pin hole
14	Filing to gage
15	Assembling with cap
16	Polishing ends, sides and bottom
17	Filing top and general cornering
18	Reaming pin hole, tapping slide-screw hole and turning back assembling screws
18–A	Bluing

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1581. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—200 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Packed in iron pots with powdered charcoal and heated to 850 deg. C. (1,562 deg. F.); left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and then in the pickling solution (1 part sulphuric acid and 9 parts water); left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

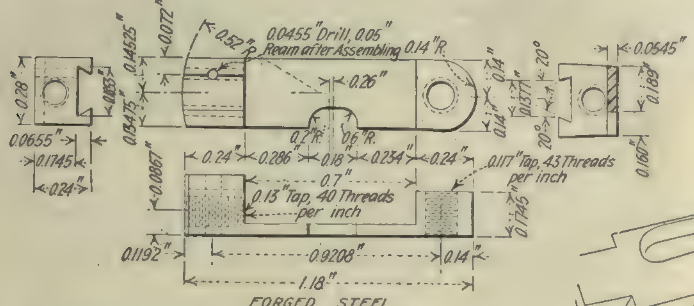


FIG. 1580

FIG. 1581

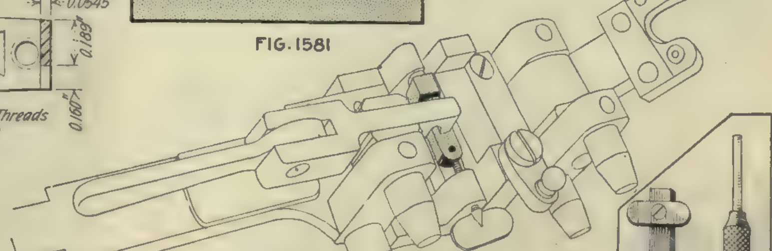


FIG. 1584

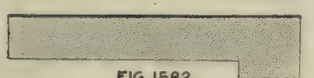


FIG. 1582

FIG. 1583

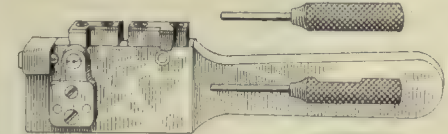


FIG. 1585

FIG. 1581-OP. A-FIG. 1582 OP. 1-FIG. 1583, 1584, 1585 OP. 3
FIG. 1586, 1587, 1588, 1589 OP. 2, 5 & 6

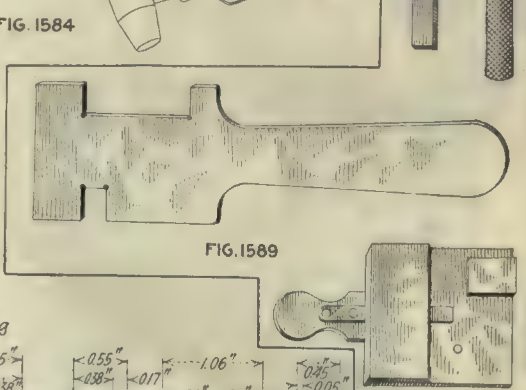


FIG. 1589

FIG. 1586

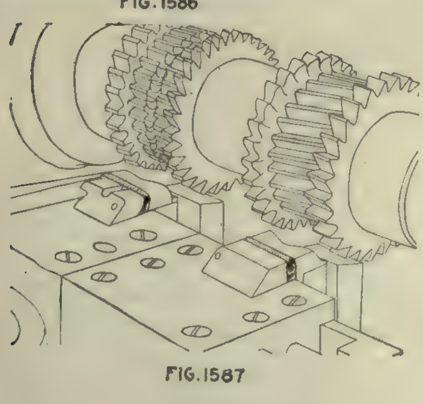


FIG. 1587

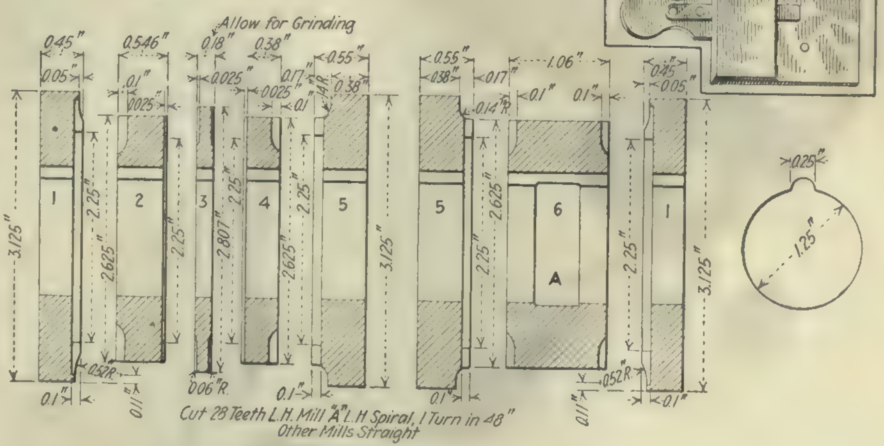


FIG. 1588

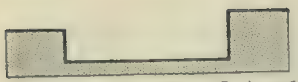


FIG. 1590

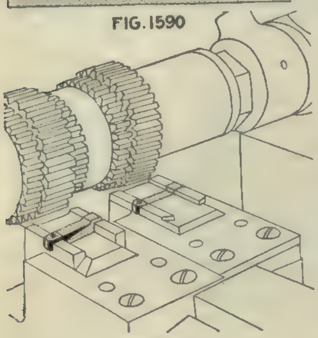
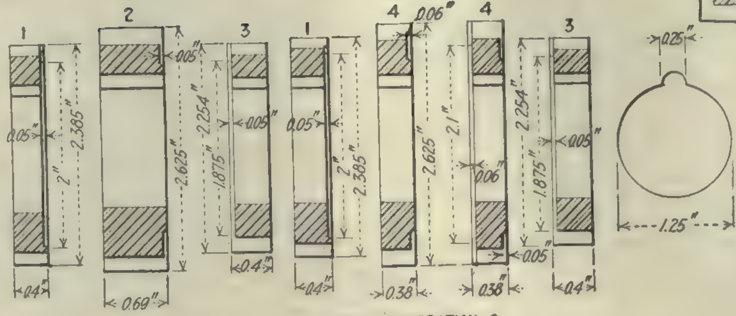


FIG. 1591



ROUGH, OPERATION 7 FINISH, OPERATION 8

FIG. 1592

FIG. 1593

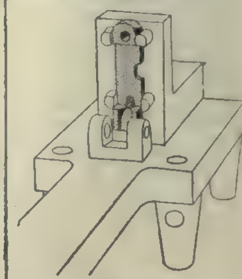


FIG. 1594
OPERATION 9 & 12

OPERATION C. TRIMMING

Machine Used—Perkins No. 19 press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—650 pieces per hr.

OPERATION 1. GRINDING

Transformation—Fig. 1582. Machine Used—Pratt & Whitney vertical grinder. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck, between strips. Tool-Holding Devices—Vertical spindle. Cutting Tools—14-in. wheel. Number of Cuts—15 passes. Cut Data—1,500 r.p.m.; 15-in. feed. Coolant—Water. Gages—None. Productions—350 per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 2

Number of Operators—One. Description of Operation—Removing burrs from operation 1. Apparatus and Equipment Used—File. Production—Grouped with operation 3.

OPERATION 3. DRILLING CAPSCREW, BINDING-SCREW AND PIN HOLES

Transformation—Fig. 1583. Machine Used—Sigourney 16-in. three-spindle. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1584. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Number of Cuts—Two. Cut Data—900 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1585. Production—80 pieces per hr.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs left by operation 3. Apparatus and Equipment Used—File. Production—Grouped with operations 3 and 4.

OPERATION 4. REAMING CAPSCREW AND BINDING-SCREW HOLES

Machine Used—Sigourney 16-in. three-spindle. Number of Operators per Machine—One. Work-Holding Devices—Drill jig. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer. Number of Cuts—Two. Cut Data—900 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—See Fig. 1585. Production—175 pieces per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operations 3 and 4.

OPERATIONS 2, 5, 6. MILLING FRONT AND REAR AND BOTH ENDS

Transformation—Fig. 1586. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Miller vise jaws, Fig. 1587.

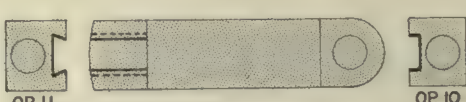


FIG. 1595

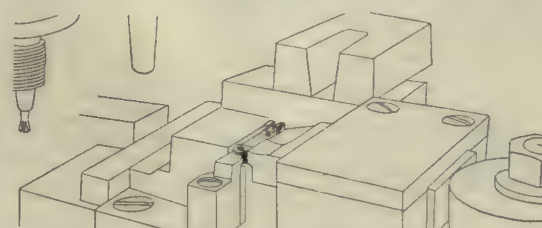


FIG. 1597

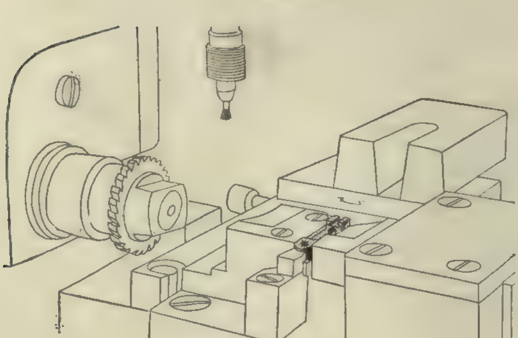
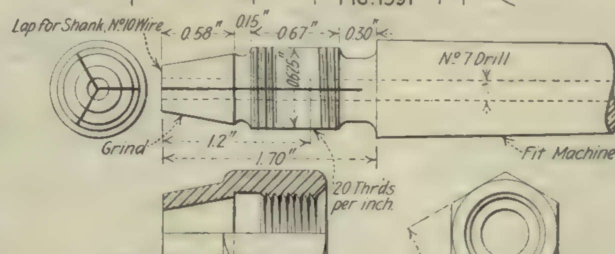
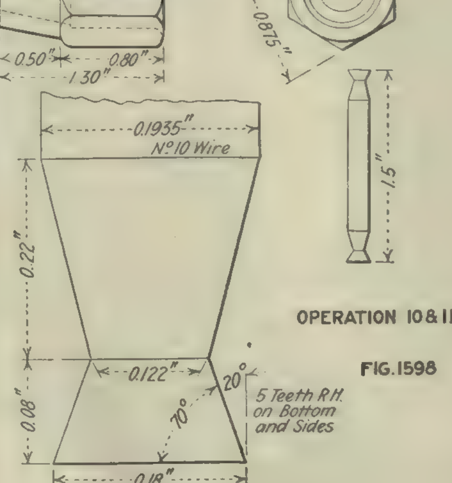


FIG. 1596





OPERATION 10 & 11

FIG. 1598

FIG. 1599

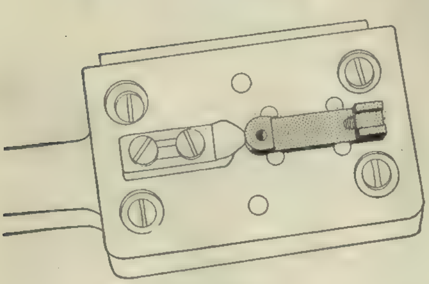


FIG. 1600

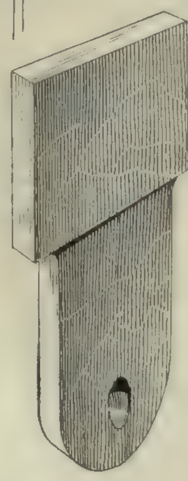


FIG. 1601

Tool-Holding Devices—Standard arbor. Cutting Tools—Two gangs of cutters, Fig. 1588. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{5}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1589. Production—30 pieces per hr.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operations 2, 5 and 6.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs from operation 6. Apparatus and Equipment Used—File. Production—Grouped with operations 2, 5 and 6.

OPERATIONS 7 AND 8. MILLING TOP AND LEAF SLOT, ROUGH AND FINISH

Transformation—Fig. 1590. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Special vise jaws, Fig. 1591; work located on pin. Tool-Holding Devices—Standard arbor. Cutting Tools—Fig. 1592. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{5}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Width of slot. Production—30 pieces per hr.

OPERATION 15. ASSEMBLING WITH CAP

Number of Operators—One. Description of Operation—Assembling with cap. Apparatus and Equipment Used—Hand screwdriver. Production—350 pieces per hr.

OPERATION 16. POLISHING ENDS, SIDE AND BOTTOM

Number of Operators—One. Description of Operation—Polishing outside. Apparatus and Equipment Used—Polishing jack and wheel. Production—80 pieces per hr.

OPERATION 17. FILING TOP AND GENERAL CORNERING

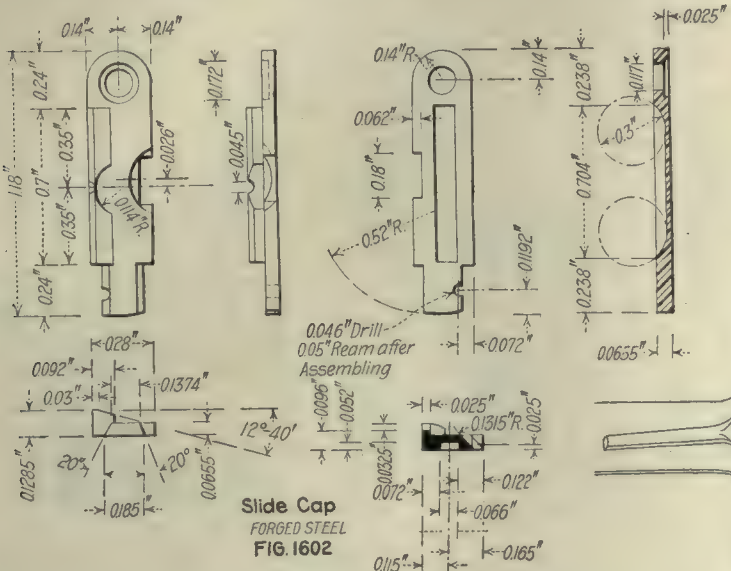
Number of Operators—One. Description of Operation—Filing and cornering. Apparatus and Equipment Used—File. Production—35 pieces per hr.

OPERATION 18-A. BLUING

Number of Operators—One. Description of Operation—Heated to 800 deg. F. in niter. Apparatus and Equipment Used—Same as for other bluing operations.

OPERATION 18. REAMING PIN HOLE, TAPPING SLIDE-SCREW HOLE AND TURNING BACK ASSEMBLING SCREWS

Number of Operators—One. Description of Operation—Reaming pin and tap hole, tapping slide-screw hole, retapping hole. Apparatus and Equipment Used—Speed lathe and reamer. Gages—None. Production—175 pieces per hr.



Slide Cap
FORGED STEEL
FIG. 1602

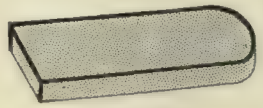


FIG. 1603
OPERATION A

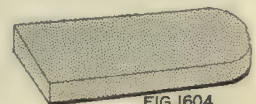


FIG. 1604
OPERATION 1

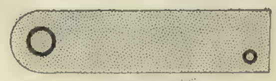


FIG. 1605

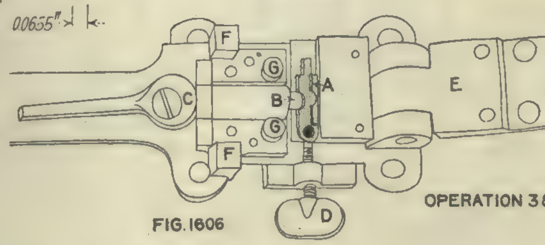


FIG. 1606

OPERATION 3 & 4

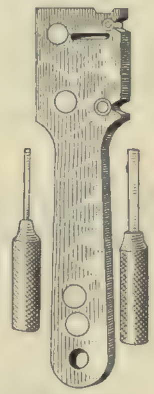


FIG. 1607

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs from operation 7. Apparatus and Equipment Used—File. Production—Grouped with operations 7 and 8.

OPERATION GG. REMOVING BURRS LEFT BY OPERATION 8

Number of Operators—One. Description of Operation—Removing burrs from operation 8. Apparatus and Equipment Used—File. Production—Grouped with operations 7 and 8.

OPERATIONS 9 AND 12. TAPPING CAPSCREW HOLES

Transformation—Fig. 1593. Machine Used—Garvin upright tapping machine. Number of Operators per Machine—One. Work-Holding Devices—Tapping jig, Fig. 1594. Tool-Holding Devices—Drill chuck. Cutting Tools—Tap. Number of Cuts—One. Cut Data—50 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Threaded plug. Production—350 pieces per hr.

OPERATIONS 10 AND 11. PROFILING CAP SLOT

Transformation—Fig. 1595. Machine Used—Pratt & Whitney No. 1 profiler; milling attachment in Fig. 1596. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, clamped by vise jaws; milling fixture, profiling fixture and form in Fig. 1597. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1598; profiling cutter. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{4}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Form of slot. Production—65 pieces per hr.

OPERATION 13. TAPPING CAPSCREW HOLES

Transformation—Fig. 1599. Machine Used—Garvin upright tapping machine. Number of Operators per Machine—One. Work-Holding Devices—Tapping jig, Fig. 1600. Tool-Holding Devices—Drill chuck. Cutting Tools—Tap. Number of Cuts—One. Cut Data—50 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Threaded plug. Production—400 pieces per hr.

OPERATION 13-A. REAMING PIN HOLE

Number of Operators—One. Description of Operation—Reaming pin hole and removing burrs thrown down by milling. Apparatus and Equipment Used—Bench lathe and reamer. Production—350 pieces per hr.

OPERATION 14. FILING TO GAGE

Number of Operators—One. Description of Operation—Filing inside of slide to gage. Apparatus and Equipment Used—File and gage. Gages—Fig. 1601, size of leaf. Production—125 pieces per hr.

OPERATIONS ON SLIDE CAP—FIG. 1602

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
1	Grinding bottom
3	Drilling capscrew and pin holes
4	Reaming capscrew hole
BB	Removing burrs left by operation 4
5 and 6	Milling front and rear edges and both ends
CC	Removing burrs left by operation 5
DD	Removing burrs left by operation 6
7	Milling top, lengthwise
EE	Removing burrs left by operation 7
II	Removing burrs from capscrew hole (reamer)
8	End milling peep-notch clearance
9	Countersinking field-view clearance
10	Milling top, buckhorn and peep notch
FF	Removing burrs left by operation 10
11	Hand milling dovetail
12	Hand milling slot for drift-slide pin
GG	Removing burrs left by operations 11 and 12
13	Counterboring screw hole
HH	Removing burrs left by operation 13
14	Filing off burrs
15	Filing in jig

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1603. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb., drop hammer. Production—200 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal and heated to 850 deg. C. (1,562 deg. F.); left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner and powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Put in wire baskets and placed in the pickling solution (1 part sulphuric acid to 9 parts water) and left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

OPERATION C. TRIMMING

Machine Used—Perkins No. 19 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—600 pieces per hr.

OPERATION 1. GRINDING BOTTOM

Transformation—Fig. 1604. Machine Used—Pratt & Whitney vertical grinder. Number of Operators per Machine—One. Work-Holding Devices—30-in. magnetic chuck, between steel strips. Tool-Holding Devices—Vertical spindle. Cutting Tools—14-in. wheel. Number of Cuts—15 trips of table. Cut Data—1,500 r.p.m.; 15-in. feed. Coolant—Water. Production—574 per hr.

OPERATIONS 3 AND 4. DRILLING AND REAMING CAPSCREW AND PIN HOLES

Transformation—Fig. 1605. Machine Used—Sigourney 16-in. three-spindle drill. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1606; work held at A by plunger B; moved by cam C; positioned by thumbscrew D; bushings are in leaf E, which is held between ears F; positioned by studs GG. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Location and diameter of holes, Fig. 1607. Production—350 pieces per hr.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 4.

OPERATIONS 5 AND 6. MILLING FRONT AND REAR EDGES AND BOTH ENDS

Transformation—Fig. 1608. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held on pin, clamped by vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1609. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Length and width; location of slot from pin. Production—30 pieces per hr. Note—Work is located from hole at end.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs from operations 5 and 6. Apparatus and Equipment Used—File. Production—Grouped with operations 5 and 6.

OPERATION DD. REMOVING BURRS FROM OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs from operation 6. Apparatus and Equipment Used—File. Production—Grouped with operations 5 and 6.

OPERATION 7. MILLING TOP LENGTHWISE

Transformation—Fig. 1610. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1611. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, Fig. 1612. Number of Cuts—One. Cut Data—70 r.p.m; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Thickness. Production—30 pieces per hr.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 7

Number of Operators—One. Description of Operation—Removing burrs from operation 7. Apparatus and Equipment Used—File. Production—Grouped with operation 7.

OPERATION II. REMOVING BURRS FROM CAPSCREW HOLE

Number of Operators—One. Description of Operation—Removing burrs from capscrew hole. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operation 8.

OPERATION 8. END MILLING PEEP-NOTCH CLEARANCE

Transformation—Fig. 1613. Machine Used—Sigourney 16-in. three-spindle. Number of Operators per Machine—One. Work-Holding Devices—Drill jig; work held on pin, Fig. 1614. Tool-Holding Devices—Drill chuck. Cutting Tools—Counterbore or end mill. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1615, location of counterbore from pin hole. Production—200 pieces per hr.

OPERATION 9. COUNTERSINKING FIELD-VIEW CLEARANCE

Transformation—Fig. 1616. Machine Used—Sigourney Tool Co. 16-in. three-spindle. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1617; work held by clamp A, which also guides end of countersink, in connection with swinging leaf B. Tool-Holding Devices—Drill chuck. Cutting Tools—Round-ended countersink, Fig. 1618. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Contour and angle of countersink. Production—350 pieces per hr.

OPERATION 10. MILLING TOP, BUCKHORN AND PEEP NOTCH

Transformation—Fig. 1619. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1620. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1621. Number of Cuts—One. Cut Data—70 r.p.m.; $\frac{3}{8}$-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—10,000 pieces. Gages—Fig. 1622; contour; location of notch; cap fits over pin X at end, and plug Y gages and locates. Production—30 pieces per hr.

OPERATION FF. REMOVING BURRS LEFT BY OPERATION 10

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 10. Apparatus and Equipment Used—File. Production—Grouped with operation 11.

OPERATION 11. HAND MILLING DOVETAIL

Transformation—Fig. 1623. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, indexing fixture, Fig. 1624; work located on pin, held by bar A, which is locked by clamp B; fixture indexes in two positions to mill both sides of dovetail. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1625, size of dovetail. Production—350 pieces per hr.

OPERATION 12. HAND MILLING SLOT FOR DRIFT-SLIDE PIN

Transformation—Fig. 1626. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1627; vise has stops A and B to limit movement. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutter, Fig. 1628. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—1500 pieces. Gages—Fig. 1629; location of slot from side, and width of slot. Production—350 pieces per hr.

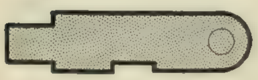


FIG. 1608

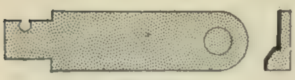


FIG. 1610

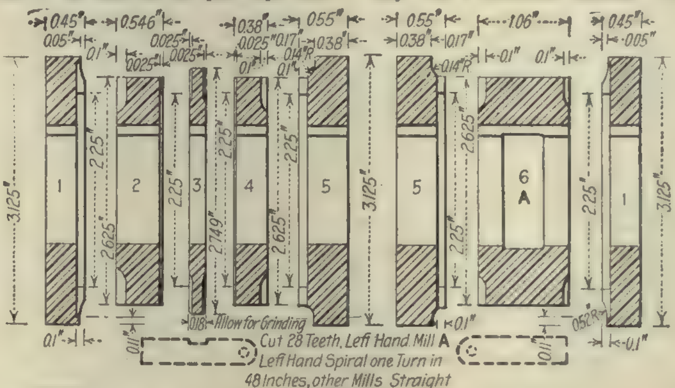


FIG. 1609

FIG. 1613

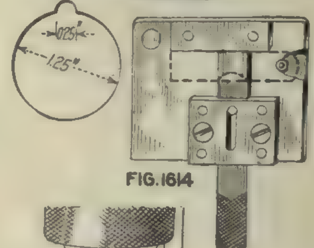


FIG. 1614

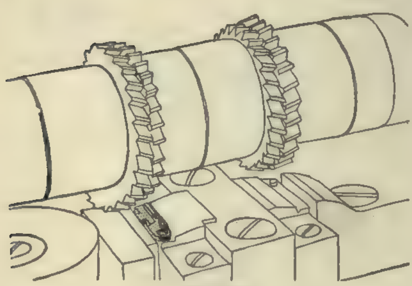
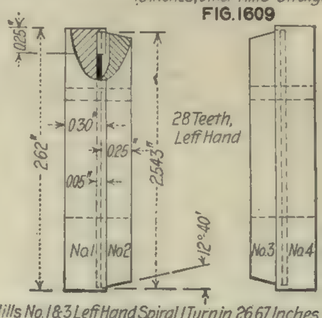


FIG. 1611



Mills No. 1&3 Left Hand Spiral 1 Turn in 26.67 Inches
Mills No. 2&4 Right Hand Spiral 1 Turn in 26.67 Inches

FIG. 1612

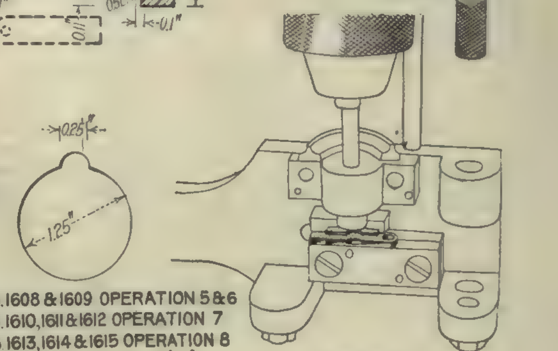


FIG. 1615

FIG. 1608 & 1609 OPERATION 5 & 6
FIG. 1610, 1611 & 1612 OPERATION 7
FIG. 1613, 1614 & 1615 OPERATION 8

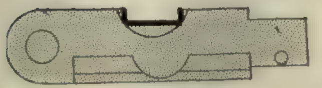


FIG. 1616

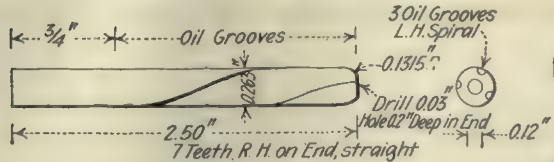


FIG. 1618

FIG. 1619

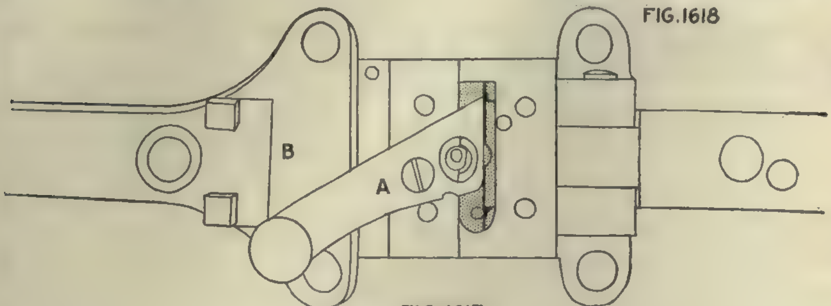


FIG. 1617

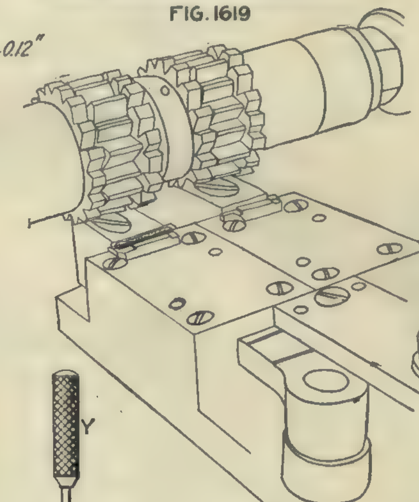


FIG. 1620

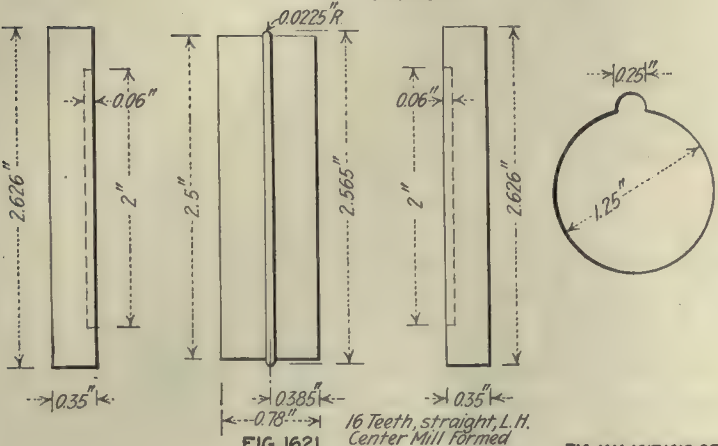


FIG. 1621

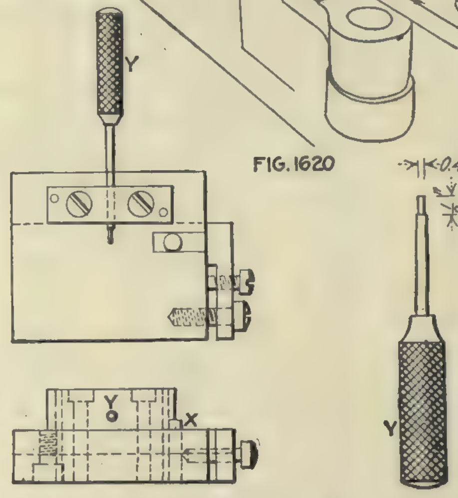


FIG. 1616, 1617, 1618-OP. 9
FIG. 1619, 1620, 1621, 1622 OP. 10

FIG. 1622

OPERATION GG. REMOVING BURRS LEFT BY OPERATIONS 11 AND 12

Number of Operators—One. Description of Operation—Removing burrs left by operations 11 and 12. Apparatus and Equipment Used—File. Production—Grouped with operations 11 and 12.

OPERATION 13. COUNTERBORING SCREW HOLES

Transformation—Fig. 1630. Machine Used—Bench lathe. Number of Operators per Machine—One. Cutting Tools—Counterbore. Gages—Diameter and depth, for screw body and head. Production—500 pieces per hr.

OPERATION HH. REMOVING BURRS

Number of Operators—One. Description of Operation—Removing burrs from operation 13. Apparatus and Equipment Used—File. Production—Grouped with operations 11, 12 and 13.

OPERATION 14. FILING OFF BURRS

Number of Operators—One. Description of Operation—Filing off burrs. Apparatus and Equipment Used—File. Production—Grouped with operation 15.

OPERATION 15. FILING IN JIG

Number of Operators—One. Description of Operation—Jig filing to shape. Apparatus and Equipment Used—File and jig. Production—350 pieces per hr.

FIG. 1623

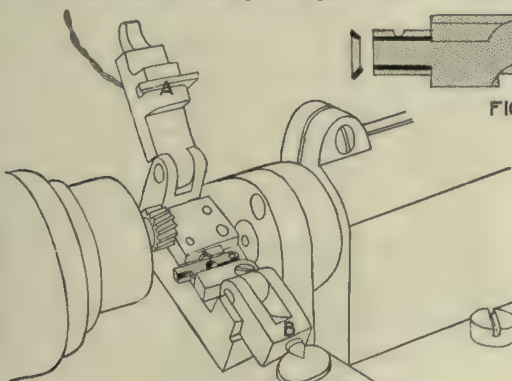


FIG. 1624

FIG. 1626

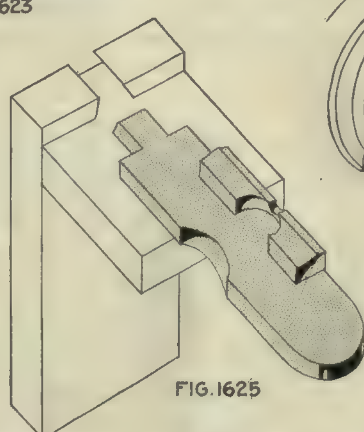


FIG. 1625

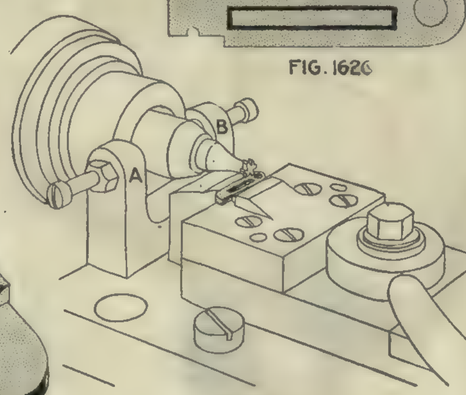


FIG. 1627

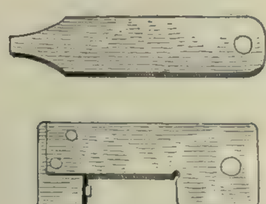


FIG. 1629

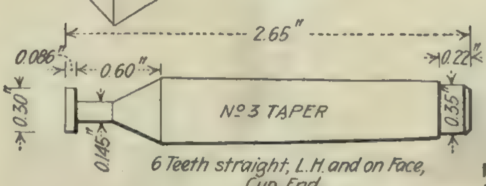


FIG. 1628

FIG. 1630

FIG. 1623, 1624, 1625 OP. 11
FIG. 1626, 1627, 1628, 1629 OP. 12
FIG. 1630

In the Munitions Shop

By Berton Braley

I won't be sorry when this war is over
And I go back to turning valves and such,
I know folks think machinists are in clover
Because munition making pays so much.
But I'll be glad to know that I am toiling
Once more for progress, when the war is through,
Not shaping things for smashing and destroying,
But things to make a battered world look new.

I've always found a lot of joy in thinking
That when a plowshare furrowed up the soil,
Or when a freight train over rails was clinking
They were somewhat the fruitage of my toil.
I knew that I—or some well-skilled machinist—
Had made some portion of that plow, or train,
And felt a pride, a pleasure of the keenest,
In having helped enrich mankind's domain.

Of course, I like the extra pay I'm earning,
But in the work itself is little thrill;
For all the metals that I'm milling, turning,
Are used to break, to shatter and to kill.
But there's a Beast that roams the land and water,
Filling the world with horror and with fear,
Drunken with hate and threatening to slaughter
All that we hold most sacred and most dear.

And it's this monster War that must be greeted
With shells and still more shells, till at the last
His power broken and his greed defeated
The menace of his savagery is past.
But when this task is done, and when the passion
And fury of the battlefields shall cease,
How glad I'll be once more to shape and fashion
Tools for a world that works and plays in peace!

Letters from Practical Men

Limit Sizes for Motor Work

The accompanying tables have been worked out by the engineers of a large motor company to standardize the three grades of fits, and show the tolerances for the various sizes and the different kinds of fits. From 1/8 in. to 1/4 in. the limits are from exact size, or +0.0 to —0.0003 for the hole, while the shafts can vary from —0.0012 for running to 0.0006 for arbor press fits.

Taking a 1½ in. size for example, we see that the hole can vary from 1.5 to 1.4995 in. The maximum shaft for

TABLE OF LIMIT SIZES

Diameter	Female Fits	Male Fits Run	Male Fits Snug	Male Fits Arbor Press
1/8–1/4	+0.0	—0.0007	+0.0001	+0.0006
	—0.0003	—0.0012	—0.0002	+0.0002
1/8	0.1250	0.1243	0.1251	0.1256
	0.1247	0.1238	0.1248	0.1252
3/16	0.1875	0.1868	0.1876	0.1881
	0.1872	0.1863	0.1873	0.1877
1/4	0.2500	0.2493	0.2501	0.2506
	0.2497	0.2488	0.2498	0.2502
17/64–7/16	+0.0	—0.0010	+0.0001	+0.0007
	—0.0005	—0.0015	—0.0003	+0.0003
5/16	0.3125	0.3115	0.3126	0.3132
	0.3120	0.3110	0.3122	0.3128
3/8	0.3750	0.3740	0.3751	0.3757
	0.3745	0.3735	0.3747	0.3753
7/16	0.4375	0.4365	0.4376	0.4382
	0.4370	0.4360	0.4372	0.4378
29/64–3/4	+0.0	—0.0010	+0.0003	+0.0010
	—0.0005	—0.0020	—0.0004	+0.0005
1/2	0.5000	0.4990	0.5003	0.5010
	0.4995	0.4980	0.4996	0.5005
9/16	0.5625	0.5615	0.5628	0.5635
	0.5620	0.5605	0.5621	0.5630
5/8	0.6250	0.6240	0.6253	0.6260
	0.6245	0.6230	0.6246	0.6255
11/16	0.6875	0.6865	0.6878	0.6885
	0.6870	0.6855	0.6871	0.6880
3/4	0.7500	0.7490	0.7503	0.7510
	0.7495	0.7480	0.7496	0.7505
49/64–1 1/4	+0.0	—0.0015	+0.0004	+0.0013
	—0.0005	—0.0030	—0.0006	+0.0006
13/16	0.8125	0.8110	0.8129	0.8138
	0.8120	0.8095	0.8119	0.8131
7/8	0.8750	0.8735	0.8754	0.8763
	0.8745	0.8720	0.8744	0.8756
15/16	0.9375	0.9360	0.9379	0.9388
	0.9370	0.9345	0.9369	0.9381
1	1.0000	0.9985	1.0004	1.0013
	0.9995	0.9970	0.9994	1.0006
1 1/16	1.0625	1.0610	1.0629	1.0638
	1.0620	1.0595	1.0619	1.0631
1 1/8	1.1250	1.1235	1.1254	1.1268
	1.1245	1.1220	1.1244	1.1256
1 3/16	1.1875	1.1860	1.1879	1.1888
	1.1870	1.1845	1.1869	1.1881
1 1/4	1.2500	1.2485	1.2504	1.2513
	1.2495	1.2470	1.2494	1.2506
1 17/64–2	+0.0	—0.0015	+0.0004	+0.0018
	—0.0005	—0.0035	—0.0006	+0.0008
1 5/16	1.3125	1.3110	1.3129	1.3143
	1.3120	1.3090	1.3119	1.3133
1 3/8	1.3750	1.3735	1.3754	1.3768
	1.3745	1.3715	1.3744	1.3758
1 7/16	1.4375	1.4360	1.4379	1.4393
	1.4370	1.4340	1.4369	1.4383
1 1/2	1.5000	1.4985	1.5004	1.5018
	1.4995	1.4965	1.4994	1.5008
1 9/16	1.5625	1.5610	1.5629	1.5643
	1.5620	1.5590	1.5619	1.5633
1 5/8	1.6250	1.6235	1.6254	1.6268
	1.6245	1.6215	1.6244	1.6258
1 11/16	1.6875	1.6860	1.6879	1.6893
	1.6870	1.6840	1.6869	1.6883
1 3/4	1.7500	1.7485	1.7504	1.7518
	1.7495	1.7465	1.7494	1.7508
1 13/16	1.8125	1.8110	1.8129	1.8143
	1.8120	1.8090	1.8119	1.8133
1 7/8	1.8750	1.8735	1.8754	1.8768
	1.8745	1.8715	1.8744	1.8758
1 15/16	1.9375	1.9360	1.9379	1.9393
	1.9370	1.9340	1.9369	1.9383
2	2.0000	1.9985	2.0004	2.0018
	1.9995	1.9965	1.9994	2.0008
2 1/64–3	+0.0	—0.0025	+0.0002	+0.0018
	—0.0008	—0.0045	—0.0008	+0.0008
2 1/16	2.0625	2.0600	2.0627	2.0643
	2.0617	2.0580	2.0617	2.0633
2 1/8	2.1250	2.1225	2.1252	2.1268
	2.1242	2.1205	2.1242	2.1258
2 3/16	2.1875	2.1850	2.1877	2.1893
	2.1867	2.1830	2.1867	2.1883
2 1/4	2.2500	2.2475	2.2502	2.2518
	2.2492	2.2455	2.2492	2.2508
2 5/16	2.3125	2.3100	2.3127	2.3143
	2.3117	2.3080	2.3117	2.3133
2 3/8	2.3750	2.3725	2.3752	2.3768
	2.3742	2.3705	2.3742	2.3758
2 7/16	2.4375	2.4350	2.4377	2.4393
	2.4367	2.4330	2.4367	2.4383

TABLE OF LIMIT SIZES—Continued

Diameter	Female Fits	Male Fits Run	Male Fits Snug	Male Fits Arbor Press
2 1/2	2.5000	2.4975	2.5002	2.5018
	2.4992	2.4955	2.4992	2.5008
2 9/16	2.5625	2.5600	2.5627	2.5643
	2.5617	2.5580	2.5617	2.5633
2 5/8	2.6250	2.6225	2.6252	2.6268
	2.6242	2.6205	2.6242	2.6258
2 11/16	2.6875	2.6850	2.6877	2.6893
	2.6867	2.6830	2.6867	2.6883
2 3/4	2.7500	2.7475	2.7502	2.7518
	2.7492	2.7455	2.7492	2.7508
2 13/16	2.8125	2.8100	2.8127	2.8143
	2.8117	2.8080	2.8117	2.8133
2 7/8	2.8750	2.8725	2.8752	2.8768
	2.8742	2.8705	2.8742	2.8758
2 15/16	2.9375	2.9350	2.9377	2.9393
	2.9367	2.9330	2.9367	2.9383
3	3.0000	2.9975	3.0002	3.0018
	2.9992	2.9955	2.9992	3.0008
3 1/64–4 1/2	+0.0	—0.0030	+0.0002	+0.0020
	—0.0010	—0.0050	—0.0010	+0.0010
3 1/16	3.0625	3.0595	3.0627	3.0645
	3.0615	3.0575	3.0615	3.0635
3 1/8	3.1250	3.1220	3.1252	3.1270
	3.1240	3.1200	3.1240	3.1260
3 3/16	3.1875	3.1845	3.1877	3.1895
	3.1865	3.1825	3.1865	3.1885
3 1/4	3.2500	3.2470	3.2502	3.2520
	3.2490	3.2450	3.2490	3.2510
3 5/16	3.3125	3.3095	3.3127	3.3145
	3.3115	3.3075	3.3115	3.3135
3 3/8	3.3750	3.3720	3.3752	3.3770
	3.3740	3.3700	3.3740	3.3760
3 7/16	3.4375	3.4345	3.4377	3.4395
	3.4365	3.4325	3.4365	3.4385
3 1/2	3.5000	3.4970	3.5002	3.5020
	3.4990	3.4950	3.4990	3.5010
3 9/16	3.5625	3.5595	3.5627	3.5645
	3.5615	3.5575	3.5615	3.5635
3 5/8	3.6250	3.6220	3.6252	3.6270
	3.6240	3.6200	3.6240	3.6260
3 11/16	3.6875	3.6845	3.6877	3.6895
	3.6865	3.6825	3.6865	3.6885
3 3/4	3.7500	3.7470	3.7502	3.7520
	3.7490	3.7450	3.7490	3.7510
3 13/16	3.8125	3.8095	3.8127	3.8145
	3.8115	3.8075	3.8115	3.8135
3 7/8	3.8750	3.8720	3.8752	3.8770
	3.8740	3.8700	3.8740	3.8760
3 15/16	3.9375	3.9345	3.9377	3.9395
	3.9365	3.9325	3.9365	3.9385
4	4.0000	3.9970	4.0002	4.0020
	3.9990	3.9950	3.9990	4.0010
4 33/64–7	+0.0	—0.0035	+0.0003	+0.0024
	—0.0012	—0.0055	—0.0012	+0.0012
4 9/16	4.5625	4.5590	4.5628	4.5649
	4.5613	4.5570	4.5613	4.5637
4 5/8	4.6250	4.6215	4.6253	4.6274
	4.6238	4.6195	4.6238	4.6262
4 11/16	4.6875	4.6840	4.6878	4.6899
	4.6863	4.6820	4.6863	4.6887
4 3/4	4.7500	4.7465	4.7503	4.7524
	4.7488	4.7445	4.7488	4.7512
4 13/16	4.8125	4.8090	4.8128	4.8149
	4.8113	4.8070	4.8113	4.8137
4 7/8	4.8750	4.8715	4.8753	4.8774
	4.8738	4.8695	4.8738	4.8762
4 15/16	4.9375	4.9340	4.9378	4.9399
	4.9363	4.9320	4.9363	4.9387
5	5.0000	4.9965	5.0003	5.0024
	4.9988	4.9945	4.9988	5.0012
5 1/16	5.0625	5.0590	5.0628	5.0649
	5.0613	5.0570	5.0613	5.0637
5 1/8	5.1250	5.1215	5.1253	5.1274
	5.1238	5.1195	5.1238	5.1262
5 3/16	5.1875	5.1840	5.1878	5.1899
	5.1863	5.1820	5.1863	5.1887
5 1/4	5.2500	5.2465	5.2503	5.2524
	5.2488	5.2445	5.2488	5.2512
5 3/8	5.3750	5.3715	5.3753	5.3774
	5.3738	5.3695	5.3738	5.3762
5 1/2	5.5000	5.4965	5.5003	5.5024
	5.4988	5.4945	5.4988	5.5012
7 1/16–10 1/2	+0.0	—0.0040	+0.0005	+0.0030
	—0.0015	—0.0065	—0.0015	+0.0015
10 9/16–14	+0.0	—0.0050	+0.0005	+0.0035
	—0.0020	—0.0075	—0.0015	+0.0015
14 1/16–18	+0.0	—0.0050	+0.0005	+0.0040
	—0.0020	—0.0080	—0.0020	+0.0015

a running fit will be 1.4985 and the minimum 1.4965, a tolerance of 0.002, as shown in the column showing sizes between $1^{17}/_{64}$ and 2 in., the limits shown being 0.0015 and 0.0035 in., or 0.002 in.

This will make the use of the table clear and I hope others will find it as useful as we have.

New York City. JOHN HAVEKOST.

Bolt-Head and Nut Diameters

The copyrighted chart shown will, I believe, greatly facilitate the work of an engineer or draftsman in the tedious work of laying out bolt clearances. Its principal merit lies in the fact that the dimensions mentioned are shown graphically; also, the working strength of each size of bolt is indicated for various allowable stress values. The chart consists of two parallel scales drawn full size, one along each side of the chart. Each graduation representing the value of a long diameter of a square or hexagon bolt head or nut has been extended to intersect with a system of converging lines, drawn from various points along the extended 7⅝-in. and 6¼-in. graduation to a common center at the zero graduation of each scale. The distances set off on this extended line represent the radius of a long diameter for a 3½-in. diameter bolt head or nut (square or hexagon heads). By virtue of the similar triangle thus formed the dimensions of bolts of any diameter or all particular dimensions within the limits of the two scales may be found and laid off to any of the various scales shown.

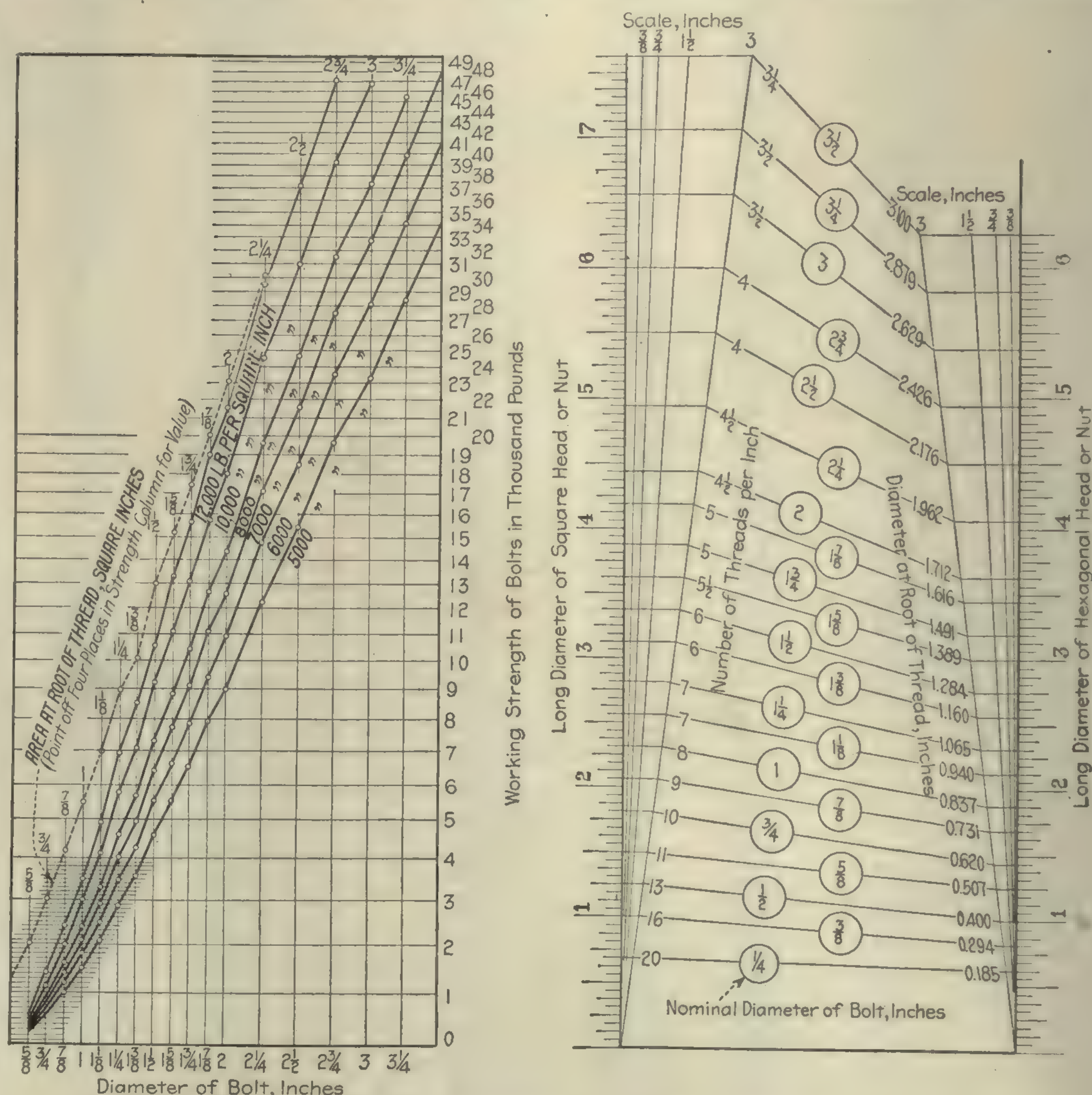


CHART FOR BOLT-HEAD AND NUT DIAMETERS

The intersecting points of each extended graduation with the converging lines drawn from the point marked scale = 3 in. have been connected, thus forming a broken line extending from one scale to the other. The connecting lines between the two converging lines bear three sets of numbers. At its center is shown the nominal diameter of bolt. To the left is given the number of threads per inch, and to the right the root diameter.

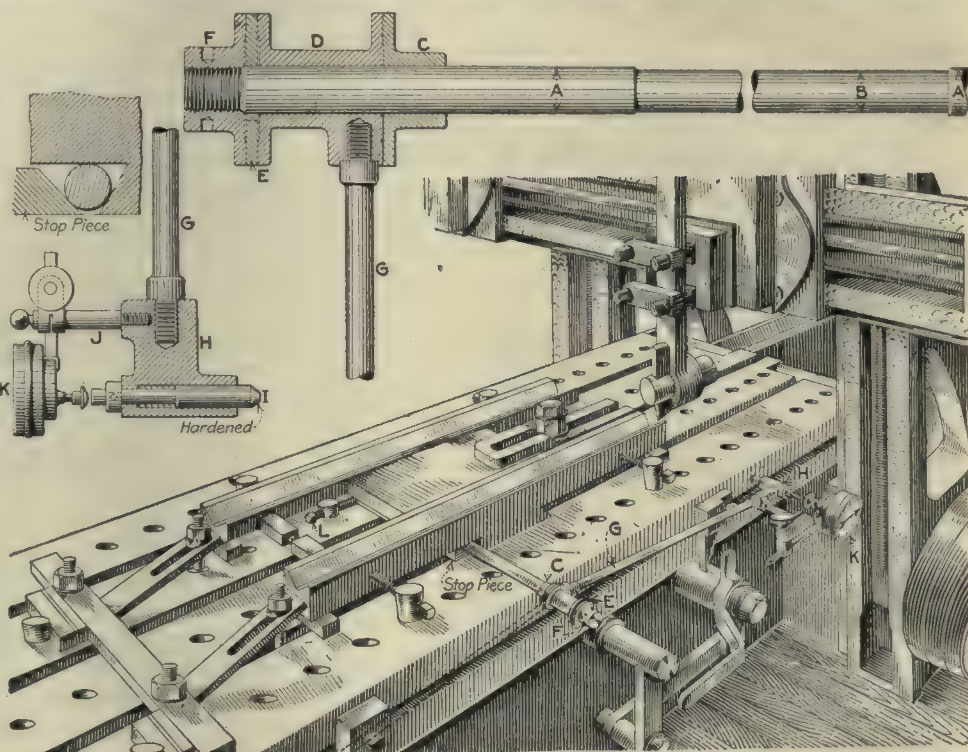
No difficulty will be experienced in working with this chart if one keeps in mind the fact that the radius of all dimensions is used. Center to center of bolts or bolt head or nut, with a desired amount of clearance, may be laid down with equal facility. D. GERBER.

Pittsburgh, Penn.

Dial Indicator for Squaring Lathe Carriages on the Planer

In the illustration is shown the design of a practical and labor-saving fixture for squaring lathe carriages on the planer table preparatory to planing them. Until recently in a shop with a production of 50 engine lathes per month there had been no end of trouble for the vise department in lining carriages with the headstock on account of the V not being planed square with the dovetail for the cross-slide. After many attempts to overcome this trouble by replaning the carriages and experimental work trying to overcome the trouble the dial test indicator shown was made. By its use in setting, this work could be planed accurately.

In the illustration, the steel bar is turned and ground at A about $\frac{1}{32}$ smaller than the depth of the dovetail on the carriage. The size at B is for clearance about $^1/_{64}$ smaller than A. One end of the bar is threaded for the adjusting nut. The thrust collar C, arm journal D, thrust washer E and adjusting nut F are made large in diameter and faced as nearly square with the hole as possible. The arm G is of steel and has a casting H on the end carrying a plunger pin I and a stud J to hold the indicator K. The spring for the plunger pin should be very light, so as not to spring the bar. The indicator used is the ordinary dial indicator and is attached to this fixture only when needed. Below is shown how the fixture is held in position when lining carriages. The stop piece shown is of the same length as the cross-slide of a carriage and is used to hold the bar up into the dovetail, as shown. A regular stop screw on the planer in line with the center of the carriage holds the fixture in position. When the test is ready to be made and the fixture is clamped into position with the stop screw L. the arm is swung around on its journal so that the plunger pin I is in contact with the edge of the planer table. The indicator can then be set at zero and the arm swung in an arc of 180 deg. until the reading of the indicator against the edge of the planer table is the same at both extremes. This insures the carriage being perfectly square. This operation should be gone through with on every carriage.



DIAL INDICATOR AND METHOD OF USE

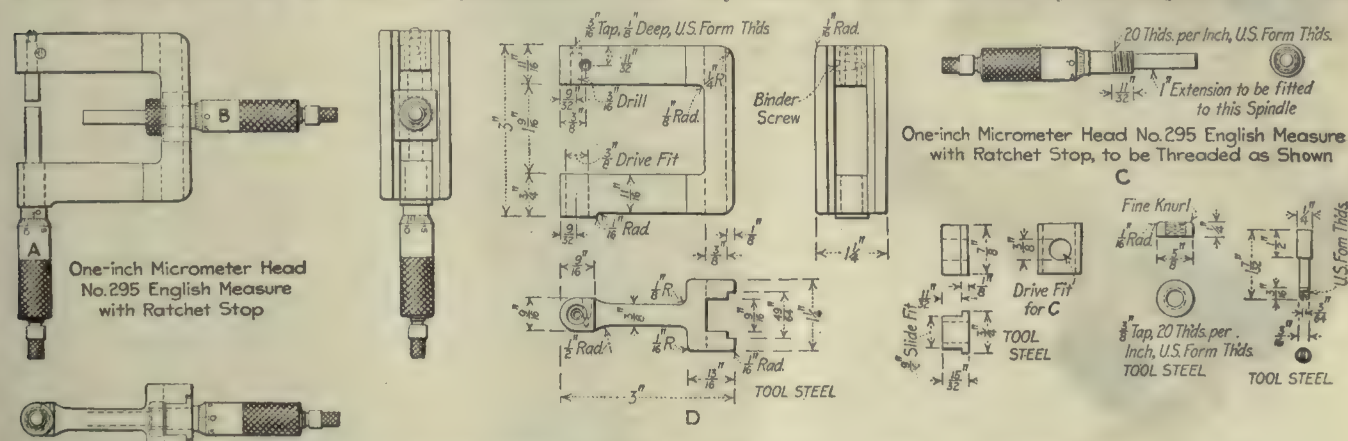
The construction of this fixture, with the exception of the bar, should be as light as practicable. The adjusting nut F should be set so that the arm journal D will carry the weight of the arm, but still be free to be turned upon the bar. This device has been successful in increasing the production of this shop, and I recommend it for lining up any similar work.

Cincinnati, Ohio. WILLIAM P. WINTERS.

Special Micrometer for Measuring Cartridge Tools

The exacting requirements that are placed upon cartridge tools result in a necessity for a special micrometer, in order to get the results required. In measuring drawing punches for brass shells and bullet covers, it is necessary to hold them very close to size, especially so on the bullet-pointing punch and the last draw-shell punch, which must be as near as possible to the right size. The accompanying illustration shows a micrometer designed for measuring the above-mentioned tools.

The taper part on the punches can be measured exactly any distance from the end by the adjustment of the spindle B. The diameter is measured by the spindle A. The extension called for at C will enable the tool maker to measure close to the end of the punch, as well as 2 in. from the end, by taking off the extension, bringing the spindle back to 2 in., which is the range for which this micrometer was designed.



THE SPECIAL MICROMETER FOR USE ON CARTRIDGE-MAKING TOOLS

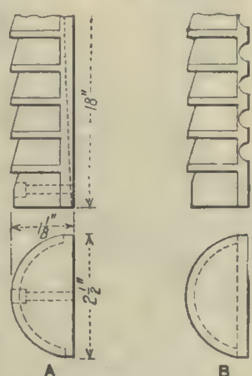
The frame D is either made from a forging or milled from a solid piece of tool steel, and the micrometer heads are stock heads made by Brown & Sharpe. It is necessary to keep the anvil and spindle A as square as possible, and the corners must be kept sharp in order to get good results in measuring. The spindle B may have the corners taken off, as this only comes in contact with the end of the punch.

This micrometer can be made to any size required for cartridge work. ADOLPH STARR.

New Haven, Conn.

Hardening Semicircular Broaches

While hardening broaches of the section shown in the illustration, the first piece developed a curvature of about ⅝ in., as at A, the teeth at the center being above those at the ends. It was retured to the furnace and when it had attained the proper heat it was given a bend in the opposite direction of about the same amount. After this the piece was again heated and then put through the hardening process, but it came from the bath much the same as upon the first trial. It was then reheated, straightened and annealed. A radius cutter was employed and the broach machined as shown at B. Upon hardening again it came out satisfactory. The other broaches in the set were treated in a like manner. Since following this method no trouble has occurred in hardening broaches of this form and what at one time seemed a difficult problem has been solved cheaply and easily.



THE BROACH

South Acton, Mass. I. KEMPT.

Threading Long Screws on a Short Thread Miller

A number of shafts with 4 ft. of thread were to be cut. As all the lathes were busy, it was decided to cut the threads in a thread miller. As this machine would cut only 14 in. of thread at one setting, the spindle from the tailstock was removed and a bushing inserted to act as a bearing for the shaft.

The threads were cut in the usual way, using the draw-in chuck. As the cut ran up, the chuck was opened, the shaft moved back, the carriage adjusted and another cut taken. A very satisfactory job was the result.

Washington, D. C. WILLIAM MACKENZIE.

Linseed Oil for Cutting

There are times when the best of cutting oils seem to fail and a satisfactory substitute for lard oil is welcome. I have repeatedly used a combination of half kerosene and half linseed oil with surprisingly good results.

Owing to the disagreeable tendency of linseed oil to gum up the bearing surfaces if allowed to stay on them, I use it only when everything else fails. But the kerosene keeps it from drying so rapidly and makes it easy to wipe off. WALTER H. WEBSTER.

Cincinnati, Ohio.

Automotive Engineers' Defense Work

The extent to which the Society of Automobile Engineers is willing to go to do all possible to develop automotive engineering—that is, engineering relating to the design and production of aircraft, watercraft and tractors as well as freight and passenger motor cars—is shown by the fact that final steps have been taken to change the name of the organization to Society of Automotive Engineers. The new name will be put into effect on Apr. 19, after which time the engineers who were formerly members of the American Society of Aëronautic Engineers and of the Society of Tractor Engineers, also engineers connected with the company members of the National Association of Engine and Boat Manufacturers, will be working together with those who have been members of the Society of Automobile Engineers, to further what standardization work shall be feasible in their fields.

The culminating decision to change the name of the Society of Automobile Engineers was based on Government coöperation in time of stress. Naturally, the old members of the Society of Automobile Engineers had much sentiment for the old name, under which there has been such remarkable growth and standardization and automobile-engineering benefit.

The training of the members of the Society of Automobile Engineers has been such as to develop ability to obtain results without regard to precedents as to equipment, material or time available. There are in the society's ranks executive engineers who are accustomed to assume large responsibilities, designing engineers expert at commercial designs for production, metallurgical engineers expert in materials and their treatment, standardizing engineers experienced in coördinating designs, research engineers capable of analyzing and solving problems of production, and efficiency engineers specializing in rapid and economical production of interchangeable parts and the development of necessary equipment for that purpose—in fact, specialists in all branches of the automotive industry, including design and production of motor cars, tractors, aircraft and watercraft.

The Preparedness Committee of the Society of Automobile Engineers, constituted of President George W. Dunham, Past President W. H. Van Dervoort and Vice President Jesse G. Vincent, represents the willingness of the members of the society to assist jointly and severally in any plans of the Government looking toward the security of the nation. This committee is not only making a classification of the society members with reference to qualification to coöperate with the Government and keeping in close touch with various Government officials, but is taking an active part in the remarkable plan under way to increase the membership of the society by several hundred (and probably one thousand) during next month, drawing upon engineers in the various automotive fields. There are a great many such men, all of whom are needed in the coöperative-work plan.

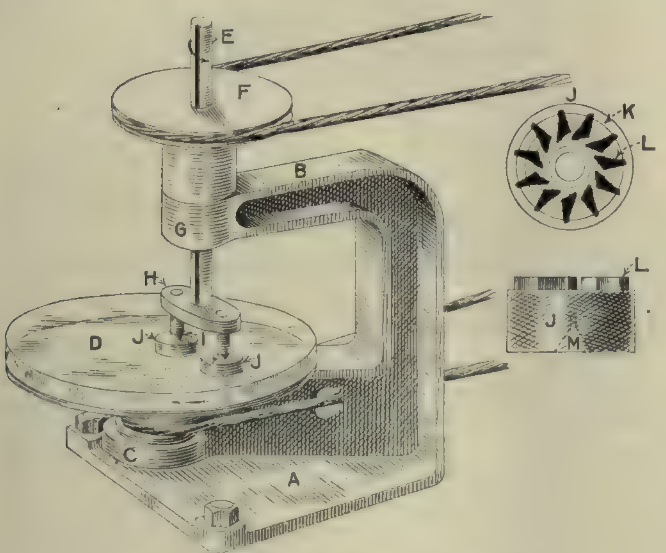
The automotive industry will have the honor and duty of taking full responsibility for important activities on behalf of the Government during the war. R. O. Gill is chairman of the Membership Increase Committee, being assisted by an executive committee that meets twice weekly in Detroit and by committees in the eight cities in which there are sections of the society, as well as by committeemen serving in over 50 large cities.

Discussion of Previous Question

Lapping Hardened Steel Surfaces

Mr. Cline's article on page 59 is in accord with the practice of one of the finest tool makers I ever knew. He was an Englishman named Stubbs and had been employed on a lot of work for the British Bureau of Standards. The method of seasoning the lapping plate is similar to Stubbs' practice, but for the finest work only, such as lapping the parts of measuring machines and the like.

For ordinary work, any piece of close-grained cast iron is all right. It should be carefully planed, and if the work is long, the plate should be scraped to bring it nearly to a true plane. For short work any kind of a fairly flat plate will do.



LAPPING MACHINE WITH GLASS LAP

Stubbs, who by the way died several years ago, had a little stunt, which he imparted to me, for the finishing by lapping of small blocks, such as height blocks, of which he had a set from $\frac{1}{32}$ to 2 in. with an extra block $\frac{3}{64}$ in. thick. These he used in combination, as the Swedish blocks are used, and with them he could get all 64th sizes from $\frac{1}{32}$ in. up. As he is now dead, it can do him no injury to give the secret, if such it is, to the readers of the *American Machinist*.

He had a coarse india oilstone for rough lapping and a "Swatty" razor hone for finishing.

The work from the surface grinder was left with about 0.0003 in. for finishing. The grinder marks and a little more were taken off the work on the india oilstone, using kerosene as a lubricant. From this operation they came with about 0.0001 in. for finishing. The last "tenth" was taken off with the Swatty. The stones were kept flat by lapping them with carborundum on a cast-iron lap.

This method of lapping small pieces is far better than with a cast-iron lap, as the stone remains flat much longer. As a matter of fact, lapping is more a question of personal skill than it is of the tools with which it is done. I refer here to the ordinary run of work, where fine grinding is just a little too coarse and fine lapping a little too refined. In other words, where the surface must be polished as well as flat.

A great deal of this class of work is done on rotary laps driven by power. In some of the watch-tool shops laps made of very heavy plate glass 1 in. or more in thickness are used. These are disks 12 or 18 in. in diameter mounted on vertical shafts. The work is cemented to the face of cast-iron disks, which have in the center of their back a female center.

Referring to the illustration, *A* is the lapping machine. It consists of a main frame of cast iron with a bracket *B* cast integral. At *C* there are bearings for the vertical shaft that carries the glass lap *D*. Means is provided for driving the glass lap in the direction indicated by the arrow.

The end of the bracket *B* is bored, vertical to the glass lap, for the vertical splined shaft *E*. A pulley *F* is bored to run on the hub *G* of the bracket. This hub is turned for this purpose. The upper part of the hub of the pulley *F* is bored to fit the vertical shaft *E* and a key is fitted into it so that it will drive the vertical shaft *E* through the spline. The lower end of the vertical shaft *E* is spread as shown at *H* and two 60-deg. centers *I* are fitted into the spread ends. The vertical shaft has free vertical movement. Means is provided for driving the pulley *F*, which in turn drives the vertical shaft, as previously stated. At *J* is shown the work holder. This is a cast-iron disk the diameter of which depends on the size of the work and of the lapping machine in which it is to be used. In thickness it is about 1 in., but this is also dependent to a certain extent on the work and the machine. The face of the disk is grooved with a series of concentric or radial or parallel V-shaped grooves *K* about $\frac{1}{16}$ in. wide and $\frac{1}{16}$ in. deep. The object of these grooves will be explained later. In the center, on the back of each work holder, there is a 60-deg. female center *M*, which should be fairly large, say $\frac{3}{4}$ in. or more in diameter. These centers are to fit the male centers *I*.

The work holders are heated on a hot plate of some sort, the grooved face is rubbed with stick shellac, and the work *L* is applied to the hot shellacked face. The whole thing is then placed under a screw press with a piece of wood next the work to force it to a seat on the work holder itself. The excess of shellac is forced out through the grooves *K*. It must be understood that a number of pieces of work *L* are usually secured in this manner to each work holder, and that all of these pieces are eventually to be finished to the same approximate thickness. When the work holders and the work are cold, the work will be found to hold very firmly to the work holders. The shaft *E* is raised and a work holder *J* is placed under each of the male centers *I*, with the work downward and the center *I* in the female center in the back of the work holder. The face of the lap *D*

is charged with flour emery and oil and the machine started. The lap rotates in the direction shown by the arrow, and the work holders revolve in an orbit on the face of it. The weight of the work holders and of the vertical shaft *E* gives the feed. The workman examines the work from time to time, and when one face is finished the work holders are removed and warmed so that the work can be taken off. Should any shellac adhere to the work it can be cleaned off by washing it in wood alcohol. The work is now cemented in the same way as before, but with the finished face of the work next to the work holder, and the other side of the work is lapped. Work is usually finished in this way (after hardening) direct from the punch press or miller, there being no grinding operation necessary. Work can be finished in this way to within 0.0005 in. with ease. Where the flour emery does not give a fine enough finish, and where absolute flatness of surface is not obligatory, the work can be finished on a boxwood lap. In this case the lap often does not rotate, but the gyratory movement of the work holders is the same, as is also the method of cementing the work to the work holders. The abrasive used may be any of the very fine abrasives; a common one used is Vienna lime, which is precipitated chalk. This is mixed with water and alcohol, one part of each, and fed on to the lap.

I have seen very fine flat finishing done with a clean glass lap charged with polishers' rouge; but for fine finishing, just as Mr. Cline says, the lap should be kept clear of coarser abrasives.

There was another article in your paper recently that was of considerable interest to me. I think it was signed by Mr. Macready. It referred to the straightening of thin hardened pieces by using a piece of oilstone. Hints like these are often worth the weight of the gage in gold, as a small gage may not weigh very much and may easily cost more than its weight in gold.

The result of the war work in this country has been so conducive to accuracy that the articles you have had recently on accurate work have been of great assistance to many of us who do not know it all, and I suspect that many of those who think they know it all have been able to learn something also.

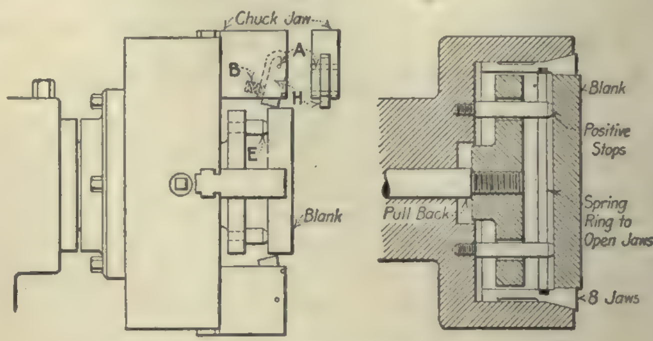
I heartily agree with Mr. Cline's remarks anent measuring. I can well remember the time when I thought I could measure to 0.0001 in. and later found that the micrometer on whose accuracy I would have staked my life was out over 0.0003 at one point. Since then I have decided, while I can work fairly close, to refrain from stating that "such and such a piece is exactly such and such a size." ROBERT MORRIS.

Hancock, Mich.

Chucking Work Parallel

Regarding H. P. Johnson's fixture for holding blanks parallel in the chuck, on page 1134, Vol. 45, in tightening the chuck jaws on the blank the tendency will be, on account of the clearance in the chuck jaws, to keep the blank away from the pins on the inserted fixture. To overcome this, if there are many blanks to be handled, I would suggest making new chuck jaws and fingers, as illustrated in Fig. 1.

The chuck jaws are slotted for the fingers *H*, the finger being held in place by the pin *A*. When the jaws are open, the finger is held out in position ready for the blank by the spring *B* against the small pin *E*. The blank being inserted and the jaws tightened, the finger exerts a pressure in two directions—one against the pin *E* in the fixture and the other against the blank,



FIGS. 1 AND 2. TWO FORMS OF CHUCKS

holding it rigidly in position against the pins in the fixture and from turning while machining.

If all disks were of one diameter, I would advise using a chuck with pull-back collet, as illustrated in Fig. 2. E. TONKIN.

Wilkinsburg, Penn.

Hardening High-Speed Steel Cutters

On page 126, a reader asks for information about hardening high-speed steel forming cutters. I have hardened hundreds of all shapes and sizes of forming cutters and reamers with practically no distortion or burning. Use malleable-iron packing boxes, not cast iron, and pack with charcoal. Break up ordinary charcoal into small pieces and put a layer about 1½ in. deep at the bottom. Then place the cutters 1 or 1½ in. from the side of the box and about 1 in. apart. They should not be crowded. Do this until the box is full. Heat up slowly to 1750 deg. F. When the heat is through, keep it there for 2½ or 3 hours; for the last 20 min. run it up to 1800 deg. F. and no more.

After this is done, take out the cutters and quench them in whale oil. Then draw them down to 420 deg. F., to take the strain out, either in oil or on a gas plate. They come out just as clean as when they were put in. Once in a while one will crack, but very rarely.

I have hardened reamers 7 in. long, the diameter varying from 0.340 in. to 0.950 in. in steps. The most that any of them ran out was 0.005 in., and most of them only 0.002 in.

I never have any trouble with the tools not standing up, if they are used properly. All our high-speed steel except turning tools is hardened by this method. I hardened in this way a small hob a few weeks ago for cutting high-speed serrating tools for putting the serrations on fuses. The hob was ⅜ in. in diameter with V-grooves cut in 0.025-in. pitch. JOHN HARTLEY.

Toronto, Canada.

[Packing in charcoal adds carbon and lowers the critical point; still, 1800 deg. F. seems rather a low quenching temperature to give good results, and 420 deg. F. also seems low for the drawing temperature. Information on this subject is of vital interest to many of our readers. —Editor.]

An Editorial in Telegrams

Showing by actual example one way that American users of machine tools can serve their Country

POSTAL TELEGRAPH - COMMERCIAL CABLES

TELEGRAM

COUNTER No. TIME FILED CHECK

The Postal Telegraph-Cable Company (Incorporated) transmits and delivers this message subject to the terms and conditions printed on the back of this blank.

SEND the following Telegram, subject to the terms on back hereof, which are hereby agreed to.

March 30, 1917

-------- ------- Machine Tool Co.

Wire progress on cutters for Watertown Arsenal order no--- also best possible delivery on grinder their order --- and miller their order ---

Council of National Defense

1

POSTAL TELEGRAPH - COMMERCIAL CABLES

TELEGRAM

COUNTER No. TIME FILED CHECK

The Postal Telegraph-Cable Company (Incorporated) transmits and delivers this message subject to the terms and conditions printed on the back of this blank.

SEND the following Telegram, subject to the terms on back hereof, which are hereby agreed to.

March 31, 1917

Council of National Defense

Your wire thirtieth cutters for Watertown Arsenal will be shipped April seventh their order --- for grinding machine and --- for milling machine best possible delivery December and September respectively according to our contract Secretary of War can take machines already sold to customers thus making delivery on grinder immediate miller in June which will be first miller ready

-------. ------- Machine Tool Co.

2

WESTERN UNION TELEGRAM

NEWCOMB CARLTON, PRESIDENT

CLASS OF SERVICE DESIRED: Fast Day Message; Day Letter; Night Message; Night Letter

Patrons should mark an X opposite the class of service desired; OTHERWISE THE TELEGRAM WILL BE TRANSMITTED AS A FAST DAY MESSAGE.

Receiver's No. Check Time Filed

Send the following telegram, subject to the terms on back hereof, which are hereby agreed to

April 2, 1917

-------- ------- Machine Tool Co.

Improvement on cutter delivery appreciated regarding delivery miller and grinder you surely have patriotic customers not getting machines for government work who would gladly accept deferred delivery and let us have machines promptly others are doing this please take up with customers and advise as we do not want government to use its authority unless absolutely necessary

Council of National Defense

3

WESTERN UNION TELEGRAM

NEWCOMB CARLTON, PRESIDENT

CLASS OF SERVICE DESIRED: Fast Day Message; Day Letter; Night Message; Night Letter

Patrons should mark an X opposite the class of service desired; OTHERWISE THE TELEGRAM WILL BE TRANSMITTED AS A FAST DAY MESSAGE.

Receiver's No. Check Time Filed

Send the following telegram, subject to the terms on back hereof, which are hereby agreed to

April 3, 1917

Council of National Defense

Reference miller and grinder for Watertown Arsenal have appealed to customers as suggested the ---- ---- company consents to release grinder for immediate shipment to Arsenal the ------ ------- company releases miller for June delivery which is first machine ready both willing to sacrifice six months to year on delivery to favor government work

-------. ------- Machine Tool Co.

4

Here is a striking example of practical patriotism that gives first aid to the Government in a vitally important matter. The Government does not wish to "rob Peter to pay Paul" nor to take machines from those making munitions for any of the countries that are fighting for freedom and democracy. Neither does it desire to exert its power of commandeering equipment. And it will not need to, if all of us follow this example of helping shops that help our Government.

POSTAL TELEGRAPH - COMMERCIAL CABLES

TELEGRAM

COUNTER No. TIME FILED CHECK

The Postal Telegraph-Cable Company (Incorporated) transmits and delivers this message subject to the terms and conditions printed on the back of this blank.

SEND the following Telegram, subject to the terms on back hereof, which are hereby agreed to.

Apr. 4, 1917

Council of National Defense

Shipping grinder to Watertown Arsenal today routing and car number later

-------- ------- Machine Tool Co.

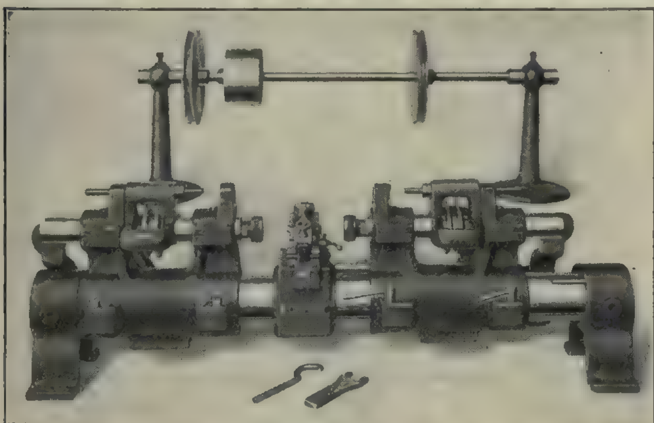
5

Shop Equipment News

Bench Drilling Machine

The Martin Machine Co., Greenfield, Mass., is now manufacturing the machine illustrated, which is known as a duplex drilling machine. It is intended especially for light drilling, reaming, milling and countersinking operations on small metal goods.

The spindles are hardened and ground and run in taper bronze bushings. Thrust bearings are also included. The sliding yoke in which the spindles run is controlled by a foot lever so adjusted that either one spindle or both spindles may be operated at a time. Adjustable stops govern the length of stroke. The center piece is used to hold fixtures for the work and may be adjusted to fit particular requirements. The equipment includes a countershaft, as illustrated.



BENCH DRILLING MACHINE
Length, 30 in.; height, 12 in.; weight, 175 lb.

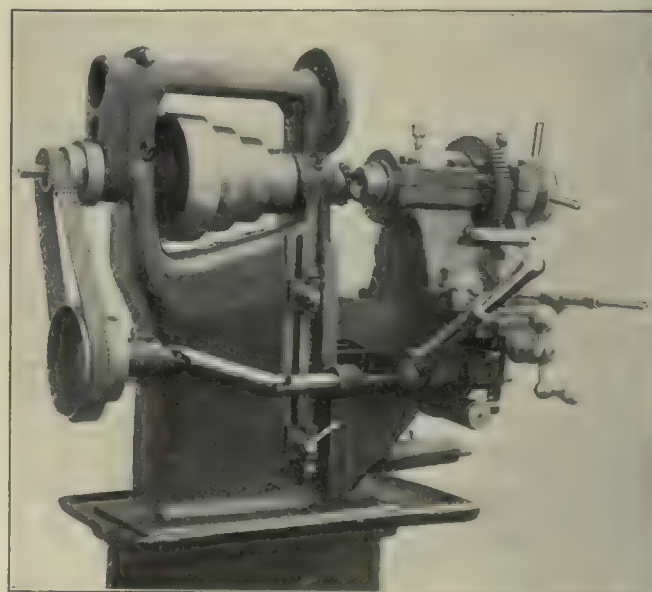
Motion-Study Watch with Computed Production Dial

The time-study watch shown has been recently placed on the market and combines a computed dial with the usual split hand feature. The dial is divided into tenths and hundredths of a minute and has figures spaced at intervals of two-hundredths. The computed dial indicates at any elapsed time what the corresponding hourly production would be for the given unit time in which the work being studied is produced. The watch has two hands—one controlled by the side plug, the other by the crown. The former is used to take out non-productive time or delays, while the latter gives the gross time. In case it is so desired, both hands may be operated as a unit controlled by the crown. The watch is made by Mortimer J. Silberberg, Chicago, Ill.

TIME-STUDY WATCH

Semi-Automatic Thread Miller

For milling internal and external threads the American Ammunition Co., Bordentown, N. J., is now marketing the attachment shown, which may be applied to either hand- or power-feed millers. The collet capacity is up to 1¾ in. on pieces not over 4 in. long and up to 1 in. on pieces that must extend through the spindle. Any pitch, either right- or left-hand, up to ½ in. may be cut; and the work can be finished in one or two cuts, depending upon the quality of finish required. The spindle, gears and lead screw are casehardened, and the nut is of bronze, with provision for taking up wear. Where a greater angle must be cut than can be taken care of by the clearance of the cutter, the work is placed either above or below the cutter and the attachment set at the proper angle to clear the threads.



THREAD-MILLING ATTACHMENT

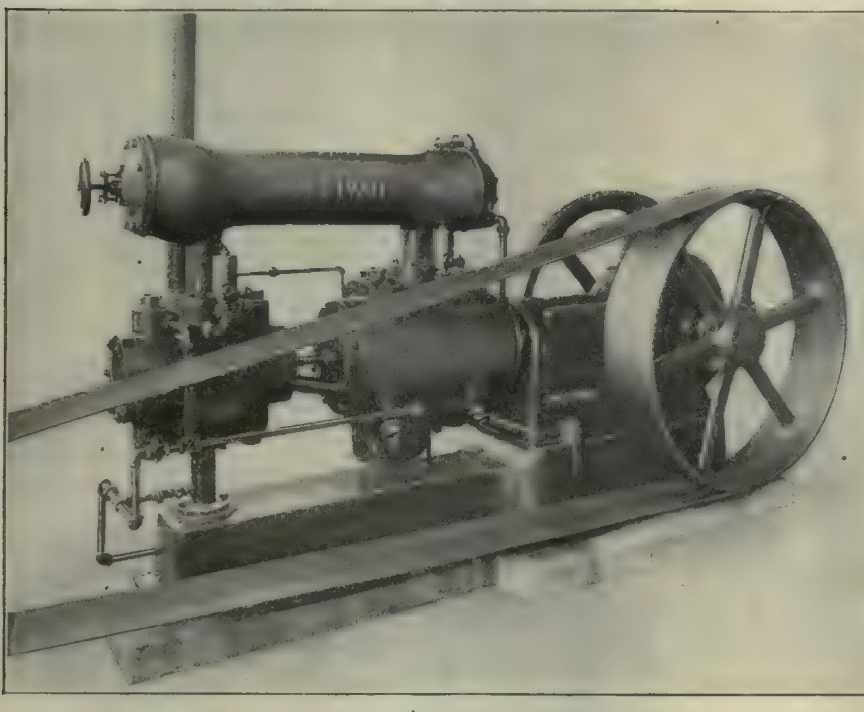
In operation the table is run back, the work is placed in the collet, and the table is run forward, bringing the work-driving worm into mesh just before the cutter comes in contact with the piece to be threaded. On the completion of the cut, the clutch is thrown out and the machine stops. On bringing the table back, the worm drops and releases the wheel, when the collet may be opened and the work removed. The only operations that are not automatic are the backward and forward movements of the table; the opening and closing of the collet; and for internal threading, the cross-movement of the slide.

Air Compressor

The illustration shows an air compressor built by the Sullivan Machinery Co., Chicago, Ill. It is a tandem two-stage belt-driven machine with cylinders 12 and 7½ in. in diameter and a 10-in. stroke, and it compresses 306 cu.ft. of free air per minute to 90 lb. pressure at 235 r.p.m. The compressor is driven at constant speed through a belt from a 50-hp. motor, and the pressure is held constant by an unloader. The latter is equipped with an arrangement for catching oil or dirt in the air line, which would be apt to prevent the correct operation of the pilot valve.

An intercooler of the standard Sullivan aluminum tube pattern is used, the air being forced across the cooling tubes three times by means of baffle plates in the passage between the two cylinders. Both cylinders are equipped with inlet and discharge valves of the automatic poppet type, which are fitted with double cushioned springs to insure quietness.

As will be noticed, the machine is of the inclosed type with dust-tight removable covers over the main bearings. Covers are also placed at each side of the crosshead guides



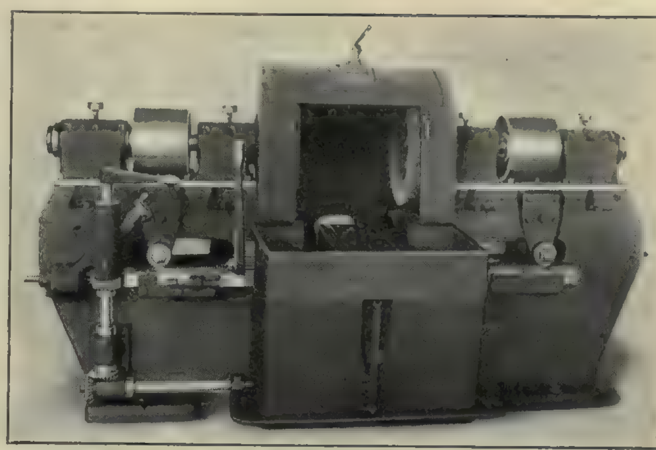
TWO-STAGE TANDEM AIR COMPRESSOR

for inspection and adjustment. The cylinders are equipped with sight-feed lubricators, and the remaining parts are lubricated by the splash system.

Double-Spindle Grinder

The Gardner Machine Co., Beloit, Wis., has recently added to its line of disk and ring wheel grinders the double-spindle grinder shown in the illustration. The machine will carry either 20-in. ring wheels or 24-in. disk wheels. A water system for wet grinding with the ring wheels and an air exhaust system for dry grinding with the disk wheels are provided.

The spindles are ground to size and are mounted in babbitt-lined bronze bushings in a sliding head moving in a sub-base that may be bolted to the machine base in



DOUBLE-SPINDLE GRINDER

Spindle diameter, 3 in.; length, 37¾ in.; bearings, 3 x 10 in.; belt pulleys, 12-in. diameter by 8½-in. face; combined lateral travel of sliding heads, 3½ in.; greatest opening between disk wheels, 24 in.; between ring wheels, 20 in.; capacity of lubricant tank, 70 gal.; over-all dimensions, 95 x 51 in.; weight, exclusive of wheel press, countershaft or grinding wheels, 5000 lb.

the desired position. Hardened and ground collars are placed on the outer end of each spindle. The cast-iron hoods are fastened to the sub-base. The sliding heads work through felt-lined holes in the hoods. The sub-bases are moved by means of the two rack and pinion mechanisms shown. The work is fastened to the sliding work table, shown at the center of the machine, and is moved in and out between the wheels by means of a rack and pinion movement controlled by the lever at the left of the table. This lever may be mounted at the right, if desired. The sliding heads are moved toward the work by means of the foot treadle or the lever at the left, the coil spring serving to back off the heads when the pressure is removed. A micrometer stop screw is used to limit the motion of the heads, and a back stop screw is also included. If so desired, either head may be locked in position, one head only being moved. Guards are used on all gears, but they have been removed from the machine illustrated, in order to show the construction and type of the various gear controls. A wheel press and countershaft are included with the machine, if these are desired.

Roll Straighteners and Shears

Kane & Roach, Syracuse, N. Y., have placed on the market several new machines for straightening and shearing round stock.

Fig. 1 shows one of a line of four hot roll straighteners. These machines will handle material at the rate of 20 to 25 ft. per min. and may be arranged for either belt or motor drive. The tables at each end are 15 ft. long and may be adjusted for different sizes of material run. Guide boxes and guides are placed between the rolls to suit the various sizes of stock. Either independent or universal adjustment of the rolls may be had.

Fig. 2 shows the automatic straightener and shears with dumping table for handling material from $\frac{1}{32}$ to $\frac{1}{8}$ in. thick and from 3 to 10 in. wide. The machine takes the material from the coil, straightens it, cuts it

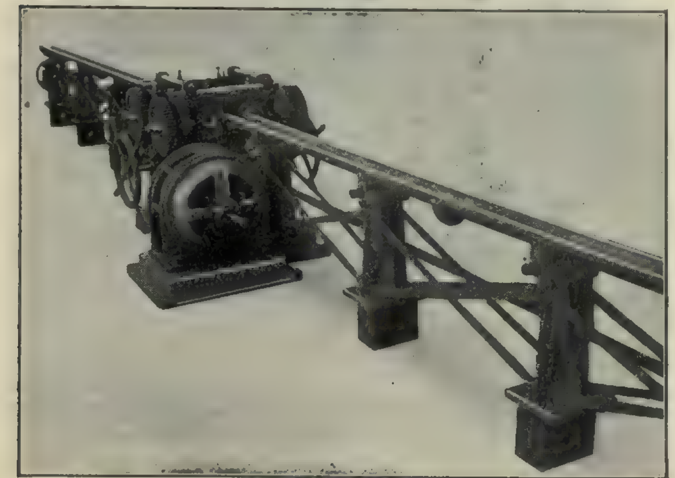


FIG. 1. HOT ROLL STRAIGHTENER

Made in four sizes with capacities for round stock as follows: $\frac{1}{2}$ to $1\frac{1}{2}$ in., $\frac{3}{8}$ to $2\frac{1}{2}$ in., 1 to $3\frac{1}{4}$ in., 2 to 5 in.; length, 36 ft.; weight, $7\frac{1}{2}$ to 8 tons

to length and dumps it automatically. Once started, the entire operation is automatic as long as there is any material in the rolls. The work is handled at the rate

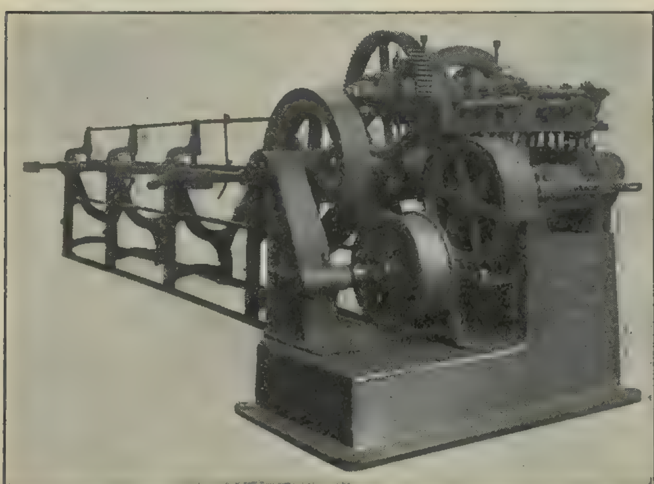


FIG. 2. AUTOMATIC STRAIGHTENER AND SHEARS FOR FLAT STOCK

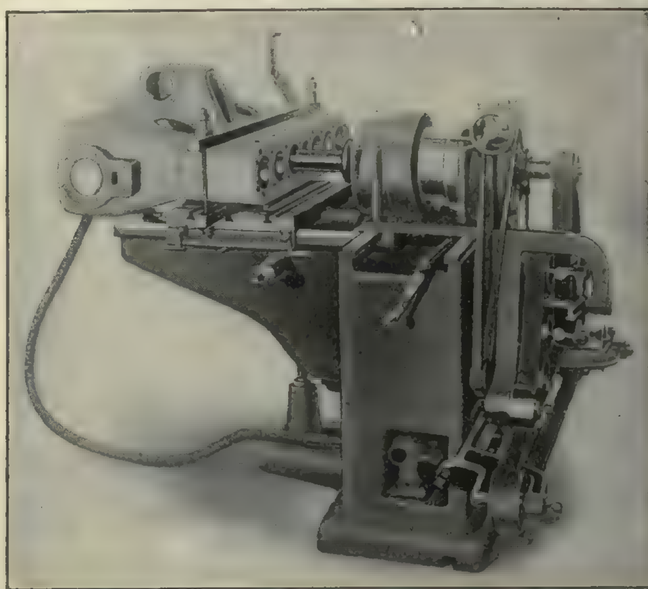
of from 100 to 125 ft. per min. The stock may be of copper, steel, brass or other material.

Cylinder Grinder

In order to provide a machine for garage use in regrinding automobile cylinders, the T. C. Olsen Machine Co., Madison, Wis., is now manufacturing the machine shown in the accompanying illustration.

The head containing the grinding spindle has a double eccentric adjustment that allows the grinding wheel to be moved from the center to the maximum grinding diameter. A micrometer adjustment is used for the eccentric. The forward and backward motion for the feed is secured by a movement of the table, while the adjustment for grinding the various cylinders in the same block is by means of the cross-slide on which the spindle is mounted.

The feed is automatically reversed at the end of each travel by an adjustable device. A belt-tightening device



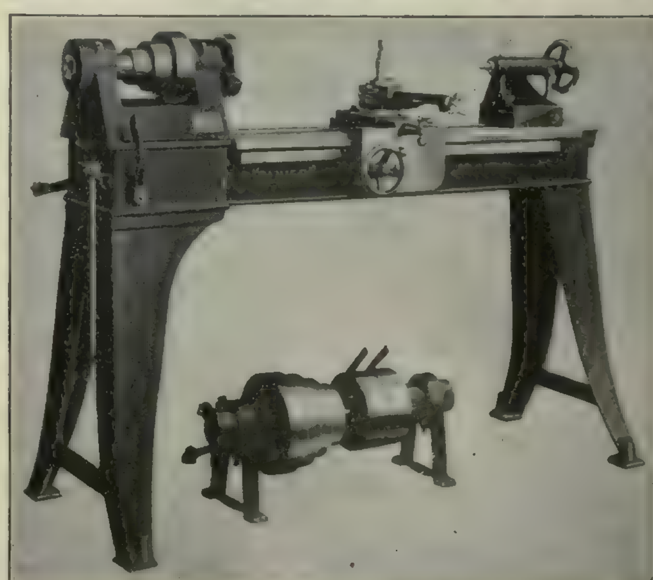
CYLINDER GRINDER

Minimum size of cylinders, $2\frac{3}{8}$ in.; maximum with 5-in. wheel, 8 in.; length, 15 in.; adjustment of spindle, 27 in.; maximum distance table to spindle center, 9 in.; minimum, 3 in.; diameter of extended spindle, $2\frac{1}{4}$ in.; spindle speed, 5000 r.p.m.; rotary speed of head, 28 r.p.m.; feed, $\frac{1}{8}$ and $\frac{3}{16}$ in.; head boxes, $7\frac{3}{4}$ in. in diameter, 4 in. long; spindle bearings, 6 in. long; floor space, 64 x 56 in.; height, 44 in.; weight, 1600 lb.; horsepower required, 3

keeps an even tension in the belt regardless of the position of the head on the bed. An apron, not shown, covers the ways and protects them from emery dust and dirt.

Speed Lathe

A 12-in. speed lathe is now being marketed by the Oliver Machinery Co., Grand Rapids, Mich. The spindle runs in split bronze bushings, and lubrication is by means



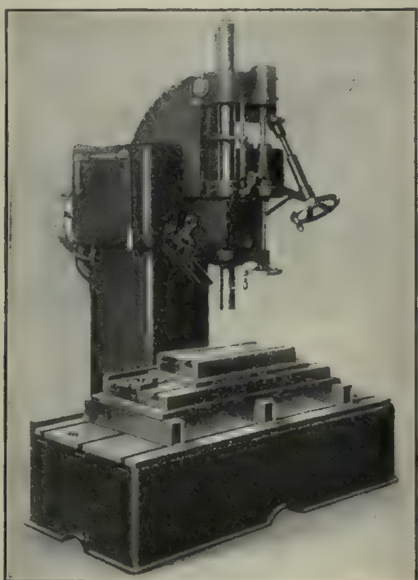
SPEED LATHE

Bed, 60 in. long; distance between centers, 36 in.; swing over bed, 12 in.; swing over carriage, $9\frac{1}{2}$ in.; cone-pulley steps, 3, $3\frac{3}{8}$ to $6\frac{1}{2}$ in. in diameter, $1\frac{3}{4}$ in. wide; speeds, 700 to 2800 r.p.m.; travel of carriage, 37 in.

of ring oilers. The hole through the spindle is $\frac{5}{8}$ in. in diameter. The inside edges of the bed act as ways for the carriage and tailstock, the top being machined flat. A hand feed carriage and a compound swivel rest are regularly furnished. The tailstock is of the set-over type for turning taper work. Two brackets are provided at the rear for supporting a tool rack. The machine can be equipped for either belt or motor drive, as desired.

Jig Boring Machine

The machine illustrated has been recently placed on the market by the Medina Machine Co., Medina, Ohio, and is listed as its universal spacing machine. The base has three T-slots for clamping the work, and a



JIG BORING MACHINE

Diameter of spindle, $3\frac{1}{2}$ in.; spindle traverse, 14 in.; column to center of spindle, 18 in.; working size of base, 27 in. by 6 ft.; working size of large platen, 22 x 48 in.; working size of small platen, 16 x 18 in.; eight spindle speeds, 54 to 414 r.p.m.; four power feeds, 0.006 to 0.032 in.; floor space, 6 ft. $1\frac{1}{2}$ in. by $49\frac{3}{4}$ in.; weight of machine, 8000 lb.

raised strip at the rear against which gage blocks may be set. The large platen is also provided with three T-slots and has two of its edges planed square and equipped with hardened strips, which are intended to bear against the gage blocks. The small platen is of similar construction, except that only two T-slots are used.

The gage-block stops fit the T-slots in either the base or the large platen and have hardened faces. An adapter gage is used, giving spacings up to $\frac{1}{4}$ in.; for amounts above this, gage blocks are provided, the lengths of which are $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1, 2, 3 and 4 in. Spacing may also be done with Johansson gage blocks.

Lathe for Buffing and Polishing Work

The machine illustrated has been placed on the market by the Noble & Westbrook Manufacturing Co., Hartford, Conn., and is known as the "Vibrationless" buffing lathe. The spindle is of crucible carbon steel, and the adjustable bearings are of cast iron. In manufacturing this machine the intent of the makers has been to provide a lathe on which unbalanced grinding or polishing wheels will automatically find and revolve on their centers of gravity, thereby running as true as a

POLISHING AND BUFFING LATHE

balanced wheel. The machine is of cabinet-base type and may be belted either from above or from below.

REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of American Machinist, published weekly at New York, N. Y., for April 1, 1917.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Assistant General Manager of the McGraw-Hill Publishing Co., Inc., Publishers of American Machinist, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher, McGraw-Hill Publishing Company, Inc., 10th Ave. at 36th St., New York, N. Y.

Editor, John H. Van Deventer, 10th Ave. at 36th St., New York, N. Y.

Managing Editor, John H. Van Deventer, 10th Ave. at 36th St., New York, N. Y.

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2. That the owners are:

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Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Bondholders, James H. McGraw, Arthur J. Baldwin, Henry W. Blake, Imogene Whittlesey, Hugh M. Wilson, Fred R. Low, Fred S. Weatherby, John McGhie, G. Eugene Sly, Estate of John A. Hill.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE,
Assistant General Manager, McGraw-Hill Publishing Co., Inc.

Sworn to and subscribed before me, this 31st day of March, 1917.

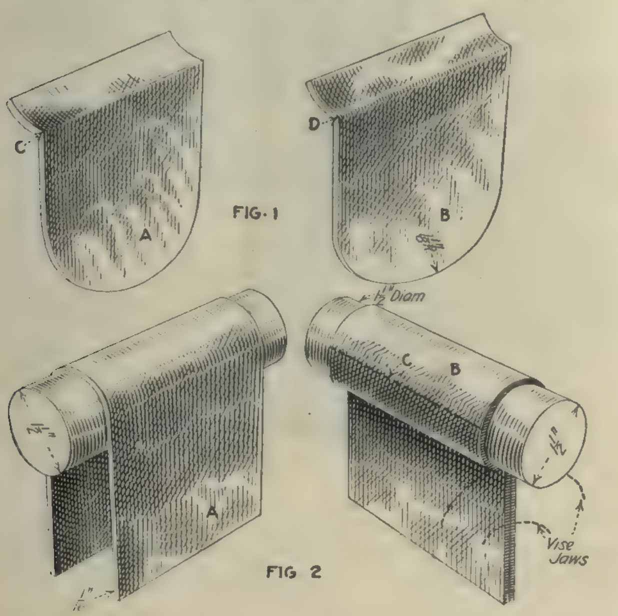
PHILIP S. HILL.

[Seal.] (My commission expires March 30, 1918.)

Forming an Awkward Radius in Sheet Steel

By Hugo F. Pusep

On page 178, W. D. Forbes shows a piece of formed sheet steel, the duplication of which at first looks very simple; but after reading the article a few times, the problem of getting that particular shape had me puzzled. At *A*, Fig. 1, is an exact duplicate of the piece described by Mr. Forbes, and the difficulty is the forming of the sharp corner *C*, which even in soft annealed stock would be an almost mechanical impossibility if we take the word "forming," as applied in this instance to $\frac{1}{16}$-in. sheet steel, at its correct meaning. Now if the piece had been as shown at *B*, Fig. 1, with a radius at *D*, then, provided the unannealed sheet steel was not very brittle, it would be possible to produce the piece in the time specified, which is about an hour and a half.



FIGS. 1 AND 2. AWKWARD-SHAPED PIECE OF SHEET STEEL AND A METHOD FOR ITS PRODUCTION

In Fig. 2 is shown how I would do the job if the above-mentioned sharp corner were eliminated and the stock soft enough to bend without cracking. Procuring a short piece of round stock $1\frac{1}{2}$ in. in diameter and a piece of sheet steel of the correct width, I should bent it to the form *A*, Fig. 2. By gripping it in a vise, as shown at *B*, I should get the form desired. All that would then be necessary would be to cut at the dotted lines *C* and file the $1\frac{1}{2}$-in. radius. For measuring the $\frac{3}{4}$-in. radius I should take a good $1\frac{1}{2}$-in. lathe mandrel, coated with a very small quantity of prussian blue, which would show clearly to a thousandth of an inch the amount the $\frac{3}{4}$-in. radius was oversize. It could not possibly be undersize on account of the stock springing back, unless it was hammered after the removal of the forming arbor.

Lubricant for Cutting Steel Gears

By J. A. Raught

On page 254 Emil Daiber asks for the best lubricant for cutting cast- and tool-steel gears on the Fellows gear shaper. After considerable experimenting with different commercial cutting compounds, and some of my own make-up, I find that a mixture of lard oil and white lead has no equal as a cutting compound on steel. I find that by its use in taper reaming and similar work, the cutters stay sharp longer and leave a smooth bright finish.

Obituary

H. J. Grover, sales manager of the small-tool department of the Brown & Sharpe Manufacturing Co., died on Mar. 29, 1917.

James Arthur Distin, assistant general manager of the Halcomb Steel Co., Syracuse, N. Y., died on Saturday, Mar. 31, as the result of an automobile accident. He was 36 years of age. After being graduated from Syracuse University in 1905 he entered the laboratory of the Sanderson Works and later went to the order department. In 1908 he joined the sales department of the Halcomb Steel Co. and advanced rapidly to the position that he held at the time of his death. He is survived by a widow and son.

Business Items

A. J. Corcoran, Inc., now at 761 Jersey Ave., Jersey City, will remove its offices to 11 John St., New York City, on May 1.

The Egyptian Iron Works is the new name of the former Southern Illinois Machine and Foundry Co. The change became effective Apr. 1.

Edgar M. Moore & Co., dealers in electrical and steam machinery, railway equipment, etc., erroneously reported to have changed their business name and address, are still doing business at 709-10 Farmers Bank Building, Pittsburgh.

Associated British Machine Tool Makers, Ltd., is the name of a private company with a capital of £100,000, recently formed by 10 British firms for the purpose of furthering the exportation of British machine tools. The 10 firms concerned are: Lang & Shanks, Churchill Machine Tool Co., Ltd., George Richards & Co., Kendall & Gent, Smith & Coventry, Asquith & Butler and Ward & Archdale. The new firm has offices at 34 Victoria St., London, S. W.

Personals

W. J. Hill has recently concluded arrangements to represent Ogden R. Adams, Rochester, N. Y. **R. M. Bateson** has assumed a like position.

G. M. Strombeck, for several years designing engineer for the Root & Van Dervoort Engineering Co., has resigned to join the Strombeck-Becker Manufacturing Co., also of Moline, Ill.

H. P. Eilers, formerly with Manning, Maxwell & Moore, Inc., has opened an office in the Singer Building, New York City, where he will handle machine tools for domestic and export trade.

Robert L. Arms, formerly connected with the sales department of Manning, Maxwell & Moore, has associated himself with Sherritt & Stoer Co., Inc., Philadelphia, as assistant to the general manager.

F. E. Russell, president and general manager of the Etna Foundry and Machine Co., Warren, Ohio, has sold his interests and will retire on account of poor health.

Forthcoming Meetings

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The National Metal Trades Association will hold its next convention on Apr. 25 and 26 at the Hotel Astor, New York City. A meeting of the administrative council of the association will be held on the day preceding that on which the convention opens.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month. Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The Society of Automobile Engineers, whose name will be changed next month to Society of Automotive Engineers, has been arranging for the most elaborate summer meeting in its history, including events and presentation of technical matter connected with aircraft, watercraft and farm tractors as well as motor cars. The various committees, including the meetings committee, of which David Beecroft is chairman and the papers committee, which is conducted by H. G. McComb, have well-advanced plans that can be put into final effect quickly as soon as it shall be known whether it will be possible or advisable to hold sessions of the scope intended. Meantime, announcement of the time and place of the meeting is being withheld pending development of international conditions, with the thought that in the event of untoward results in this respect the society shall be as untrammeled as possible with plans interfering in any way with direct work for the nation.

American Aircraft Development

By Fred H. Colvin

SYNOPSIS—Some of the air and sea planes which are now being built in this country for use both in our own army and navy and in those of our allies on the other side.

Those who have followed the development of aircraft during the few short years of the existence of heavier-than-air machines that actually fly, cannot fail to be impressed not only with the wonderful feats that are being accomplished every day, but also with the mechanical development that makes such accomplishment possible. In contrast with the earlier machines, made for the most part of bamboo or similar material, fastened together with crude connections and with wire-wound joints, the modern airplane is both startling and interesting. Wings, ribs and struts are now very largely standardized and are being manufactured on a commercial basis, as can be seen by a visit to any of the large factories building airplanes.

One builder, the Sturtevant Co., is using steel longerons or framework for the fuselage, or body, and pressed-metal ribs and struts for ailerons, elevating planes and rudders, with the full intention of extending this metal construction to the entire frame of the plane in the near future. The L. W. F. fuselage also contains a large number of steel braces which add greatly to its rigidity and strength. The general design of machines is more businesslike in every way; and the number of machines, motors and other accessories exhibited at the first Pan-American Aëronautical Show in New York indicates that the new industry has not only come to stay, but that it is growing very rapidly.

In addition to the advent of the new machine a new nomenclature has also come into being, which must be learned by those who would keep abreast of all mechanical developments. And in spite of the fact that the first successful heavier-than-air machine was designed and developed in this country, nearly all these terms come from France, owing probably to the fact that, although not the first in the field, the French, unhampered by patent litigation, have developed the airplane more actively than any other country. As a result we have now in common use such terms as *hangar,* the house or tent or shed that protects the airplane from the weather; *fuselage,* or body; *aileron,* the movable part of the wings, which enables the aviator to maintain his balance; and *nacelle,* an extension in front of the body proper for an observer or gunner. These are only general terms, and there have been developed a host of technical terms dealing with the design and construction, which require considerable time and patience to master unless one is directly engaged in the building of aircraft.

The Problem of the Motor

Although the developments that have taken place are perhaps more noticeable in the case of the planes themselves, these are no more radical than the progress in the motors that make mechanical flight possible. These motors have been greatly improved, not so much by a reduction in weight as by improvements in design and workmanship, so as to allow the motors to generate full power over a long-continued period.

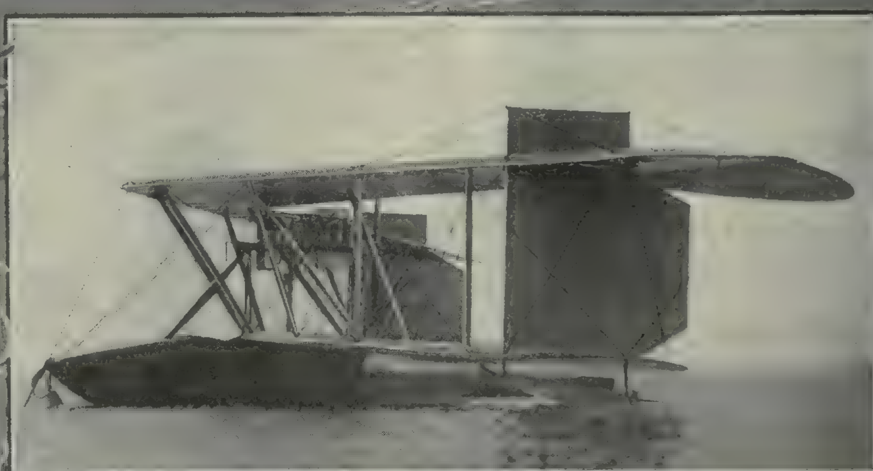
In order to understand thoroughly the airplane-motor problem, it is necessary to consider the vast difference

CURTISS TWIN-MOTOR MILITARY TRACTOR

WRIGHT-MARTIN MILITARY TRACTOR

BURGESS-DUNNE FLYING BOAT

L. W. F. MILITARY TRACTOR

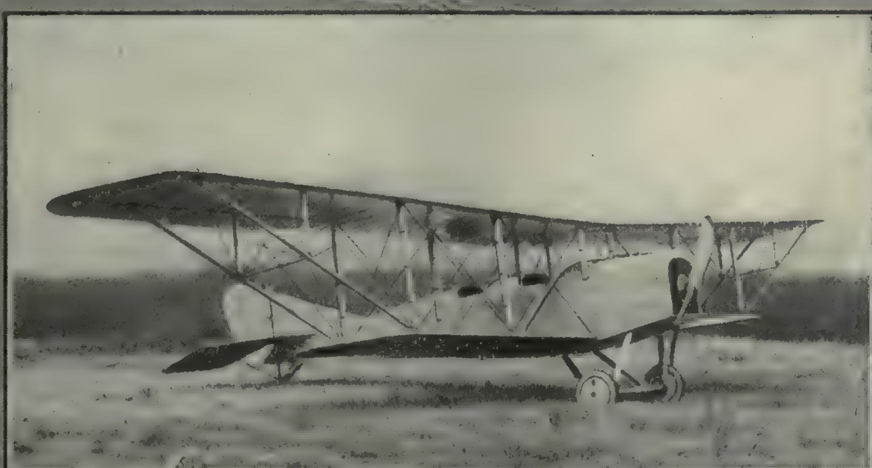


BENOIST MILITARY TRACTOR

CURTISS FLYING BOAT

THOMAS MILITARY TRACTOR

STANDARD MILITARY TRACTOR



between the service demanded of an automobile motor and of the motor in an air machine. In ordinary touring the average automobile motor loafs along, using only from 10 to 25 per cent. of its maximum power, and it is seldom that full power is maintained for more than a very few minutes. The only exception to this is in the case of racing cars in long-distance events, and we are all familiar with the large number of motor accidents that put racing cars out of commission after a few hundred miles. With the airplane motor, on the other hand, full power must be exerted a large proportion of the time; for it must be remembered that the heavier-than-air machine will not stay in the air at low speed and that nearly all flying is done with a wide-open throttle.

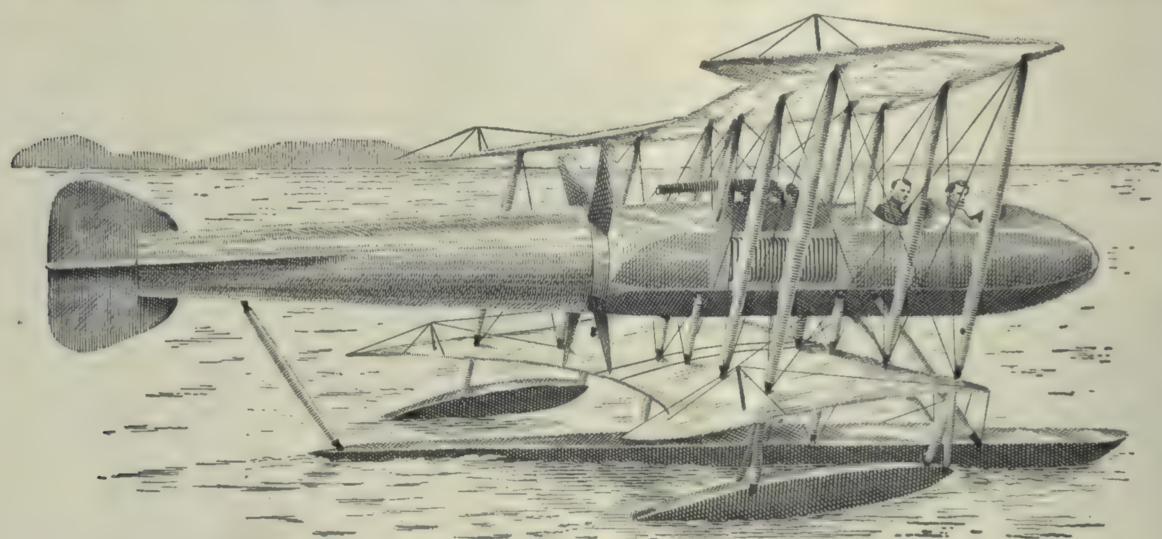
This requirement also emphasizes another important fact about aviation, in which it differs from any other form of locomotion. The student of the automobile can learn to handle his machine by driving as slowly as he desires until he has thoroughly mastered the steering, gear shifting and other motor intricacies. The student of aviation, however, must learn all the preliminaries with a machine that cannot leave the ground, owing to its small wing surface. He begins by driving it back and forth over a level field, learning his controls and trying to imagine what he could do in the air. This is called "taxi-ing" or "grasshoppering."

His first air flights are with an instructor; but when he actually takes hold of the machine himself, he cannot take the air slowly, but must be traveling at least 40 miles an hour and in the case of the small high-speed machine at a much higher rate. Worse than this, he must make his landing at a speed at least as high as when he leaves the ground. This means that in most cases he is traveling from 40 to 50 miles an hour when he touches earth, and in the case of the small scout machine he is probably traveling at least 60 miles per hour. Realizing this, we cannot fail to have the utmost admiration for the successful aviator, who drives at will and successfully brings his machine back to earth.

The past two years have developed the airplane at a tremendous rate; and although it has all been from a military point of view, the improvements that have been made, both in speed and in weight-carrying machines, will find their field in peaceful pursuits in the years to come. We do not know, and we shall not know until the war is over, just what these developments have been. We do know, however, that small scout planes are attaining a speed of 140 to 160 miles per hour; that huge seaplanes have been built carrying four motors of 250 hp. each and having a lifting capacity of over six tons in addition to the weight of the airplane itself.

The high speed of some of the foreign scout machines is largely due to the reduction of weight, and strength, beyond what we in this country consider safe practice. We use a factor of safety of 6 to 8 while some of theirs are said to come below 3.

Motors are built with six, eight and twelve cylinders and in some cases develop as high as 35 hp. per cylinder, although the average is considerably below this. The motors run from 100 to as high as 250 or 300 hp. in a single motor, there being few machines today equipped with motors of less than 100 hp. Motor speeds are for the most part dependent upon the best speed of the propeller, which ranges from 1250 to 1400 r.p.m.



THE GALLAUDET TWIN-MOTOR SEAPLANE

In order to reduce motor weight, higher speeds are being used; and as a consequence the propeller shaft is geared down so as to secure the correct propeller speed. There are several ingenious methods of doing this, the most novel being that used in the Gallaudet machine, illustrated above. Here the four-bladed propeller is mounted on an annular ring, which revolves on a large ball bearing in the fuselage directly behind the wing, or plane. The motor is geared into an annular gear securing the proper propeller speed. This design maintains the full streamline of the fuselage and also eliminates the inefficient area of the propeller as usually built.

All the machines illustrated have motors of either the vertical or the V type. Many of the small scouting machines used on the fighting front in France are equipped with the Gnome type of motor, in which the cylinders revolve with the propeller. This motor requires extremely accurate workmanship, but gives high power with low weight and has been very successful for small high-speed machines. A description of this motor will appear later.

The various types of motors, while developing along somewhat similar lines, have interesting mechanical

distinctions. Aluminum has entered largely into the construction of airplane motors in order to reduce weight, and some motor builders are now using aluminum cylinders with cast-iron liners to provide the bearing surface for the piston and its rings. In some cases the lining is of fairly high carbon steel, either in the form of a tube or a sleeve bored from a forging, as in the case of the Sturtevant motor. The cylinder of the new Curtiss motor is built up of an inner and outer steel shell, the space between forming the water jacket. In the Van Blerck motor, pressed steel has replaced aluminum almost entirely for the cylinder base and crank case.

Hollow crankshafts and camshafts, tubular connecting-rods and those which are milled to a very light I or H section, tend to produce lighter parts. Aluminum pistons are quite frequent, although the Gnome motor, which is probably the lightest weight per horsepower, uses a high-grade cast-iron piston with remarkably thin walls.

Lubrication, which is the life of a motor developing its maximum power, is an essential feature and is given careful attention. Forced lubrication is used in every case, the oil sump being so located that it will always be filled with oil no matter what the position of the motor, except of course when it is temporarily upside down in looping or similar maneuvering. Both geared and piston pumps are used, although the simplicity of the old geared pump makes it much in favor.

A Fast Scouting Machine

Coming now to the airplanes themselves, perhaps the latest and most striking development is pictured at the beginning of this article. It is the Curtiss tri-plane scout, which is one of the fastest machines yet developed in this country. It has a total wing spread of 25 ft. and an overall length of 19½ ft., while it stands less than 9 ft. high. The wings are only 24 in. wide, with a gap of 30 in. between them, giving a total supporting surface of 142.66 sq.ft. The motor is a Curtiss model OXX of 100 hp. at 1400 r.p.m., and with cylinders 4¼ x 5 in. The empty machine weighs but 970 lb.; its flying weight with 25 gal. of gasoline, 4 gal. of oil and an allowance of 165 lb. for the pilot, is 1320 lb. It has a maximum speed of 115 miles per hour and a minimum of 55 miles per hour. Under normal conditions it is able to leave the ground in less than 300 ft. and can climb 9000 ft. in 10 min. Its fuel supply will carry it about 2½ hours at maximum speed, or a distance of very nearly 300 miles.

Another unique machine is the Burgess-Dunne flying boat. It combines the boat body with the Dunne type of wings, which secure inherent stability by the sweeping back of the wings to a considerable angle. This construction eliminates the use of a tail and rudder, steering being accomplished by the use of ailerons on the ends of each upper wing. This machine, as illustrated, has a wing span of 53 ft., a total length of 25 ft. 2 in. It will carry a live-load of 560 lb., has a 100-hp. Curtiss motor and will travel from 43 to 68 miles per hour. It carries three people and full load for 3 hours.

The Standard airplane shown is of the tractor type, which means that the propeller is in front and pulls the machine along. Here, both planes are 40 ft. 1 in. long, 6 ft. 6 in. wide and the same "gap," or distance, between the planes; the overall length is 27 ft. These wings have a "sweep back" of 10 deg., a "dihedral," or upward, angle of 3 deg. and a "stagger" (the front wing projecting over the lower wing) of 15 in. The wing area is 491 sq.ft., with ailerons on both upper and lower planes. A Hall-Scott 135-hp. motor is used. The weight of the machine, including motor and fuel for one hour's flight, is 2700 lb.; besides this it will carry a useful load of 800 lb.

The Curtiss twin-motored tractor has been developed primarily for military purposes. It weighs but 2110 lb. empty, but can carry a useful load of over 1000 lb. The power plant consists of two Curtiss eight-cylinder motors, each developing 100 hp. These give it a maximum horizontal speed of 85 and a minimum of 48 miles per hour with a climbing speed of 400 ft. per min. It will also fly and climb with one motor. The front cockpit is for a gunner, giving him a wide range of vision and a wide angle of fire. This front portion of the fuselage is called the nacelle.

The effect of two propellers turning in opposite directions is to equalize torque and gyroscopic effect. The use of two motors allows a greater power without resorting to extra-large propellers or to excessive propeller speeds. The gasoline consumption is 20 gal. per hour.

The Thomas machine is a tractor biplane having a wing span of 37 ft., a total length of 25.5 ft., wing cord, or width, 5 ft. 3 in., with a gap or distance between wings of 5 ft. The total lifting area is 401.4 sq.ft., with a loading of 5.6 lb. per sq.ft. The empty machine weighs 1500 lb. equipped with a Thomas 135-hp. eight-cylinder motor. It will carry fuel for a 4-hour flight, one passenger and the pilot and a useful load of 350 lb. besides. The speed range is from 40 to 90 miles per hour, with a maximum gasoline consumption of 14 gal. per hour; oil, 1½ gallons.

For Military Reconnoissance

The Wright-Martin tractor also carries two people and is designed for land reconnoissance work. The upper plane is 50.7 ft. and the lower 36.9 ft., with a width of 5.5 ft., a gap of 6 ft. and a stagger of about 14 in. The overall length is 26.7 ft. and the height 11.3 ft. There is a slight dihedral angle of 1 deg., the total supporting area being 458 sq.ft., with a loading of 6.25 lb. per sq.ft. The weight of the planes without motor is 1107 lb.; the 150-hp. motor, propeller and accessories, 798 lb.; gasoline and oil for 4¾ hours' flight at full power, 480 lb. The speeds are from 47 to 90 miles per hour, with a climbing speed of 350 ft. per minute.

The Gallaudet hydro-airplane (seaplane in England and much more easily said) is a novel machine, as previously mentioned. Its wing spread is 48 ft., with a width of 7 ft., giving a 48-ft. area of 602 ft. The total length is 33 ft. There are two four-cylinder motors built by Dusenburg, which develop 140 hp. each (35 hp. per cylinder); and though this particular machine is extra heavy, weighing 4600 lb., a speed of 91 miles per hour was attained at the official navy trial. Great efficiency is also claimed for the four-bladed propeller, which is 9 ft. 6 in. in diameter.

The Benoist military tractor has an all-steel fuselage. The wings have a spread of 45 ft., a width of 5 ft. and a gap of 6 ft. with no sweep back or rake, no dihedral angle and no stagger. The length is 28 ft., the motor is a 100-hp. Roberts six-cylinder, two-cycle, vertical and water cooled. The complete machine weighs 1300 lb. and can

carry a useful load of 600 lb. With this load it will climb 250 ft. per min. and fly at speeds of from 40 to 65 miles per hour.

The fuselage of the L. W. F. machine is of the monocoque or one-piece type, being made of laminated wood. The spread of the upper plane is 48 ft. and the total length of machine is 26 ft. The motor is either a Sturtevant or Thomas 140 hp. It weighs about 2000 lb. and with a standard Government load of 1000 lb. it climbs 375 ft. per min. and has flown from 45 to 93.8 miles per hour on Government tests.

The Curtiss flying boat is known as model F. The upper plane is 45 ft. 2 in. and the lower plane 35 ft. long. The width of wing is 62 in. and the gap 71 in., neither stagger, sweep-back or dihedral angle being used. The total height is 9 ft. 8½ inches.

The total supporting surface is 420 sq.ft., the loading being 5 lb. per sq.ft. of supporting surface. The motor is an 8 cylinder, 100 hp., consuming 9 gal. of gasoline per hour.

The hull is 24 ft. 7 in. long, 4 ft. 7 in. wide, and 3 ft. 7 in. high. The weight of machine is 1440 lb., or with 660 lb. useful load, 2100 lb. With this it has a normal climbing speed of 150 ft. per min. and a flying speed of from 45 to 65 miles per hour in the air. These flying boats can also skim the surface of the water at high speed.

An Edge-Rolling Machine for Sheet-Steel Work

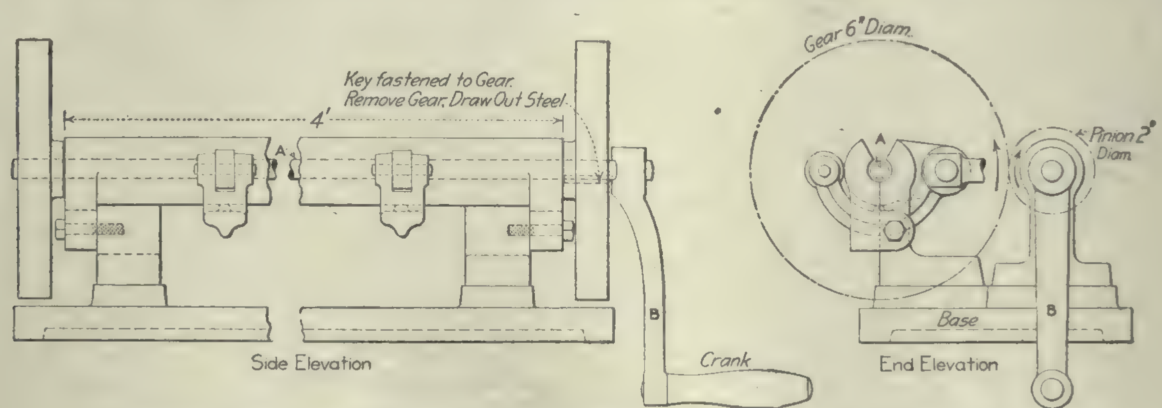
By G. A. Aduddle

The illustration is of a machine that rolls the edges of steel shelves, burner box corners and top rails on cabinet gas ranges. These rolled edges not only enhance the appearance of a range, but they also obviate the use of a lot of nickel bands which after a short time, unless extra care is taken to keep them clean, become tarnished and make the stove look cheap.

The cost of making these parts is reduced to a minimum as it is only necessary to japan them to get a nice finish that will conform to the other parts of the stove in appearance.

The machine is operated by hand. The operator inserts the edge of the steel to be rolled in the slot which runs the full length of the $\frac{7}{16}$-in. rod *A*, and turns the handle *B* three complete turns. As the gearing is 3 to 1, the handle can be turned without much exertion. When the forming of the rolled edge is finished, the operator removes the large gear keyed to the forming rod, and the rolled piece is easily withdrawn. Owing to the spring of the steel, it opens to $\frac{9}{16}$ in. in diameter outside. By replacing the large gear on the forming rod and meshing it with the pinion gear on the handle, the machine is again made ready for work.

It must be understood that some of the parts of the same range have different-sized rolled edges for which, of course, another machine of the correct dimensions is employed.



THE EDGE-ROLLING MACHINE FOR STEEL SHELVES, BOX CORNERS AND SIMILAR WORK

Suggestions Relative to the Manufacture of Parts to Limits

By F. H. Bogart

SYNOPSIS—It is generally admitted that the war has exerted and will continue to exert an influence for the better upon manufacturing in general. The use of limits and limit gages so indispensable to munitions manufacture is just as applicable to other branches of production. Their use, however, must be controlled by intelligence, otherwise they are a hindrance and an expense.

The distribution of small subcontracts for munitions components among a number of manufacturers has brought to many of them their first experience in the manufacture of interchangeable parts to limits. Many of these manufacturers have now learned from direct experience what the leading automobile and parts manufacturers learned some years ago—that the greater initial expense for special equipment and small tools necessary to produce parts to the required degree of accuracy to meet limit gages, is more than offset in the economy and uniformity of production once the manufacturing processes are well organized and under way. The natural result will be that a great many small plants that have previously looked upon this rather disconcerting preliminary investment as prohibiting them from manufacturing by this method, will from now on adopt the interchangeable principle in the manufacture of their regular product.

The experience of a majority of these manufacturers has been limited to the production of munitions parts of which the detail drawings, with all the dimensions and limits determined, were furnished them complete. The task of changing over the separate units or components of their own product preparatory to manufacturing to limits and presumably with the use of limit gages, will therefore call for a knowledge of certain details which might not be learned until numerous mistakes had been made, and these mistakes corrected only after repeated revisions, with resultant delay and financial loss. It seems timely, therefore, to suggest a few points that may prove of assistance.

Steps Involved in a Change

The change from hit-or-miss production to interchangeable manufacture involves at least four distinct steps, as follows:

1. A classification of the dimensions on the working drawings.

2. The selection of a method of expressing both the dimensions themselves and the allowable variation from those dimensions.

3. The selection of a working point or base line on every separate part, from which point or line all dimensions in the same group must originate.

4. The determination of the limits allowable to meet the conditions in every instance.

Nos. 1 and 2 amount to the adoption of rules of drawing-room practice that once determined upon become a fixed method for that particular plant and require no continued attention. Nos. 3 and 4 have to be determined for every separate piece that it is proposed to manufacture by the interchangeable method.

The classification of the dimensions on the working drawings involves a separation on the detail prints of the parts or components to be manufactured—of the essential from the nonessential dimensions. The term "essential dimension" has come into use as descriptive of the specification of those parts of a manufactured component that come in contact with, or fit into or around, another component with which it is later to be assembled. Obviously, nonessential dimensions are the specifications of parts of the component that bear no important relation to any other part either of itself or an adjacent part with which it is later assembled. A careful study of the relation of every part to the assembled unit, and the separation of every dimension into these two classes is very important, because it establishes the points where it is going to be necessary to work close and eliminates from two-thirds to three-quarters of the dimensions on the average manufactured part from the careful analysis required of the essential dimensions.

It is equally important to indicate clearly on the detail drawings of every part the distinction between the essential and nonessential dimensions, and it is almost universal practice to do this, but by varying methods.

Requirements for Expressing Dimensions

The first requirement, therefore, of an adequate method of expressing dimensions for interchangeable manufacture is to enable the person reading the drawing to distinguish at a glance which of the dimensions are essential and which unimportant. Probably the method in most general use at present is to determine what should be an ample allowance for excusable errors in rapid production under average conditions. On such parts as ordinarily come under the classification of light manufacturing, the usual tolerance is 0.020 in.; or where fractions are adhered to, $\frac{1}{32}$ in. Once the tolerance has been determined as meeting conditions in a particular line of manufactured parts, every nonessential dimension on the details of those parts will specify this tolerance as a working limit. On a drawing dimensioned after this method, a measurement of 2.125 in. plus or minus 0.002 in. would be identified at a glance as essential, but 2.125 in. plus or minus 0.010 in. would as easily be identified as nonessential.

This method has the disadvantage that it really sets up as definite a limit on these supposedly nonessentials as on the most particular dimensions. From time to time parts will be machined slightly outside even this wide allowance, or cast parts and forgings at points not requiring finish will be found outside the limits. The production man or inspector must then decide from some source of information other than the detail print whether such parts are O.K. or must be rejected.

A method in quite common use among automobile manufacturers is to mark *a* after the essential dimensions, indicating that such must be accurate. Just what

degree of accuracy is required is not always specified, but some stamp a note on each drawing, stating that "dimensions marked *a* must be machined as closely as possible to the figures given." This method has one very apparent defect. It leaves to the judgment of every individual under whose supervision the parts manufactured to such prints must pass, the determination of what is required by the specification to work "as closely as possible" to the dimensions given, with the probability of a wide difference of opinion. In effect, it puts parts so dimensioned outside the requirements for interchangeability, by assuming that a sufficiently close degree of accuracy will be adhered to at each stage in production to meet the necessary requirements. There is no basis for such an assumption nor any way of fixing responsibility for trouble resulting from failure to specify definitely at the outset.

Essential and Nonessential Dimensions

A third method that is fast gaining favor and adoption is to specify the essential dimensions to three decimal places, or as some say in thousandths of an inch; the nonessentials in whole numbers and fractions. Thus, a shaft $2\frac{1}{8}$ in. in diameter would be dimensioned 2.125 in. if the dimension were essential, and $2\frac{1}{8}$ in. if nonessential. An even dimension like 2 in. becomes 2.000 in. if it is an essential dimension. The fact that no essential dimension is ever absolute, but always has certain fixed limits of allowed variation, makes it possible to express nearly every essential dimension in not more than three figures of decimals. For instance, $2\frac{1}{16}$ in. would ordinarily be written 2.0625 in. But allowing a tolerance of 0.003 in. the dimension could be written in any one of these ways: 2.0625 in. plus or minus 0.0015 in.; 2.063 in. plus 0.001 in. minus 0.002 in.; or 2.064 in. minus 0.003 in., each successive method of expressing the same thing being more easily understood at a glance.

There are exceptions to the use of only three decimal places, of course, such as hardened and ground parts requiring a very high degree of accuracy, and parts assembled by force or shrink fits. But these would comprise only a very small percentage of the average product, and on all tool-finished metal parts 0.001 in. is the smallest practical working limit, and no lesser division of an inch should be found on a working drawing. Drawings dimensioned in this manner usually bear a note explaining the distinction in dimensions, and specifying that where unimportant surfaces are machine-finished, a variation of not more than plus or minus 0.010 in. from the dimension given is desirable.

As previously stated, every essential dimension must allow the production department some tolerance, which is definitely fixed by assigning to each dimension of this class certain working limits. The method of expressing these limits is beginning to vary considerably. Up to within a short time it was well-nigh universal practice to specify the maximum and minimum dimensions outside which the measurement at that point must not go in any case, by allowing a definite variation both above and below the absolute dimension. This is commonly called the "plus or minus limit" and is expressed by writing the allowed variation in thousandths after the absolute dimension, and prefixing the plus and minus sign. Thus 2.125 in. $\pm$ 0.003 in. fixes 2.122 in. and 2.128 in. as the minimum and maximum dimensions respectively, and limits the range of variation on that particular dimension, on every part that may be produced, to some point inside these two figures.

While this method has been very commonly used, it has many disadvantages. For one thing, it forces those that may be constantly reading drawings dimensioned by it to too much mental arithmetic in adding and subtracting decimals. As has been already pointed out, it necessitates the use of four decimal places to express a tolerance of 0.001 in. Added to the mental operations is the confusion caused by having the critical figure buried in the middle of the decimal, whereas it should be at the end. Thus 2.000 in. plus or minus 0.0005 in. fixes maximum 2.0005 in., minimum 1.9995 in. as the working limits, both terminating with the figure 5, and it takes a considerable degree of mental agility to determine from a glance at the drawing what the limiting dimension would be, or from a glance at the gage what the working tolerance was.

But the best argument against the use of plus and minus allowances is the ease with which dimensions may be permitted to "overlap" each other on those sections of adjacent components intended to fit together. The possibility of overlapping and its serious consequences were forcibly impressed upon the writer several years ago, while in the employ of a company manufacturing automobile parts. This company took a contract for several thousand completely assembled units made up of possibly twenty components, the specifications and working drawings being furnished by the contracting company. The drawings when received were found to have plus and minus limits of allowable variation affixed to every dimension, the first of the kind to come into the plant. We took up the matter of designing tools and gages with careful attention to detail, as it was entirely new experience.

An Example of Wrong Dimensioning

Before proceeding very far, it became apparent that something was wrong. For example, the diameter of a driving pin might be dimensioned 0.748 in. plus or minus 0.001 in.; the bushing into which the pin was to be a free fit when the parts were assembled would be dimensioned 0.750 in. with an allowance of 0.001 in. either way. The limiting dimensions in this case would be for the pin, maximum 0.749 in., minimum 0.747 in.; for the hole in the bushing, maximum 0.751 in., minimum 0.749 in. It is apparent that, while there would be a clearance of 0.004 in. between the largest hole and the smallest pin, there would be a line-and-line fit between a pin of maximum diameter and a hole of minimum diameter.

Examples like the foregoing were scattered throughout the entire set of drawings that had been submitted to us, the maximum size in many instances being actually larger than the minimum dimension of the part it was supposed to fit into. Just as we were debating whether it would be advisable to call the customer's attention to this point, a telegram was received directing that all work on the contract be stopped, awaiting letter advices. It developed that our customer had in some manner discovered his error, and all outstanding prints were recalled and revised. In this particular case the net result was a delay of from six to eight weeks in getting production started, but had the matter gone farther it

is easy to estimate that the financial loss would have been considerable.

From such experiences, the writer has come to favor a method which has never yet come under observation on American drawings, but which is used to some extent on details of munitions parts. In its application to diametrical dimensions, this method is extremely simple. On external diameters the dimension is invariably specified *minus* the allowed tolerance; on internal diameters it is invariably specified *plus* the tolerance. For example, the diameter of a pin which was later to be assembled in a bushing would be dimensioned 0.748 in. minus 0.001 in., the hole in the bushing would be dimensioned 0.749 in. plus 0.001 in.

The same principle is followed in specifying linear or length dimensions, the distance between surfaces, or shoulders between which parts are to be assembled, being detailed a base line or reference point from which all the principal linear dimensions originate. It has always been recognized as good practice, and widely though not universally used. But on drawings giving working tolerances on all essential dimensions, it is necessary to adopt this method exclusively.

Before discussing in detail the advantages of the method and the troubles likely to follow the use of any other, it is advisable to emphasize two points that are quite generally either not understood or overlooked. Granting tolerances on a working drawing is in the nature of a guarantee to the production department that any and every part produced within the limiting dimensions created by the tolerances granted will be O.K. Every tolerance, in other words, sets up two limiting points and says, in effect, "Inside these points you can go as far as you like, but outside means spoiled work." Obviously,

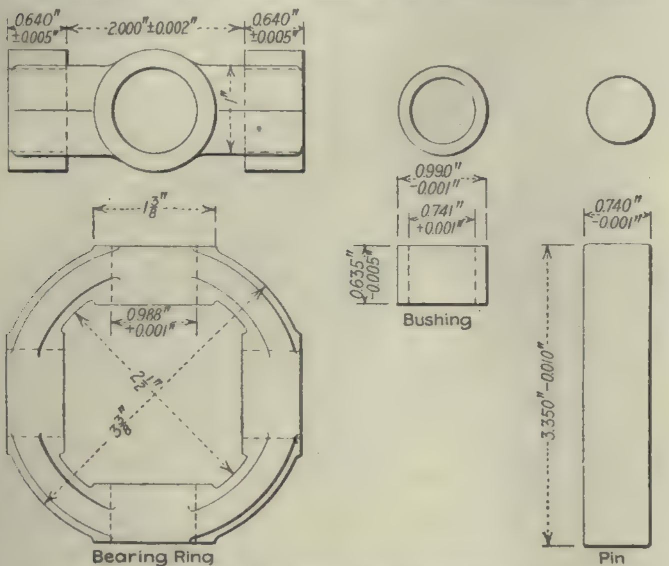


FIG. 1. A PIN AND BUSHING

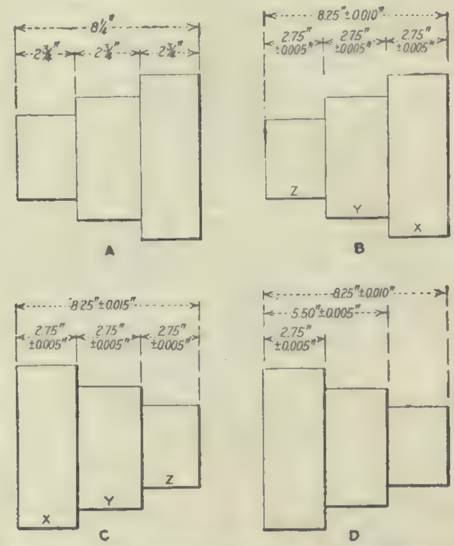


FIG. 2. FOUR METHODS OF DIMENSIONING

dimensioned with a plus allowance; the part or parts fitting into the space having in every instance a minus allowance.

In Fig. 1 are shown details of three parts used quite generally in automobile design, and known as a four-bearing ring, bushing and driving pin. The dimensioning of these illustrates graphically not only the method of expressing the dimensions as advocated, but clearly shows how the allowances are specified in the manner just described. The numerous advantages of this method will be appreciated from even a casual analysis of these sketches. It reduces necessary additions and subtractions to a minimum, and shows at a glance the full tolerance between the largest and smallest part that may be produced within the allowed limits. The absolute dimensions specified show the minimum clearance between any finished surface of a part and the surface of another part fitting to it when assembled, as for example between the pin and bushing in Fig. 1. The critical dimension always corresponds to one marking on the gage used, facilitating both the identification and checking of the gages. In short, it requires less mental effort to "read" a drawing dimensioned by this method, and the probability of error is reduced immeasurably.

In some plants that find it necessary to revise their drawings for interchangeable manufacture, it may already be drawing-room practice to select on every part to be

it is the responsibility of the initiative granting the tolerances to see that the producton department is safeguarded in this guarantee—that they can use the full range of tolerance on every dimension on a part without getting into trouble.

This privilege of taking advantage of the full range on every tolerance dimension suggests the other point to be emphasized; never rely on "averages" in working to limits. Time and again the writer has seen good mechanics deceived on this point, and accept responsibility for the production of parts dimensioned in such a manner that they could be machined to the tolerances only by good fortune or accident.

These two points will be made clear by reference to Fig. 2, in which are shown four examples of a conventional three-step cone pulley marked *A* to *D* respectively. Example *A* shows this pulley as it would be dimensioned on an old-time print. Example *B* shows how this same drawing would come out of some drafting rooms if they were set to the task of dimensioning the working drawings of a product for manufacturing with limit gages. Treating the matter as a simple case of changing nominal dimensions for the same sizes, with the allowable error in machining limited, the drafting room erases the old figure on the tracing, rewrites it in decimals, and affixes a tolerance based on its judgment as to what the production department ought to be able to work to,

which in the example shown is plus or minus 0.005 in. on each step, and plus or minus 0.010 in. on the overall length. The writer does not recall a single drawing of any magnitude specifying tolerances, that has come under his observation to date, that did not show subdimensions with tolerances piled one on top of the other, adding up to a total overall dimension—also with a tolerance—as shown in example *B*. Yet example *B* as dimensioned could not be produced interchangeably, as will be apparent from a moment's analysis. Bearing in mind that without regard to how the piece is machined the shop may take full advantage of every tolerance, assume first that they start from the large end, face off the rim, and then machine, each successsive step working toward the small end. If steps *X*, *Y* and *Z* happen to be all to the minimum gage, the overall length will be 0.005 in. under the minimum: if all the steps are to the maximum gage, the total length is 0.005 in. over the maximum. Only by the successive steps happening to average up maximums and minimums could the total come out inside the tolerance granted for the total length, when machined in this manner.

Many manufacturers have already traced out this difficulty, and in an effort to overcome it have made the total tolerance equal the sum of the separate tolerances. Example *C* shows the same drawing revised in this way. Assume now that for their convenience the production department faced off both ends to length as the first operation, and then finished the steps from the small end toward the large. The overall length might be 8.265 in., the first two steps machined might be to the minimum gage, leaving 2.775 in. for the width of step *X*, which is 0.020 in. greater than the maximum limit allowed.

This brings us to the most important principle of tolerance dimensioning: *Never* combine two or more tolerance dimensions to make up a total tolerance dimension, or specify any single dimension in such a way, that is related to or affected by any other. Adherence to this principle in adopting a dimensioning method for working drawings will save any manufacturer 95 per cent. of the trouble he would otherwise have. Had some of the contractors for munitions parts taken the drawings as originally submitted and revised them with this principle in mind, retaining the same nominal dimensions and limits, and had they followed this up with designs of tools and gages based on the same principle, it would have worked magic in the satisfactory production of those parts.

The writer has in his notebook a sketch made from an original print of a fuse component. This sketch is reproduced at Fig. 3-A exactly as it was dimensioned on the print, only the principal dimensions being given. The same part is shown at Fig. 3-B dimensioned with the "platform" as the principal reference line for outside dimensions, the face of the base for inside base depths, and the face of the stem for stem end bores. It will be observed from this drawing that subreference lines may be established for certain groups of dimensions at will, as long as no linking dimension is interposed between two separate dimensions or groups.

The determination of the tolerance that can be allowed in each instance is a matter of expert mechanical judgment, based on experience and a knowledge of the function the part is to perform. In a revision of detail tracings of a product that has been manufactured, the tolerances should not be left to the drafting room, but to the men who have had the broadest experience both in the manufacture of the product and its use or service afterward. This may call for consultation and coöperation to a considerable degree, but it is necessary to get results.

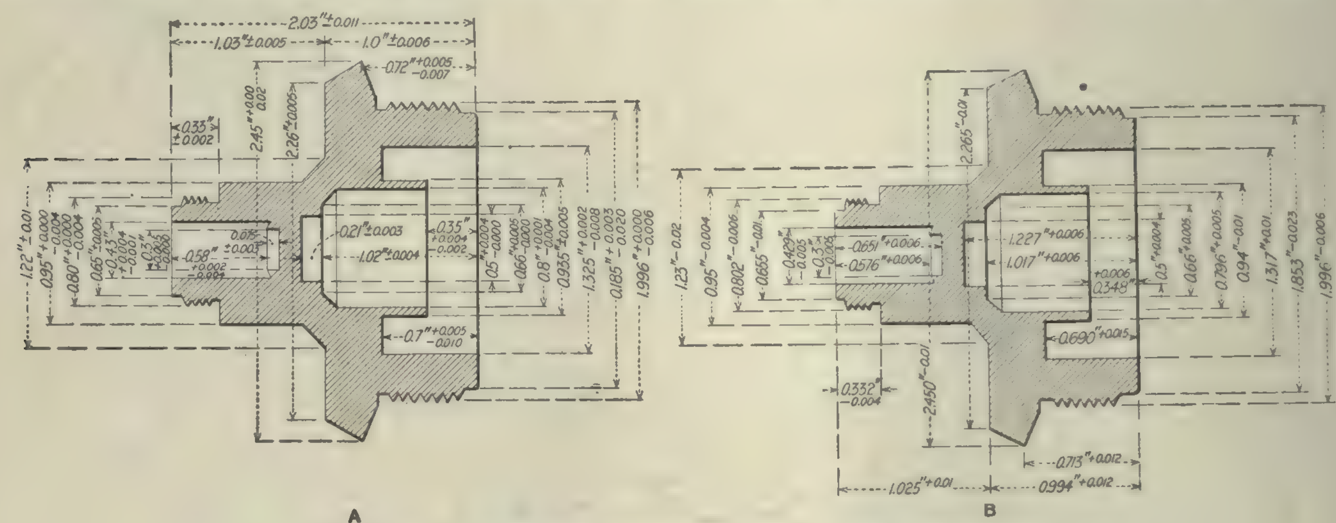


FIG. 3. TWO METHODS OF DIMENSIONING A FUSE COMPONENT

Two points that have a bearing on the determination of tolerance dimensions should be borne in mind. In limit gage work there is no such thing as standard sizes. By that is meant that every tolerance dimension represents a range of sizes between two absolute dimensions, one of which might be a so-called standard, but obviously both cannot be. Moreover, in the manufacture of the parts, micrometers, calipers, scales, etc., are not used, but gages establish the two limiting dimensions for every tolerance granted, and the operator has no concern as to what these dimensions are in figures, his sole concern in every instance being to work somewhere between the two limits as established by the gages. It has always been a characteristic of American design that it follows in the track of standards. Thus, if $\frac{5}{8}$ in. seems too small, jump to $\frac{11}{16}$ or $\frac{3}{4}$ in.; never to 0.640 or 0.650 in., although either might be adequate. Tolerance dimensioning eliminates any excuse for this habit, and in the revision of drawings fractions in sixteenths and thirty-seconds

should be changed to easily computed decimals, unless it is necessary to keep the product manufactured by the new method as nearly interchangeable with the old as possible.

The final point is that revision of drawings presents an excellent opportunity to put into effect small economies in standardizing materials. To refer again to the pin and bushing in Fig. 1: A factory which at one time produced two parts of this nature had a standard 1-in. reamed hole in the bearing ring and a standard $\frac{3}{4}$-in. hole in the bushing, which was originally of bronze. Later a hardened steel bushing and hardened steel pin were used, but because of the standard size holes and the necessity of grinding allowance on both the pin and bushing, the first had to be turned from $1\frac{3}{16}$-in. stock and the other from $1\frac{1}{16}$-in., the latter a size not readily procurable. A change of manufacturing method made it possible to remedy this difficulty. The hole in the ring was reduced to 0.990 in. and the bushing hole to 0.740 in. It was possible to use standard cold-drawn steel for both parts, the surface being hardened and ground to size without any turning operation. It made no difference that two "standard" holes were changed to odd sizes, as one was ground to gage and the other finished to size by a broaching process. In fact, there is not much point left to the plea for sticking to standard size holes, except in small quantity production and rough work. In the modern, efficient plant, producing a high-grade product, practically all the tools, even though they may be so-called standard sizes, are made to special order, and one size is as easily obtained as another.

Charts for Broach Design

By L. A. Williams

The charts herewith were plotted to assist in arriving at quick results when used in connection with the design of broaches.

The chart, Fig. 1, gives the difference in area between a hexagonal figure and an inscribed circle, and between a square figure and its inscribed circle. It also gives the

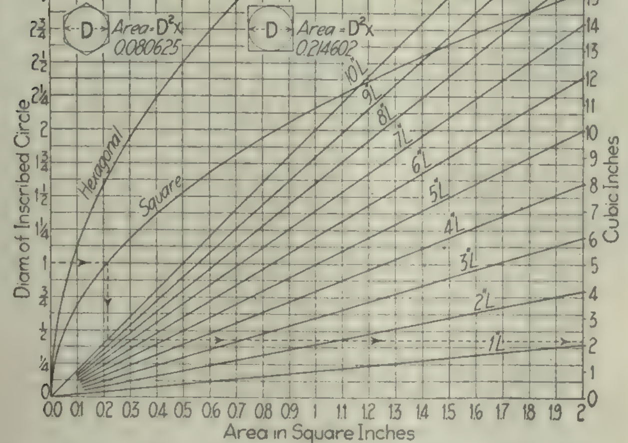


FIG. 1. CHART TO OBTAIN DIFFERENCE BETWEEN A HEXAGON OR SQUARE AND INSCRIBED CIRCLE

corresponding cubic measurement for any length of work up to 10 in. The method of using the chart is as follows: Starting at the left-hand side on the line opposite the desired inscribed circle diameter, follow this line toward the right until it intersects with the curved line representing either the hexagonal figure or square, as the case demands. Then from this point follow the intersecting vertical line to the bottom of the chart, where the area is given in square inches. To read cubic inches follow the vertical line to where it intersects with the angular line representing the length of work; then from this point follow the horizontal line to right-hand side of the chart, where the cubic inches may be read.

The chart, Fig. 2, is intended to give sectional area and cubic inches of metal removed for multispline holes, such as are used in gears on automobile transmissions.

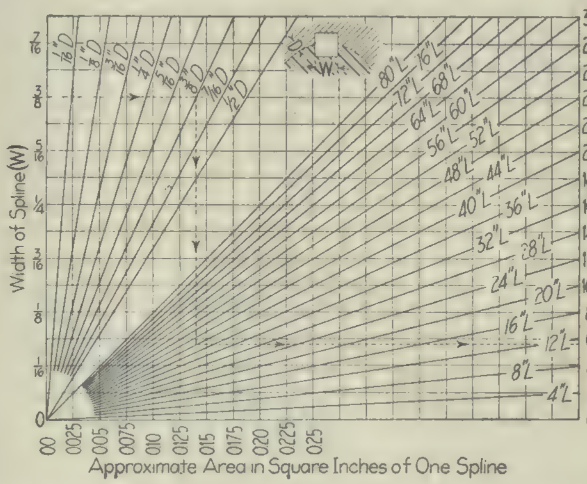


FIG. 2. CHART TO OBTAIN SECTIONAL AREA AND CUBIC INCHES FOR SPLINE

(The results derived from this chart are not strictly correct, but the error is negligible.) The procedure in using this chart is similar to that given for Fig. 1. The lower angular lines represent the total length of all the splines added together; that is, four splines in a piece 3 in. in length equal "12 L" on chart.

The third chart, Fig. 3, deals with the relation between pitch and number of teeth, length of taper, thickness of chip per tooth and the amount of taper. This chart was made up primarily to give the thickness of chip per

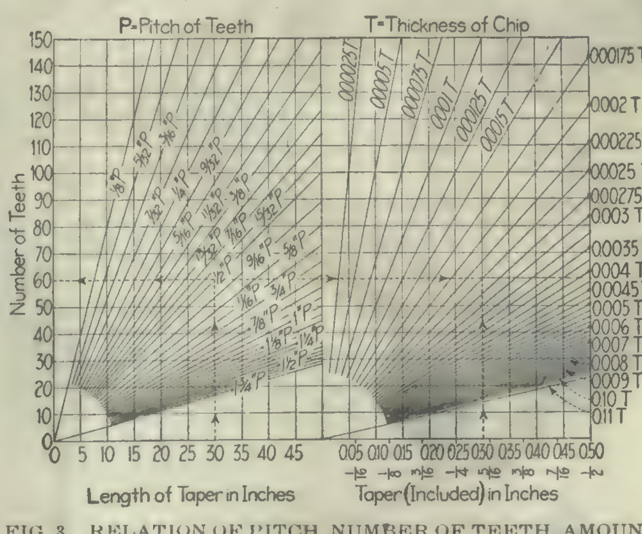


FIG. 3. RELATION OF PITCH, NUMBER OF TEETH, AMOUNT AND LENGTH OF TAPER AND THICKNESS OF CHIP

tooth, as given by the right-hand group of angular lines, but it will be evident that this may be used as a starting point if so desired, and the other required quantities plotted from it.

Machine Operations in the Panama Canal Shop

Editorial Correspondence

SYNOPSIS—In an earlier article on the Panama Canal shops at Balboa reference was made to the variety of repair work handled in different departments. It is purposed in this article to show some of these operations in detail.

Much of the work commonly taken care of in this plant is of interest because of its size, which frequently is such as to make necessary unusual methods of holding or machining the various surfaces. The overhauling of locomotives is, of course, more or less along the customary lines of procedure in general railroad shops, but a number of novel or improved tools and devices have been developed for certain parts of this work; these will be illustrated in a later article. In connection with the upkeep of dredges, floating cranes and other equipment peculiar to the operations requisite in the Canal Zone, there is much to be seen by the visitor that will be found to be more or less novel to him, either because of the magnitude of the members under repair or because of some peculiarity in their design or construction.

One of the features to attract attention in the main machine shops is a series of laying-out benches that enable fairly large-sized work to be laid off for the boring of holes, the planing and slotting of surfaces and so on. These benches, or tables, are formed of heavy iron castings, in the shape of a surface plate, deeply ribbed underneath to prevent deflection. These plates are finished to a true surface on top, squared up all the way around and supported on legs formed of 4-in. gas pipe. About halfway up the uprights is attached a convenient shelf for holding tools and small work. A number of these plates will be seen in Fig. 1, and on the table in the foreground will be noticed a job of laying-out consisting of a heavy link from a ladder dredge, which has been whitened around the sides preparatory to the application of scriber, height gage, center punch, etc.

At either end of the link casting there is a squared hole, or socket, to receive the blocks for the pivots, or short shafts, about which the links oscillate. In laying-out other portions of this work the pivoting shafts, or studs, must be in line, or parallel in the horizontal plane, and the heights and longitudinal positions of other holes or surfaces correctly located in reference thereto.

Dredge Dipper Work

Another operation in connection with dredger parts is illustrated in Fig. 2. This represents the bail of a big dredge dipper undergoing the boring of the holes for the dipper trunnions. The work is a big forging some 8 ft. across from arm to arm, with a 4-in hole bored through each arm; the two are required to be in line. A still larger hole is bored through the flat body of the member for the swivel by which the dipper is operated.

For putting through trunnion holes in the arms, the work is placed as shown on the table of a horizontal boring machine, the outer arm, which extends beyond the outboard support for the boring bar, resting upon wooden horses, as illustrated. The body of the forging, which projects some little distance over the front edge of the work table, is supported in a similar manner. A large twist drill is first run through, and the holes are then enlarged to correct size by the regular boring bar, which carries flat cutters adapted to suit the diameter required.

A similar forging already bored and ready for assembling on a dipper is shown on the floor in the foreground of Fig. 3, from which a fair idea of the dimensions of the part may be obtained.

Immediately at the rear and in the center of the photograph will be noticed the rotary member for a big pump used on a suction dredge. This also has been undergoing repairs.

Fig. 4 shows another machining operation on a dredge part, a ball-and-socket joint for the big pipe line of a suction dredge. The casting is here seen gripped in the four-jaw chuck on the lathe, with a tool at work machining the outside of the hemispherical surface. Upon the completion of this surface the interior ball seat is machined to correct diameter and curvature by an internal tool, which is controlled in its passage along the surface by a suitable guiding mechanism actuating the cross-slide.

A characteristic job on one of the big planers is illustrated in Fig. 5. The work is a heavy yoke-shaped frame, which has to be planed down the inside of the uprights and surfaced between; certain bosses and ledges are also finished at the outer ends. The machine used is a four-head planer on the table of which the casting is supported by suitable blocks and by a series of jacks placed under the broad projecting flange extending along both sides of the frame.

Heavy Steel and Structural Work

The view in Fig. 6 illustrates a great steel spud sent in from one of the big dredges for repairs. This spud is in appearance similar to an enormous box girder, with sheave wheels at the end for the operating cable. It measures about 3 ft. square in section and is some 60 or more feet in length. While in service the spud was ruptured at several points along the length; and these cracks, extending nearly halfway across the width of the face, were welded under the oxyacetylene torch just before the photograph was taken, the position of the welds being plainly shown in the view. This spud is of such length and weight that two flat-cars were required to ship it between the shops and the dredge.

Another view, Fig. 7, shows this spud from the opposite end, while in the foreground a number of workmen will be seen drilling and riveting another heavy member of girder form.

For supporting the pipe line of suction dredges at work in the canal, steel pontoons are used; and a number of these floats are included in the photograph, Fig. 8. The pontoons are made in the shops and consist of cylindrical tanks about 3 ft. in diameter by 30 ft. in length, riveted up from boiler plate and provided with the requisite cleats at the ends for the anchoring cables. They are found very convenient in service, as they are readily floated into the necessary positions and applied in any number required to suit the length and position of the sand pipe.

FIGS. 1 TO 8. VARIOUS TYPES OF WORK CARRIED ON IN THE PANAMA CANAL SHOPS

Fig. 1—Convenient laying-out tables for heavy work. Fig. 2—Boring trunnion holes in dipper bail. Fig. 3—Large dredge parts ready for service. Fig. 4—Machining ball joint for dredge pipe line. Fig. 5—Large open-side planer with side housing. Fig. 6—A welding job on a large dredge spud. Fig. 7—Building up a structural-steel member. Fig. 8—A set of pontoons for floating a dredge pipe line

Electric-Welding in the Manufacture of a Safe-Cabinet

By Robert Mawson

SYNOPSIS—In this article are shown the electric-welding operations that enter into the manufacture of a safe-cabinet, or cabinet safe. It may be seen by referring to either the finished product or the parts used in its construction that the cabinet presents a neat appearance. Operations on the back, shelves, drawers and uprights are described. Production times are given.

Prior to the year 1905, business and professional men were utilizing two classes of containers in which to preserve and protect valuable papers and the like—namely, heavy iron safes and filing cabinets. In 1905 a cabinet was produced that afforded not only the protection of the heavy iron safe, but also the portability, light weight and filing convenience of the ordinary filing cabinet. This cabinet was inserted in a furnace and subjected to an intense heat of approximately 1800 deg. F. for 45 min.; it was removed from the furnace when red hot and allowed to fall from a tower 30 ft. high; then a ton of heavy débris was dropped on the safe-cabinet from the 30-ft. tower, after which it was put back into the furnace and heat again applied on all sides continuously for 1 hr. When the cabinet was opened the contents were found to be intact. This safe-cabinet is manufactured by the Safe-Cabinet Co., of Marietta, Ohio.

As the success of the safe depends on its design and construction in the shop, some of the electric-welding operations employed in its manufacture are here described. The machines used are Winfield electric spot-welders.

In Fig. 1 is shown one of the safe-cabinets closed; it measures over all $82\frac{1}{4}$ in. high, $50\frac{3}{4}$ in. wide and 28 in. deep. A view of the cabinet open is shown in Fig. 2. Here may be seen the shelves, which may be moved to suit various heights of books; the document drawers at the top and other types of drawers below.

When manufacturing the inner side, or back, the three parts are punched, perforated and bent to shape. A set of these parts is shown in Fig. 3. The side is made from 0.035-in. (No. 21 gage) sheet steel and is 57 in. high by 22 in. wide; the strips are 0.070 in. (No. 15 gage) thick. The portion of the side where the strips are fastened was first painted to prevent any danger of corrosion, as it is somewhat difficult to paint under the strips after they are in position. The operator then places one of the strips over the side, measuring from the edge to have it square, and spot-welds a place at each end of the strip.

The strip is then finish spot-welded on the side, about 30 spots being used. The operator then spot-welds the other strip in a similar manner. The average time required to fasten the two strips in position by spot-welding is about 3 min. In Fig. 4 is shown one of these inner sides after the strips have been welded in position.

FIG. 1. A SAFE-CABINET CLOSED

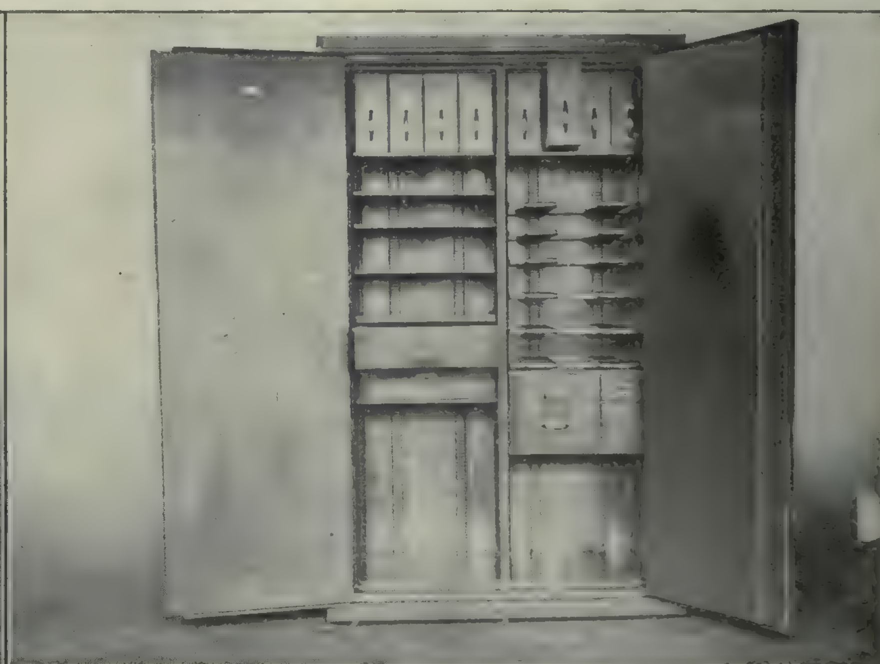


FIG. 2. THE SAFE-CABINET OPEN

Welding the Shelf

In Fig. 5, on the right, are shown two parts that form the shelf before the strip has been spot-welded in position; on the left is one of the shelves after the spot-welding operation. The shelf is 30 in. high and 18 in. wide and both it and the added strip are of steel 0.050 in. (No. 18 gage) thick. The shelf stop is fastened with six spot-welds; approximately 1 min. is required for the operation.

An interesting example of the advantages of spot-welding is in the making of the drawers. In Fig. 6.

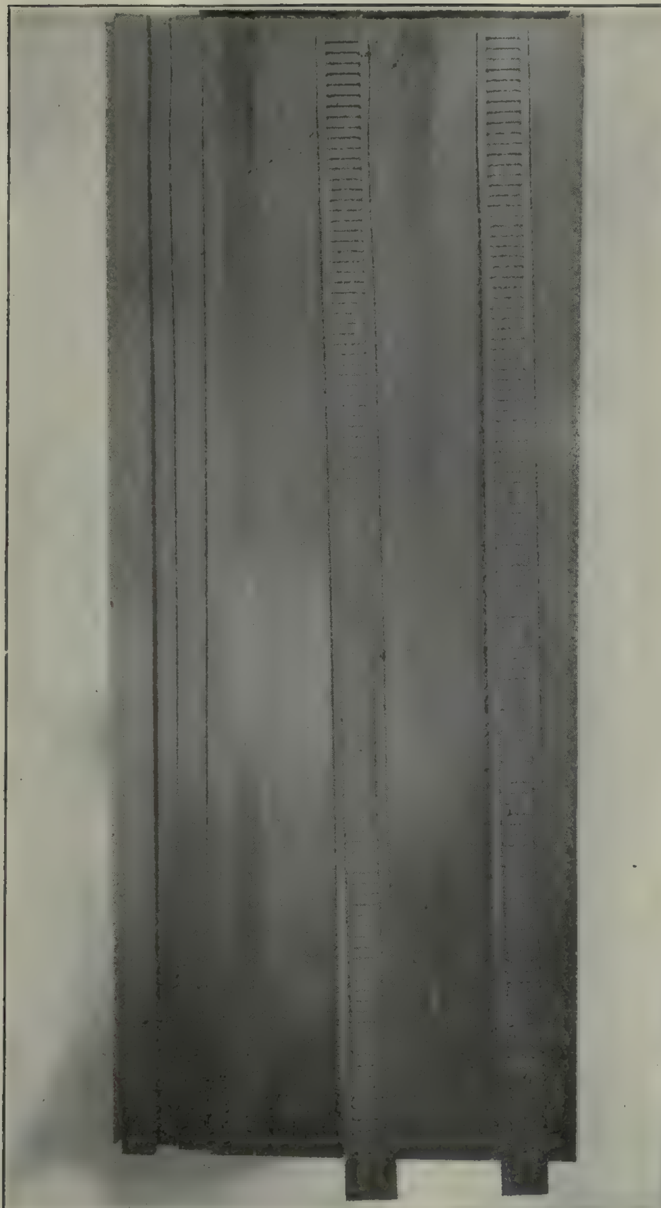


FIG. 3. INNER SIDE, BEFORE WELDING

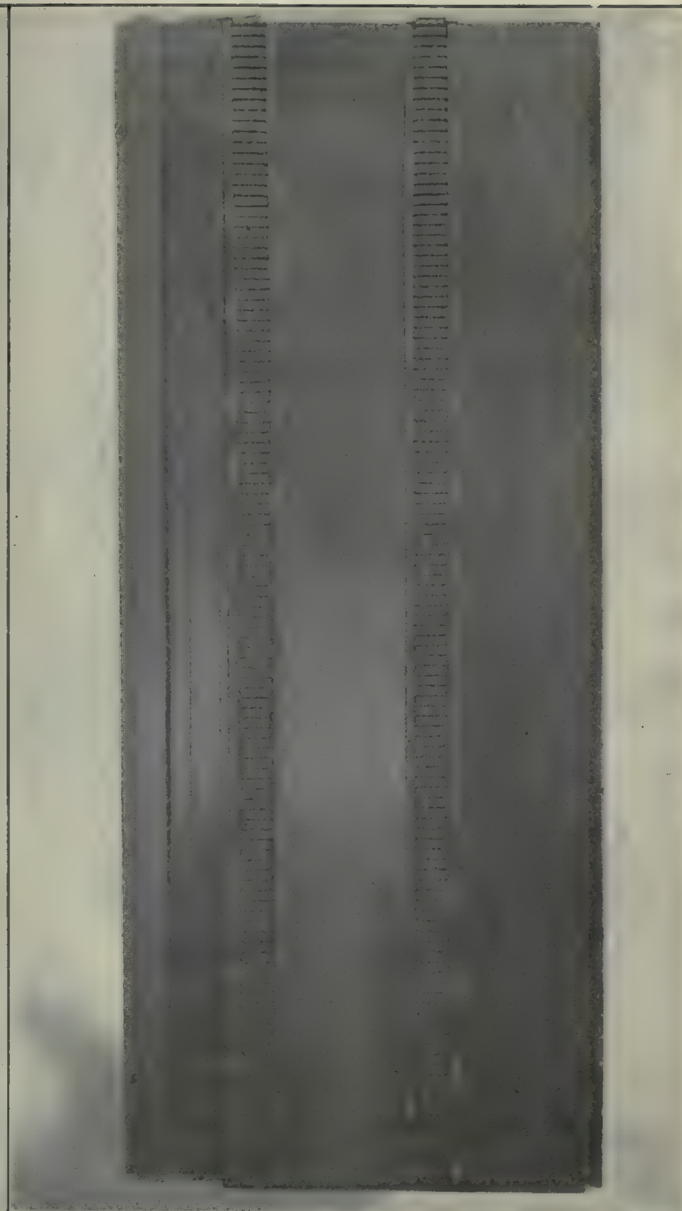


FIG. 4. INNER SIDE, AFTER WELDING

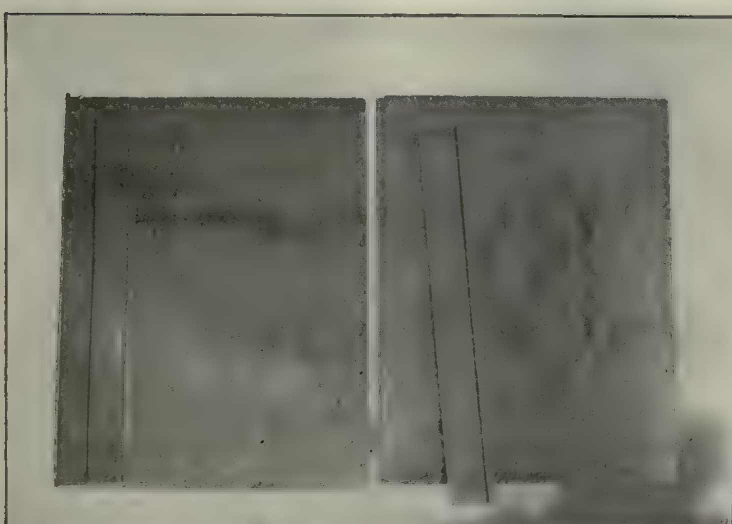


FIG. 5. SPOT-WELDING THE SHELF

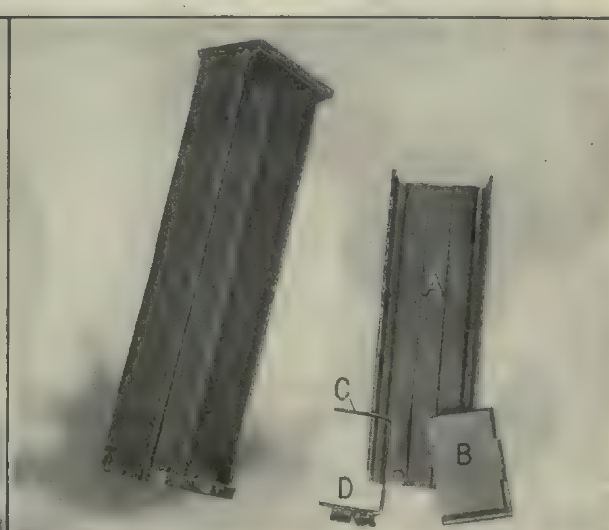


FIG. 6. A SPOT-WELDED DRAWER

at the right, are shown the drawer body *A*, the head *B*, the bail *C* and the angle irons *D*. The body is made from 0.025 in. (No. 24 gage), the head from 0.031 in. (No. 22 gage) and the bail and the angle irons from ⅛ in. thick steel. When completed the drawer measures 6 in. wide, 18 in. long and 4 in. deep, and requires 14 spot-welds, the approximate time being 3 min. At the left of the illustration is shown a similar drawer, but of a larger size, after the spot-welding operations have been performed.

In the manufacturing of the pans two bands are spot-welded at one end of the piece. In Fig. 7 at *A* is shown the pan after it has been blanked and formed, the piece being 10 in. wide, 12 in. long and 2 in. deep. The steel used is 0.050 in. thick (No. 18 gage). The bands, or stops, are shown at *B*, and are of steel ⅛ in. thick. These bands are spot-welded in the recesses at the ends of the pan, two welds being used for each. A pan of another size, after the spot-welding operation, is shown at the right of the illustration.

In the manufacture of the uprights there is also a spot-welding operation. In Fig. 8 at *A* and *B* are shown the parts for making an upright. The upright body *A* is of steel 0.025 in. (No. 24 gage) thick, and the suspension angle *B* is also of steel, but 0.0625 in. (No. 16 gage) thick. When welding the suspension iron in position it is slid back against the raised edge, shown at the extreme left of the piece *A*, and four spot-welds are made. At the right of the illustration is shown one of the uprights with the suspension angle spot-welded in position.

A spot-welded drawer tray is shown in Fig. 9. This tray measures 12 in. long, 8 in. wide and 4½ in. deep, and is made from steel 0.031 in. (No. 22 gage) thick. In the making of this tray 16 spot-welds are necessary, and the approximate time required is 3 min.

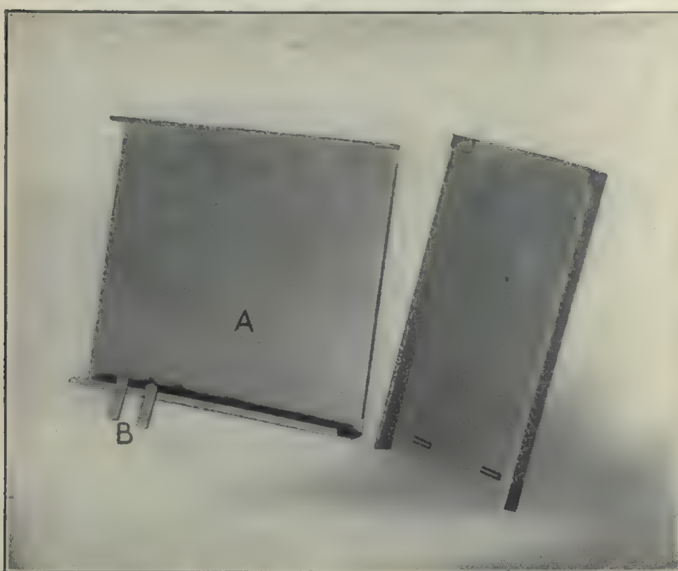


FIG. 7. SPOT-WELDED PAN

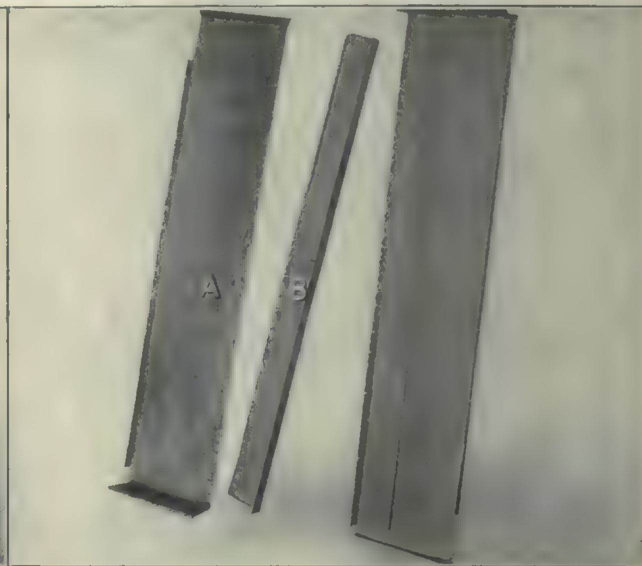


FIG. 8. SPOT-WELDING OPERATIONS ON UPRIGHTS

Spot-Welding the Case

A set of the parts used in the construction of a drawer case is shown at the right of Fig. 10. The elements of the case are made from the following thicknesses of steel: Sills *A* 0.050 in. (No. 18 gage), uprights *B* 0.025 in. (No. 24 gage) and channels *C* 0.0625 in. (No. 16 gage). To assemble these parts 14 spot-welds are used. One of the cases assembled and welded is shown at the left of the illustration; the piece measures 20 in. long, 12 in. wide and 6 in. deep.

In Fig. 11 is shown the method used to insure rigidity of the entering member of the lock bolts. This is first united to the bar with a rivet, as shown at *A*. The joint is then fully closed, as at *B*, by means of the spot-welder, so that any danger of the end *C* moving on the bar *D* and thus causing trouble when locking the safe-cabinet doors is removed.

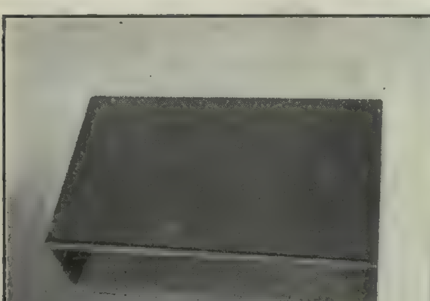


FIG. 9. WELDED DRAWER TRAY

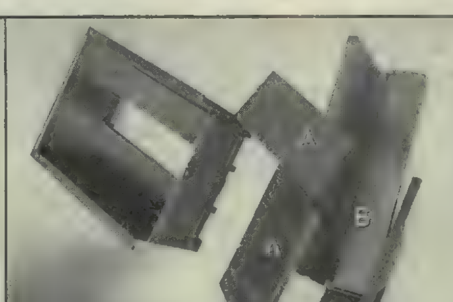


FIG. 10. CASE AND ITS ELEMENTS

FIG. 11. A WELDED LOCK BOLT

Costs of Shop and Office Lighting

By C. E. Clewell*

SYNOPSIS—A series of cost tables for the installation of shop- and office-lighting systems. The various cases are representative of good practice in the arrangement of lamps and intensity of the illumination, and the items of cost are carefully explained. Suggestions are made to govern the use of data of this kind, with particular reference to the unusual advance in prices during the past year. This article is of special interest in view of the recent shop-lighting legislation passed by several states.

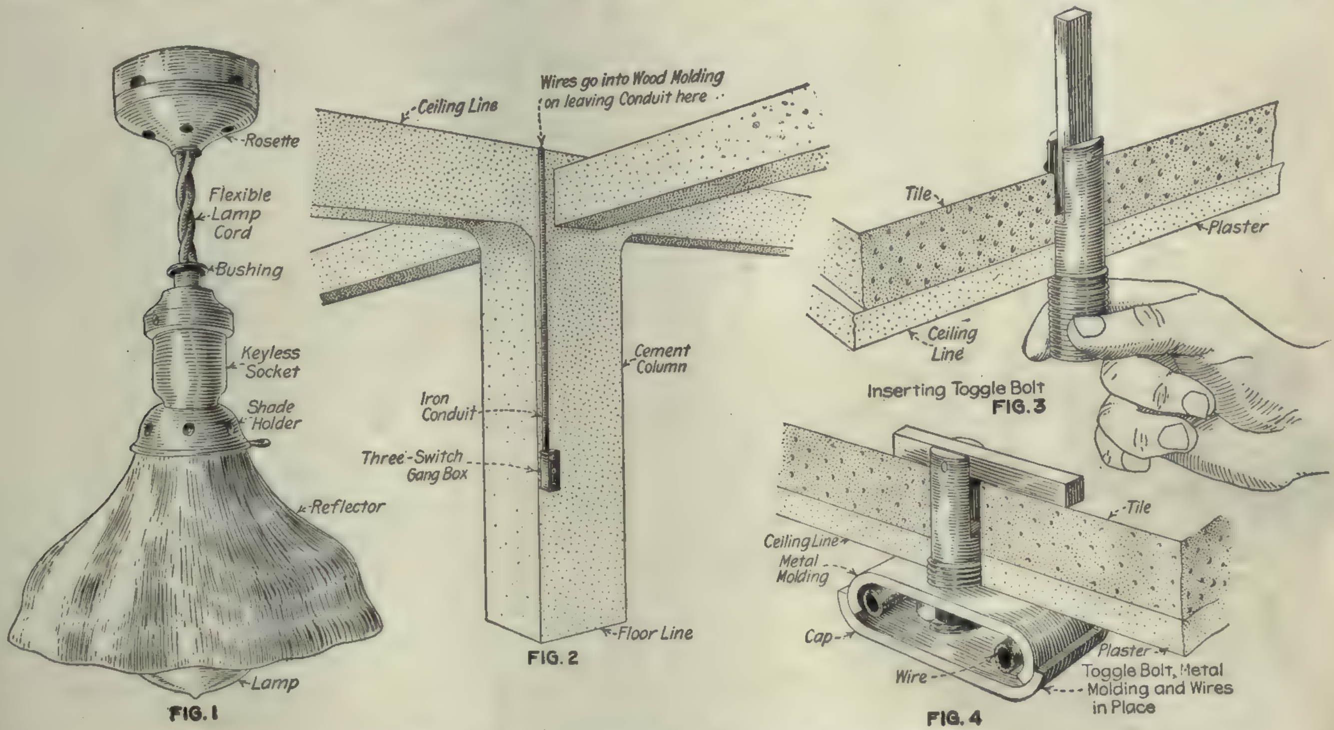
The adoption of codes of shop lighting in two states during 1916 and the possibility of similar legislation in other states shortly, make the subject of costs of installing modern lighting systems of particular interest at this time. In a general way, it is quite difficult to assign definite installation costs for any given class of wiring work and factory construction, because of the variable nature of some of the elements that enter into such costs. It is interesting, however, to observe that in the accompanying tables the costs per outlet for a given class of wiring work do not differ very radically from the average value given in the various cases. Hence, we may conclude that, within certain limits, costs of this kind when properly applied form a means for preliminary estimating as to about what a proposed installation is going to cost. From this standpoint the figures given in this article may be looked upon as of special interest and value.

The installation costs in these tables have been secured from actual installations on a basis of the labor and material and are not estimates. Three cost columns are given for each table—that is, (1) the total cost of the given installation, (2) the cost per outlet and (3) the cost per 1000 sq.ft. of floor area. The total cost given in the first cost column is made up of the total material, the labor and an indirect or an overhead charge, since these installations were all made by the regular electrical department connected with the plant in which the work was done. The second cost column in each table is found by dividing the total cost (first column) by the number of lamps installed. It should be noticed that all the systems refer to the overhead method of lighting, in which one lamp corresponds to one outlet.

Items Covered in the Costs

It should be noticed further that the costs per outlet include, in general, only the costs of the equipment at the outlet plus the labor, material and overhead charges for running the wires and switch circuits immediately concerned with the outlets themselves. Extensive feeder circuits and such equipment as transformers or power-house apparatus are not included. To illustrate just what items are considered in these cost per outlet columns, the following list is given as representative of practically all the installations: Tungsten lamp, reflector, shade holder, socket and bushing, rosette.

These items refer to the outlet itself and are illustrated very well in Fig. 1, which is a typical case. With lamps of the larger sizes there was generally a wire mesh around the reflector for protection against falling particles of



FIGS. 1 TO 4. DETAILS OF VARIOUS OUTLETS

Fig. 1—Diagram showing material used in typical outlet, exclusive of wiring and switch circuits. Fig. 2—Method of extending switch circuits down a cement column in conduit (for cases where the overhead wiring is placed in wood molding). Fig. 3—Preparing for the support of metal molding on a plaster and tile ceiling. Fig. 4—Metal molding and wires supported to a plaster and tile ceiling (see also Fig. 3)

*Assistant Professor of Electrical Engineering, University of Pennsylvania.

glass in case of breakage, and two small chains usually joined the shade holder and the ceiling as an added safeguard against falling. In addition to the foregoing items the following material is also included—that is to say, the portion of each of the following items that may be charged to one outlet. Thus, if one snap switch controls four lamps, its cost is distributed over four outlets in the cost per outlet. The list comprises snap switch, fuse block, fuse plugs, fuses, flexible lamp cord, conduit boxes, conduit, molding and capping, screws, rubber-covered wire, friction tape, solder, labor, overhead charges.

It is understood of course that some of these items in their entirety will not apply to one or another of the installations in the tables, but in a general way they are typical of the things that are included in the total costs given.

Interesting Features in the Tables

Several particularly interesting features may be observed in these tables. The cost per outlet is comparatively low for the smaller lamps and high for the larger lamps, while the actual cost per 1000 sq.ft. of floor area is somewhat lower usually for the larger than for the smaller lamps. This might be expected because of the added labor and material where a relatively large number of lamps is used for a given floor area.

Special attention is directed to the descriptive headings at the top of each table, as these indicate the condition under which the work was done, the class of wiring and the type of lamps used. Thus in Table I the wires are run in wood molding on a wood ceiling, and 60-watt Mazda lamps are employed. Notice also the column containing the watts per square foot for each individual installation. The foot-candle intensity on the working plane for all the cases given ranges approximately from 2.5 to 3.5 foot-candles. The average cost per outlet is given under each table, where there are two or more installations involved in the given table.

TABLE I. INSTALLATIONS ON WOOD CEILINGS WITH WOOD MOLDING AND 60-WATT MAZDA LAMPS

Number of Installation	Class of Work	Approximate Ceiling Height, Ft.	Number of Lamps Installed	Watts per Sq.Ft. of Floor Area	Total Floor Area, Sq.Ft.	Average Spacing Between Lamps Ft.	In.	Actual Cost of Total Installation	Cost per Outlet	Cost per 1,000 Sq. Ft. of Floor Area
1	Shop office	12	72	1.35	3,205	6	8	$223.36	$3.11	$69.60
2	Shop office	12	24	1.50	960	7	9	72.37	3.01	75.36
3	Shop office	13	48	2.05	1,405	6	2	163.03	3.39	116.00
4	Shop office	13	21	1.75	719	6	4	100.51	4.78	139.[illegible]
5	Manufacturing	10	180	1.15	9,360	8	0	478.99	2.66	51.17
6	Packing space	10	24	1.12	1,290	7	6	83.89	3.49	65.00
7	Shop office	12	24	1.60	900	6	6	84.05	3.50	90.03
8	Shop office	12	12	2.18	330	5	6	47.31	3.94	143.50
	Average cost per outlet									$3.48

All the offices listed are either offices located immediately in the plant or in one of the main office buildings connected with the plant. In the use of these tables it is suggested that due weight be given to the approximate ceiling heights, as this has some influence on the costs, the higher ceilings usually involving a higher labor cost because of the added inconvenience in getting at the ceiling when stringing the wires.

Classes of Wiring Used

Tables I and III cover wood ceilings and wood molding work. Where the number of switch loops is large—that is, where there is only a relatively small number of lamps per switch—this is likely to increase the cost materially, especially if these switch loops must be run down cement columns, as in Fig. 2. In the case shown here the three-switch gang box controls eighteen 100-watt Mazda lamps, which means six 100-watt lamps per switch. The ceiling wiring is placed in wood molding on the wood ceiling. The switch loops from the ceiling to the gang boxes cost about $5 each, whereas the ceiling outlets themselves complete cost about $2.50 each (see installation No. 16 in the tables). The distribution of $5 per switch box over 18 ceiling outlets amounted of course to quite a small item per outlet. Where pull switches are mounted on the ceiling, with a piece of ordinary twine hanging down within easy reach of the floor for their operation, the cost for switch circuits will naturally be considerably reduced.

Table II covers tile and plaster ceilings, where metal molding is employed. These costs refer to the method of supporting the metal molding by means of some kind of toggle or expansion bolts. Thus in Fig. 3 a toggle bolt is being inserted in an opening previously drilled through the plaster and tile. In Fig. 4 the toggle bolt is shown in place, and the base of the metal molding is shown bolted to the ceiling. The wires are put in place just before the capping is snapped on the molding base. This method of wiring is neat and effective, and a comparison of Tables I and II shows that the costs are not much higher, on the average, for the metal than for the wood molding.

TABLE II. INSTALLATIONS ON TILE AND PLASTER CEILINGS WITH METAL MOLDING AND 60-WATT MAZDA LAMPS

Number of Installation	Class of Work	Approximate Ceiling Height, Ft.	Number of Lamps Installed	Watts per Sq.Ft. of Floor Area	Total Floor Area, Sq.Ft.	Average Spacing Between Lamps Ft.	In.	Actual Cost of Total Installation	Cost per Outlet	Cost per 1,000 Sq. Ft. of Floor Area
9	Main office	12	27	1.54	1,053	7	0	$121.16	$4.48	$114.30
10	Main office	12	37	1.59	1,397	6	6	169.85	4.59	122.00
11	Main office	10	37	1.90	1,144	5	10	114.23	3.08	97.02
12	Main office	12	59	1.65	2,509	7	0	235.60	3.99	93.90
13	Main office	13	32	1.66	1,155	6	8	122.25	3.82	105.84
14	Filing vault	10	53	1.07	2,966	8	7	196.70	3.71	66.30
15	Main office	10	8	1.45	330	6	11	31.96	3.99	96.85
	Average cost per outlet									$3.95

TABLE III. INSTALLATIONS ON WOOD CEILINGS WITH WOOD MOLDING

Number of Installation	Class of Work	Approximate Ceiling Height, Ft.	Number of Lamps Installed	Watts per Sq.Ft. of Floor Area	Total Floor Area, Sq.Ft.	Average Spacing Between Lamps Ft.	In.	Actual Cost of Total Installation	Cost per Outlet	Cost per 1,000 Sq. Ft. of Floor Area
	100-Watt Mazda Lamps									
16	Manufacturing	13	243	1.78	13,633	8	0	$564.65	$2.44	$41.41
17	Machine shop	12	60	1.56	3,840	9	0	204.88	4.65	53.86
	250-Watt Mazda Lamps									
18	Manufacturing	16	6	1.38	1,092	13	6	46.45	7.74	42.50
19	Shop space	20	20	1.67	3,000	10	6	102.63	5.13	34.21
20	Shop space	20	24	....	2,880	9	0	185.52	7.73	64.40
	500-Watt Mazda Lamps									
21	Shop space	20	12	2.08	2,375	14	0	160.08	13.34	67.50
	Average costs per outlet:									
	100-watt									$3.54
	250-watt									6.87

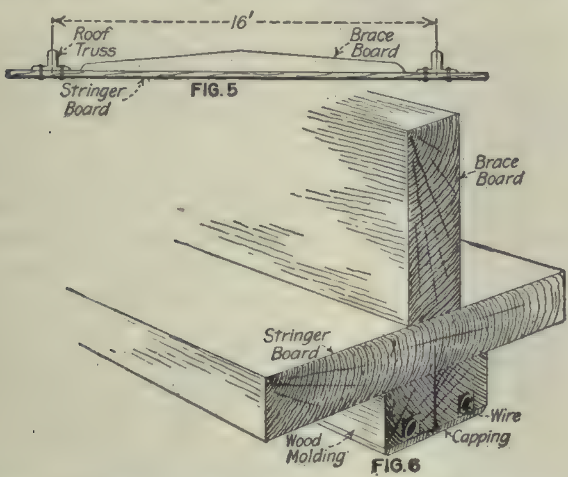
In Table IV the overhead roof trusses are open with no ceiling. Stringer boards are run up and down the aisle so as to pass over the lamp locations, these boards being supported between adjacent trusses (see Fig. 5). The wood molding for supporting the wires is then fastened to the under side of the stringer boards, as in Fig. 6, which is a sectional view. In this illustration notice the brace board, which is required because of the long distance between supports.

In Table V, installation No. 28 refers to a case where small boards were fastened to the exposed trusses at the lower part of each pair of brick arches, wood molding being fastened, in turn, to the under side of these boards. The ceiling was very low and easily reached, the cost of installation being relatively small. Installation No. 29 is a case where iron conduit was fastened to the iron trusses of another similar ceiling, which, however, was considerably higher and more difficult to reach.

Cautions in the Use of the Tables

All these costs apply to installations made in one large plant where the wiring force, because of the large amount of this kind of work, became very proficient and where the labor cost was quite low in consequence. Moreover, these costs apply to material purchased in large quantities and prior to the very remarkable increases in prices during the past year or so.

Some of these tables (III, IV, V) refer, at least in part, to Mazda 250- and 500-watt lamps. Lamps of these sizes are no longer manufactured in the vacuum types (the kind referred to in the tables), but nitrogen-filled units of about corresponding candle power ratings will hardly vary in price enough to affect these costs appreciably.



FIGS. 5 AND 6. STRINGER AND BRACE BOARDS FOR CARRYING WIRES BETWEEN BEAMS

Particular care must be taken to keep in mind just what is included in these costs, as outlined above. Where additional material, such as distributing transformers, high-voltage distributing circuits and the like, form a part of a given lighting installation, the cost per outlet, as well as the total costs and the costs per unit of floor area, will naturally be correspondingly increased. A case of this kind came to my attention some time ago, where in addition to lamps, etc., wiring and installation expense, as in these tables, there were included as part of the estimated cost the transformers, high-voltage fuses, lightning arresters and switchboards, all of which together totaled $22.28 per outlet for 100-watt tungsten lamps. This, obviously, is a unit cost not in any sense to be compared with those given in these tables.

In brief, the costs in these tables should be most useful in those cases where old electric-lighting systems exist in the shop and where a new and improved arrangement of more modern lamps is to be substituted, so as to use the old supply circuits, but where an entirely new layout of wiring must be made to accommodate the new and improved plan of outlets. In such a case practically the only costs involved in making the new installation will be those covered in these tables, with due regard to changes in the prices of wiring materials and labor charges. The tables show fundamentally how much it cost one factory to equip 29 of its installations with modern lighting, and from this viewpoint the data may at least be suggestive to others who are confronted with similar work.

TABLE IV. INSTALLATIONS ON ROOF TRUSSES (NO CEILINGS) WITH STRINGER BOARDS AND WOOD MOLDING

Number of Installation	Class of Work	Approximate Ceiling Height, Ft.	Number of Lamps Installed	Watts per Sq.Ft. of Floor Area	Total Floor Area, Sq.Ft.	Average Spacing Between Lamps Ft.	In.	Actual Cost of Total Installation	Cost per Outlet	Cost per 1,000 Sq. Ft. of Floor Area
	100-Watt Mazda Lamps									
22	Manufacturing...	16	34	1.63	2,090	8	5	$182.46	$5.35	$87.30
23	Manufacturing...	9	150	1.60	9,360	8	0	724.64	4.83	77.39
	250-Watt Mazda Lamps									
24	Shop space.......	18	10	1.56	1,603	12	8	76.79	7.68	47.80
25	Manufacturing...	16	18	1.48	3,024	13	0	189.81	10.54	62.76
26	Paint shop.......	16	15	1.77	2,121	13	9	116.55	7.77	44.40
27	Shop space.......	16	29	1.13	6,400	14	6	146.34	5.46	22.90

Average costs per outlet:

100-watt	$5.09
250-watt	7.86

Comparison with Other Figures

It is a matter of interest to compare the costs in these tables with similar costs from other sources. Several cases will therefore be given for this purpose. For example, the "Handbook on Shop Lighting," issued by the Industrial Commission of Wisconsin (written by F. Schwarze), contains the statements that the wire and conduit in a shop-lighting system cost about 150 per cent. more than the cost of the lamp, and that the cost of wire and knobs for open wiring work is about 125 per cent. of the cost of the lamp (conditions of about two years ago).

TABLE V. INSTALLATIONS ON ARCHED BRICK CEILING CONSTRUCTION WITH IRON TRUSS SUPPORTS

Number of Installation	Class of Work	Approximate Ceiling Height, Ft.	Number of Lamps Installed	Watts per Sq.Ft. of Floor Area	Total Floor Area, Sq.Ft.	Average Spacing Between Lamps Ft.	In.	Actual Cost of Total Installation	Cost per Outlet	Cost per 1,000 Sq. Ft. of Floor Area
	100-Watt Mazda Lamps—Wood Molding on Boards									
28	Toolroom........	9	7	1.44	487	8	5	$15.13	$2.16	$31.06
	250-Watt Mazda Lamps—Iron Conduit									
29	Dynamo room....	20	40	1.93	5,183	14	0	407.22	10.18	78.58

From the same source we find that the labor charge for a conduit installation is approximately 45 per cent. of the cost of the lamp and wiring materials, while the labor for an openwork installation costs approximately 50 per cent. of the cost of the lamp and wiring materials. These figures do not include the cost of the mains and distributing centers. This information is summarized as follows:

Conduit Installation

Tungsten lamp	$0.70
Conduit, wire, etc	1.75
Labor	1.12
Reflector	1.25
Total	$4.82

Open-Type Installation

Tungsten lamp	$0.70
Wiring materials	.70
Labor	.70
Reflector	1.25
Total	$3.35

These figures thus agree quite closely with those in the accompanying tables.

Again, J. B. Whitehead, in "Lectures on Illuminating Engineering," pp. 266 and 267, says in part:

The figures given below apply to interior wiring of all classes . . . They cover the portion of the work from the main source of supply, assumed to be at the building line. In case the building is lighted from its own plant these figures will apply to the portion of the installation lying between the lamp and the plant switchboard. No lamps, fixtures or reflectors are included in these prices:

	Per Outlet
Exposed wiring	$1.50@1.60
Wood molding wiring	2.00@2.50
Concealed knob and tubes ($1 to be added per switch outlet)	2.50@3.00
Iron conduit (new buildings)	4.50@5.00
Iron conduit (concrete buildings)	5.00@6.00

In the above, switches and base-board plugs are considered as outlets when iron boxes are included. If the switch and plate are also to be furnished, approximately $1 per outlet of this nature should be added. For the larger installations in modern buildings the price of $7 per outlet, including all wiring and feeders up to the lighting fixture, has been found to be a fairly close figure.

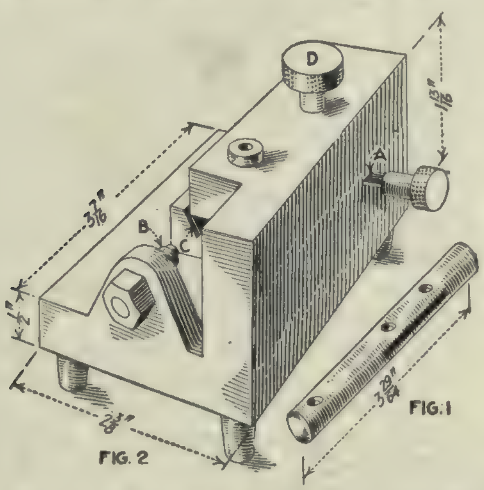
The foregoing costs apparently apply mainly to residence and office-building lighting, and moreover, they were compiled about six years ago. For these reasons they are presented merely for the purpose of the most general comparison with the tables that form the basis of this article.

Drill Jig for Holes at Right Angles to Slot

By Fred H. Korff

Some stems of varying lengths were to be drilled with three holes in the same relation to one another in the different pieces.

In Fig. 1 may be seen one of the stems. It is made of naval brass and directly in the center has a slot $1\frac{5}{16}$ in. long. The limits of variance for this slot are 0.0015 in.,



FIGS. 1 AND 2. THE PIECE TO BE DRILLED AND THE JIG USED

or a total of 0.003 in. from one side of the stem to the other. The three holes must be drilled, as shown, to form an angle of exactly 90 deg. with the slot.

These requirements made it necessary to consider adjustable stops in laying out the jig, which was designed as shown in Fig. 2. The slide *A* made the jig a success; *B* is the stop; *C*, the V-block; and *D* is the holding screw.

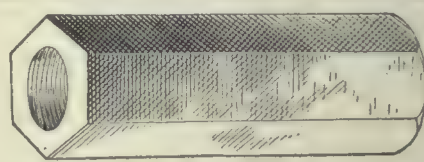
In performing the work, the stem is placed in the V-blocks at *C*, and the slide *A* is pushed through the slot in the stem. As the slide is 0.002 in. smaller than the slot, it permits a snug fit, thereby holding the stem rigid, and preventing it from turning. The screw *D* is then tightened down, and the holes are drilled.

This device is accurate, and the idea has since been successfully adapted to other operations.

Extension Nuts for Refitting Connecting-Rods

By Frank C. Hudson

Anyone who is familiar with the modern automobile or airplane engine knows how closely the connecting-rod bolts and nuts are fitted and how little clearance there is for wrenches around the nuts. When one has to put these nuts on and take them off a number of times, as is often



EXTENSION NUT FOR FITTING CONNECTING-RODS

necessary in refitting a connecting-rod bearing to the crankpin, it consumes considerable time and is also apt to jam the corners of the nuts.

It will pay to make extra-long nuts, such as are used in the factories where these motors are built, as illustrated herewith. They can be made of either hexagon-screw stock of the proper size, with the ends drilled and tapped, or from round stock, with a pin driven through for turning the extension nut.

With these nuts the bearing cap can be easily fitted up snug to test the bearing, and it can be as quickly removed for any scraping or shimming that may be necessary. Any shop that does much fitting of this kind can well afford to make several pairs of these extension nuts, marking them with the name of the motor on which they are to be used. They save time, skinned knuckles and cuss words.

Easy Methods of Measuring an Odd-Tooth Gear

By G. M. Bartlett

To measure the outside diameter of an odd-tooth gear, caliper the distance from the middle of one tooth to the middle of the tooth nearly opposite. Divide this measurement by the cosine of $\frac{90°}{N}$, where N is the number of teeth in the gear. The result is the real outside diameter of the gear.

The same process is employed to measure the bottom diameter of a gear.

In cutting sprockets to a given bottom diameter a similar method is used for setting the calipers. For example, if it is desired to cut a 13-tooth sprocket, 1-in. pitch, $\frac{5}{8}$-in. roll diameter, the table calls for a pitch diameter of 4.179 in. and a bottom diameter of 3.554 in. Multiply the pitch diameter by the cosine of $\frac{90°}{N}$, and subtract the roller diameter. The result is 3.523 in. Set the calipers for this distance.

Design of Keyway Broaches*

By Walter G. Groocock

SYNOPSIS—Keyway broaches may be made in three different ways—a simple series of blades; rectangular blades, each secured in its own carrier, or in a solid broach. In this article each type is illustrated and limitations discussed.

There are many points in broach design that are debatable, and this is particularly true of keyway broaches. They may be made in three different ways, and each of these ways has its own advantages and drawbacks. These broaches may be constructed as a simple series of blades that are drawn through the work, being held in position relative to the work by means of a locating center; or they may have similar rectangular blades each secured in its own stock or carrier; or they may be made with the cutting portion integral with the stock—that is, solid broaches.

The first kind is shown in Fig. 1 and is especially suitable for single keyway jobs. The second system is much favored by some tool designers on account of the supposed cheapness of replacing the blades. The third system is at first sight the most expensive. This, however, is open to question. But suppose they are more expensive to make. In those plants where the closest of work is required—more particularly with regard to double keyway work—such small added cost is more than offset by the accuracy of the product from the solid type of broach.

The one great drawback to the loose-blade broach is the fact that it is impossible to hold the blades sufficiently solid in their holder to prevent their springing to either one side or the other. As mentioned before, the type shown in the illustration is most suitable for single keyway jobs, because the slight angle that may take place in pulling it through the work is not readily apparent even when a good gaging system is in vogue. Moreover, any angle that may exist can be readily accommodated by the single key and therefore is not so detrimental from the assembling point of view as a similar angle in the case of double keyway jobs.

With this class of broach, the work is placed on the hardened work adapter A, Fig. 2, which has a rectangular groove B milled through it lengthwise. The broaches should be a good sliding fit in this groove, but owing to the impossibility of keeping this fit sufficiently close, any variation in the material being broached or any difference in the sharpness of the corners of the broach teeth has a tendency to force the broach over to one side of the slot. The result of this crowding over is a more or less slight lean, or angle, of the finished keyway.

Two or more broaches are required to get a keyway out to the necessary depth; but when the number of pieces to be done will not warrant a complete set, a makeshift arrangement, as follows, will answer fairly well: Arrange the broach to take out half of the keyway at a pass, and for the second pass use a parallel gib key, as shown at C. Should the depth be such that a third pass is necessary, then a thicker gib will provide for this if the inclination of the broach teeth is adjusted to suit.

While this method may be used as a makeshift on a common grade of work, it should be pointed out that the more the broach is raised in the slot the greater will be the error in the result. Obviously, the less bearing surface the broach has in its adapter the greater will be the liability of its leaning over sidewise when at work. For

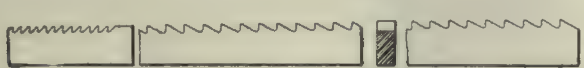


FIG.1 Broach for Single Keyway

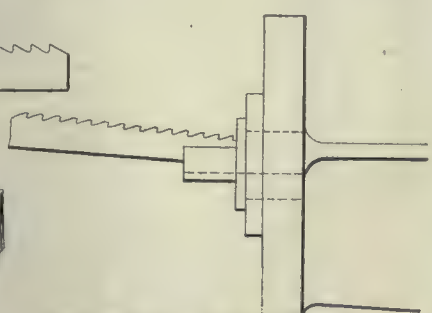


FIG.4 Position of Broach when raised

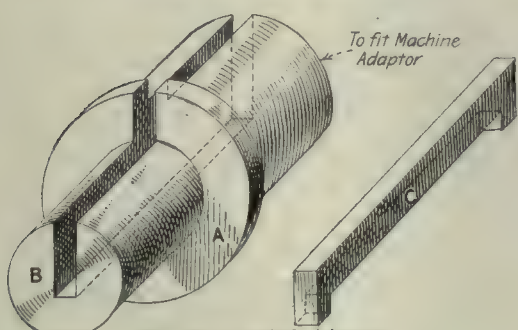


FIG.2 Broach Work Adapter

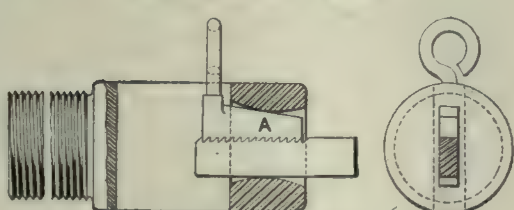


FIG.3 Holder for Broach

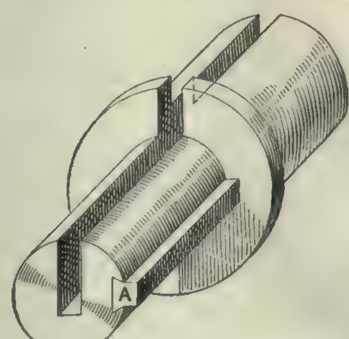


FIG.5 Adapter for Double Broaching

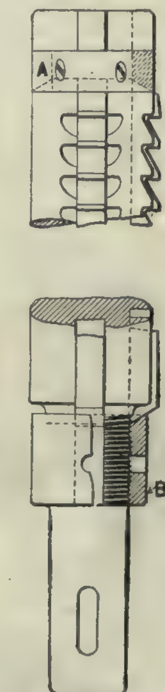


FIG.6 Method of Holding the Blades

FIGS. 1 TO 6. VARIOUS DETAILS IN REGARD TO KEYWAY BROACHES AND THEIR USE

this reason this system of using gibs should never be adopted when good results are required.

A good method of pulling broaches of this type is by means of the wedge *A*, Fig. 3. The wedge is serrated on its under side, and the broach blade is serrated to correspond. The top side of the slot should be made rounded, as shown. The under side of the slot in the pull adapter should also be rounded.

The reason for this is as follows: In the tension-type broaching machine with this class of broach it is impossible to get everything in line, and a certain amount of float should be allowed. This is usually given in the slot and stem (of the round-stem type of broach). In the type under discussion, if the key and the bottom of the tension grip are flat, then when the tension comes on, the whole will be rigid. Consequently, the broach will be sprung, if any misalignment exists. A further reason for the rounding is that with some jobs the broach must be taken out, when run back, to put a fresh piece of work on the work adapter. The straight-type wedge requires a hammer to release it, whereas the curved wedge is easily released by raising the end of the broach, as shown in Fig. 4.

SUCCESSIVE DIAMETERS IN INCHES FOR TEETH IN A SET OF KEYWAY BROACHES

No. of Tooth	No. of Broach 1	2	3	4	5	6
1	1.491	1.564	1.614	1.664	1.490	1.624
2	1.494	1.566	1.616	1.666	1.495	1.628
3	1.497	1.568	1.618	1.668	1.5	1.632
4	1.5	1.54	1.62	1.67	1.505	1.636
5	1.503	1.572	1.622	1.672	1.51	1.64
6	1.506	1.574	1.624	1.674	1.515	1.644
7	1.509	1.576	1.626	1.676	1.52	1.648
8	1.512	1.578	1.628	1.678	1.525	1.652
9	1.515	1.58	1.63	1.68	1.53	1.656
10	1.518	1.582	1.632	1.682	1.535	1.66
11	1.521	1.584	1.634	1.684	1.54	1.664
12	1.524	1.586	1.636	1.686	1.545	1.668
13	1.524	1.588	1.638	1.688	1.55	1.672
14	1.53	1.59	1.64	1.69	1.555	1.676
15	1.533	1.592	1.642	1.692	1.56	1.68
16	1.536	1.594	1.644	1.694	1.565	1.684
17	1.539	1.596	1.646	1.696	1.57	1.688
18	1.542	1.598	1.648	1.698	1.575	1.692
19	1.545	1.6	1.65	1.7	1.58	1.696
20	1.548	1.602	1.652	1.702	1.585	1.7
21	1.551	1.604	1.654	1.704	1.59	1.704
22	1.554	1.606	1.656	1.706	1.595	1.708
23	1.557	1.608	1.658	1.708	1.6	1.712
24	1.56	1.61	1.66	1.71	1.605	1.714
25	1.563	1.612	1.662	1.712	1.61	1.714
26	1.563	1.612	1.662	1.714	1.615	1.714
27	1.563	1.612	1.662	1.714	1.62	1.714
28	1.563	1.612	1.662	1.714	1.62	1.714
T. S.						
1st Tooth	1.52	1.675	1.745	1.865	1.52	1.75
26 Tooth	1.675	1.745	1.865	1.965	1.75	1.96
B	1.488	1.55	1.59	1.64	1.7*	1.59
C	0	0.404	0.403	0.402	0.4	0.439
R	$1\frac{1}{4}$ in.	$1\frac{9}{32}$ in.	$1\frac{5}{16}$ in.	$1\frac{5}{16}$ in.	$1\frac{5}{16}$ in.	$1\frac{3}{8}$ in.
W	0.406	0.405	0.404	0.403	0.439	0.439
F	.....	.....	.....	1.693	.....	1.693

* Turn 1.93

Other Use for Single-Blade Broaches

The single-blade broach is often used on double keyway jobs. Where the quantity of work to be done is small and accuracy is not of importance, it no doubt fills a want. But compared with either of the other two systems it is slow. One method used is as follows: The work is first broached out as if for a single keyway. It is then slipped on the work adapter, Fig. 5, and the operation repeated for the second keyway. The drawbacks of this method are, first, the work is handled twice for each broach; second, there is little chance of getting close results, because to get the work on and off the adapter without losing time the key *A* must be fairly free in the keyway already broached. Therefore, this allowance added to the small allowance in the broach slot has an effect on the accuracy of the finished work. This means that the assemblers have to ease the side of the keys to get the work together. Consequently, money saved in the first cost of broaches is spent in another section of the factory, quite apart from any question of interchangeability.

Another method of doing this class of work with a single broach is to have a dividing arrangement on the broaching machine whereby the work may be indexed for the second keyway. The drawbacks of this system are the first cost of the dividing arrangement, the slowness of the method—for not only must each broach be pulled through twice, but the work must be secured to the indexing fixture—and the uncertainty of the result, from reasons already stated. There is also another source of trouble through this method. Owing to the fact that, no matter how well a broach may be cutting, a certain amount of burr is thrown up, it is necessary to have the work adapter, or broach guide, rather slack in the bore of the work or it cannot be indexed without using considerable force. This means additional error in the result.

The second type to be discussed comprises broaches with blades inserted in a solid stock. This construction does not appear to give satisfaction in service. Two methods that have been used are as follows: The broaches were designed to have the blade secured by means of screws, and each blade was in two parts, held by a screw at each end. The blades were let into slots in the stock and butted to the slot end. Although this set of broaches did much work, they were a constant source of trouble.

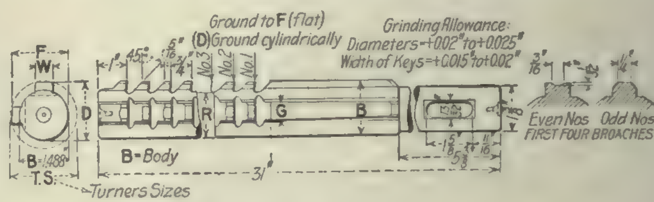


FIG. 7. STANDARD KEYWAY BROACH

Method To Hold on the Blades

The other method, which is illustrated in Fig. 6, had some interesting points. It will be seen that the way in which the blades are held is the one adopted on reamers. The blades are secured in the center by a pad wedge, bearing on a ridge formed on the blades. This is not shown. The body for the broach has a groove cut in the end for the ring *A*. The two slots for the broach blades are milled from end to end. The ring *A* forms a stop for the blades, which are kept tight in position by the screwed ring *B*. For large broaches where this design can be applied, it has distinct advantages over the one already mentioned. From the tool maker's point of view, advantage is derived from the fact that the slots for containing the blades are milled through and can thus be ground true after hardening. This admits grinding the blades correct to width in their flat state and, incidentally, spare blades may be kept ready for insertion.

Coming now to the solid type, Fig. 7, I have found that this style of keyway broach gives the best results because of the various reasons stated and for the further reason that I have never yet been able to keep the inserted blades tight in their position. Invariably they work loose and are a constant source of trouble. On the other hand, the only drawback to the solid broaches is that, because they are solid, they appear to be costly.

Experience has, however, demonstrated that, when accurate production is required, the solid type costs less to install and keep in order than do those with loose blades. In making the solid-type double keyway broaches the stock is centered and turned, the size for the tooth portion being taken at the first and last tooth and turned parallel. Afterward a taper cut from one to the other completes the turning. Before the broaches are taken from the lathe, the positions of the teeth are lightly marked by rings made with a pointed tool. The next operation is milling away the bulk of the material, leaving $\frac{1}{32}$ in. all round for the final milling. The teeth are cut in the shaping machine with a form tool made to the correct shape of the space. This tool is fed downward at an angle of 10 deg., thus giving the necessary front rake to the teeth. The operation of shaping the teeth is a very rapid one, as a boy can do this work on 100 teeth in 6 hr. After the key slot is milled in line with one of the rows of teeth, the whole broach is milled down to 0.015 to 0.025 in. over size. It is then ready for carbonizing.

Allowable Load per Tooth

The allowable load per tooth of a double keyway broach can only be—with safety—the same as for a six- or eight-spline broach working on the same material. The figuring up, however, must be done differently. The reason for this is as follows: In double keyway broaches with the keys at right angles to each other, when measurements are taken after the milling is done, the measurements are not made the full diameter, but only across the body and one tooth. This, of course, applies also to spline broaches with an odd number of splines. Therefore, the rise per tooth to be allowed on the table showing sizes for a six-spline broach would be double the rise per tooth given on the table for a double keyway broach having the same load per tooth.

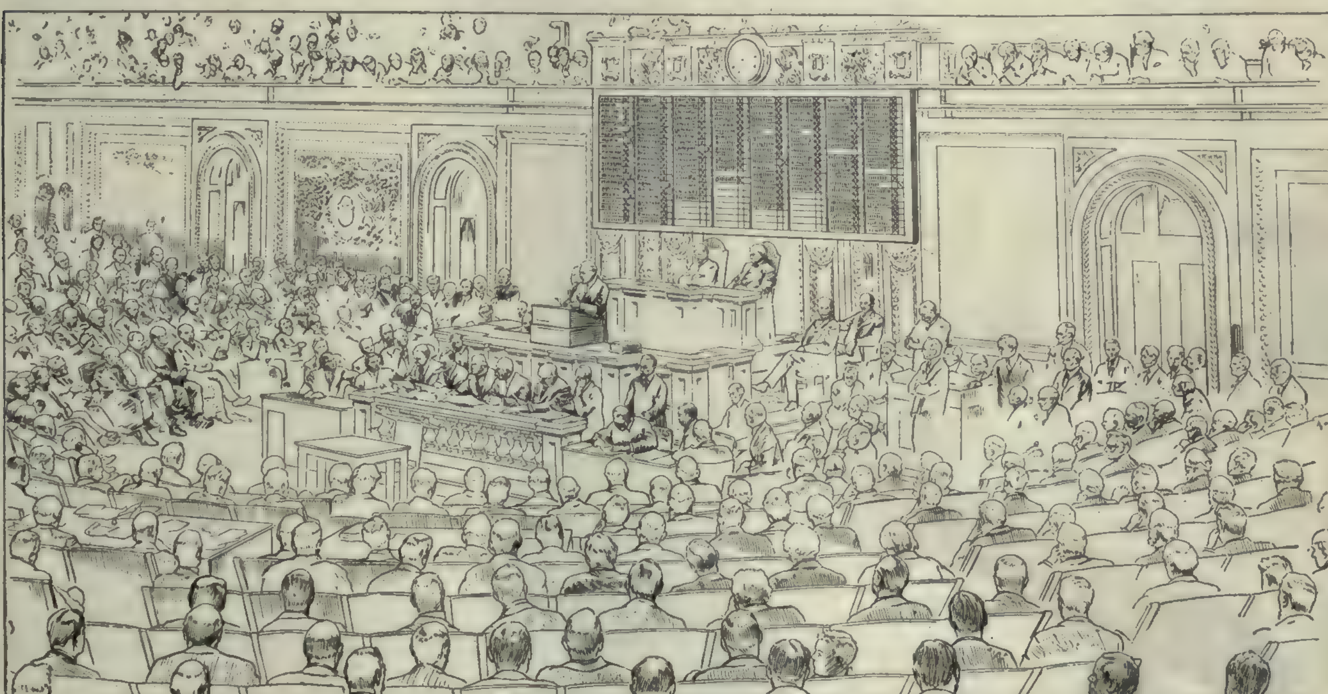
A standard sheet for this type of broach is shown in the table, made for broaches with 28 as the maximum number of teeth. This covers the range of length that can be made on an ordinary-size miller. Two points in Fig. 7, need special mention. Keyways, when finished, have square bottoms, while the dimension D is finished as a radius. This means that the last few teeth have to be ground flat on the surface grinder. The dimension F covers this point and represents the size of the hole plus the depth of the keyway in the work. Another point is the dimension C. This may be expressed either as shown or as the depth of the chip space. As shown, the chip space would vary in depth. When the spaces are shaped in with a form tool, R is best expressed as the depth to be cut. To avoid repetition, the load per tooth and the method of applying the load for keyway broaches will be discussed under spline broaches, from which they do not differ in any essential detail.

The sizes that were used for a very successful set of broaches are given in the table. These broaches have done good work on deep keyways in gears made from tough steels used in the automobile trade. The lengths of the holes varied from 3 to 4 in.

Congress Should Vote by Machinery

By Wilfred Lewis*

Did you ever stop to consider the enormous waste of time in Congress and other legislative bodies in the simple expression of their will, after discussion has been closed? I was astonished to find that it generally takes an hour and a half to call the roll and record the vote of the House of Representatives. It seemed to me, when I was in the Capitol, that in this "electrical age" the whole thing might be done in half a minute or less with more precision and fewer chances for error.



TIME-SAVING DEVICE FOR RECORDING THE VOTE OF CONGRESS

It occurred to me while listening to the debates in the House, followed by such interminable roll calls, that a vote on any question had better be "seen than heard," that the old maxim should not be applied exclusively to

*President, Tabor Manufacturing Co.

children. The talk, of course, will go on forever, but with a little preparation the vote might be flashed instantly on a screen back of the speaker in full view of every member and be photographed by an operator in the gallery near the clock. This procedure would require that every member of the House have a lock-box in front of his seat which, when opened, would cause his name to appear in a certain space on the wall or screen. When a vote was called for, he would press a button showing "yes" or "no" opposite his name, or simply vote "present" by doing nothing. The number or title of the bill would be displayed at the same time; and if the record was illuminated, it could be quickly photographed.

I believe the time will come when all legislative bodies will be equipped for voting in this expeditious way, and that the same method will be adopted by engineering and other bodies that have no time to burn.

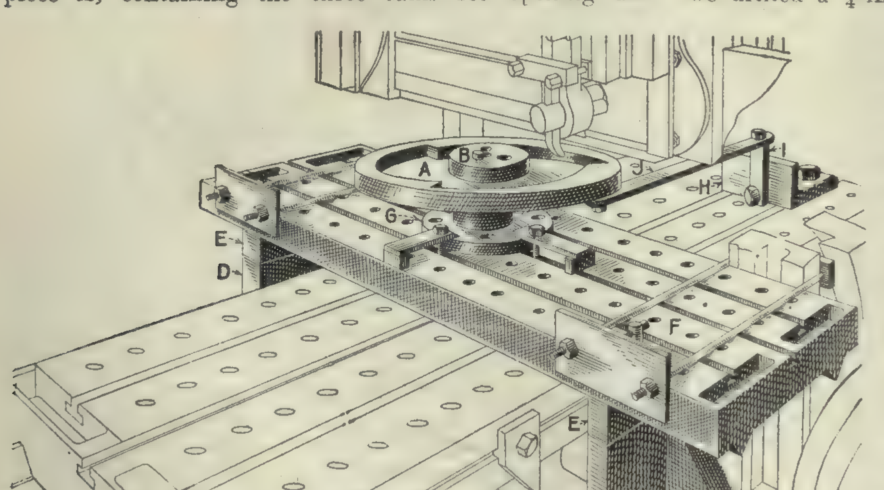
You can readily estimate the cost of the voting done by 500 or 1000 high-priced men day after day and year after year in the present absurd way. The cost of installing effective voting machinery in Congress might be considerable, but it would soon be saved at the rate of perhaps $2000 an hour in the cost of legislation; and more time could also be given to the consideration of the bills presented.

The illustration gives an idea of how the installation might appear.

Machining a Three-Jawed Chuck Cam on the Planer

By Earl F. Hayward

In a small shop where I was recently employed we had to make a three-jawed chuck large enough to take in 6-in. pipe. We got along very well until we came to the piece *A*, containing the three cams for opening and closing the jaws. Not having a miller large enough for the job, we thought first of using a large drilling machine, but gave it up in favor of the planer and finally decided upon the following rig:



PLANNING THE CAMS FOR A THREE-JAWED CHUCK

The first thing was to make an arbor. We secured a casting *B*, 12 in. in diameter by 1 in. thick, with a hub 2 in. long and 8 in. in diameter. We put a 1¼-in. hole through the center of the hub, mounted it on an arbor and turned it down to fit the hole in the casting *A*, leaving a 1-in. flange to drive the casting up against. The next step was to lay out very carefully three holes in the hub the required distance off center to give us the right curve on the cams. We then put the arbor on a faceplate and bored and reamed the holes. Removing the hub from the lathe, we forced it into the casting, taking care to have the three holes in correct position in relation to the cams. We were then ready to rig up the planer.

First, we carried two large angle irons *D* to the planer and put them on the floor, one on each side of the table, just in front of the uprights. We placed a parallel *E* on the top of each angle, so as to make them about ½ in. higher than the top of the table. Then an extra planer table *F* was set on the two angle irons, forming a sort of bridge that the table would just pass under. The weight of the extra table being sufficient to keep it down, all that was necessary to secure it in position was to strap it back against the uprights. This gave us a good solid table to put our work upon.

Turning up a 1¼-in. stud, we drove it into an old shaft coupling *G* and then squared up the end of the coupling. We placed this about in the center of our built-up table and strapped it down. Another angle iron *H* was strapped to the table of the planer about 3½ ft. back of our built-up table. Taking a piece of 2 x ¾-in. machine steel a foot long, we turned up a stud *I* on one end, 2 in. long, ¾ in. in diameter, and bolted it to the angle iron in an upright position. The work with the arbor inserted was mounted on the stud that we had previously bolted to the constructed table.

Cutting off a piece of 2 x ½-in. iron about 4 ft. long, we drilled a ¾-in. hole in one end and a ½-in. hole in the other end. The ¾-in. hole end was put on the ¾-in. stud; the other end was connected to the work by a ½-in. bolt through one of the three ½-in. holes that had been drilled at the time of turning the outside diameter. This made a connecting-rod *J* between the moving planer table and the work on the stationary built-up table. When the planer was started, the connecting-rod pushed the work around on the stud; and when the planer reversed, it pulled the work back again. By adjusting the shifting dogs on the planer we got just the right length of stroke, which imparted the reciprocating motion to the work and gave it about one-third of a turn forward and back. The illustration shows the built-up table and the work on it. The rest was easy—simply squaring down the surface in the usual manner. Having finished one surface, all that we had to do was to lift the work off the stud and put it on again on the next hole and move the connecting-rod to another of the ½-in. holes. In this way we got a much better surface on the cams than we would have by milling.

United States Munitions*

The Springfield Model 1913 Service Rifle

Drift Slides, Windage Screw, and Butt Plate I

SYNOPSIS—The standard peep sight is 0.05 in. in diameter but both the 0.04 and 0.06 are given. The windage screw and butt plate also have some interesting fixtures and gages.

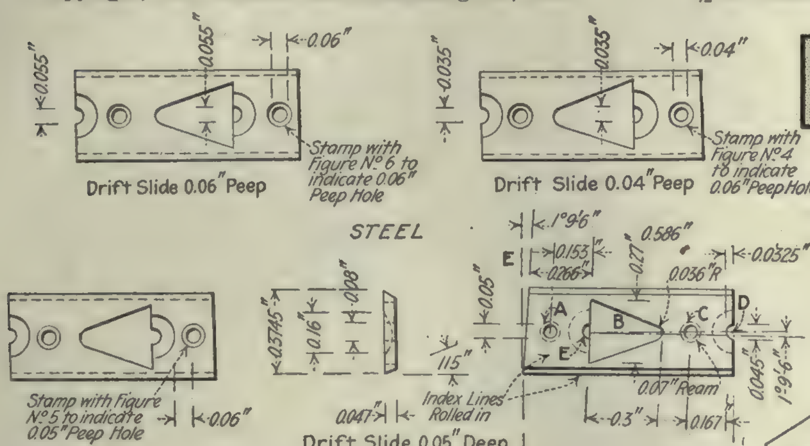


FIG. 1631


FIG. 1632, OP. A

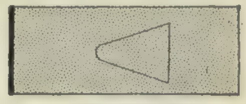


FIG. 1633, OP. 14

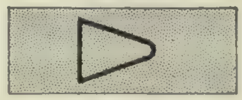


FIG. 1634


FIG. 1636

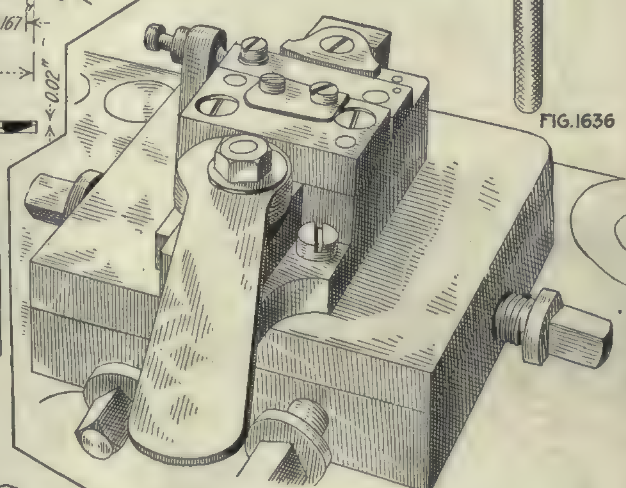


FIG. 1635, OP. 10


FIG. 1637

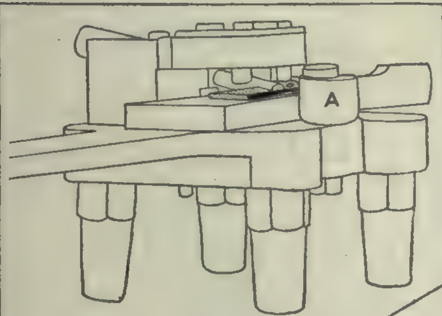


FIG. 1638
OPERATION 3

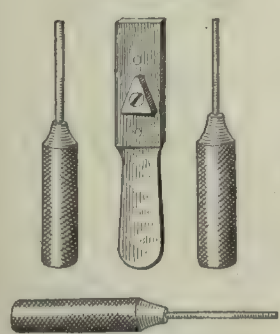


FIG. 1639

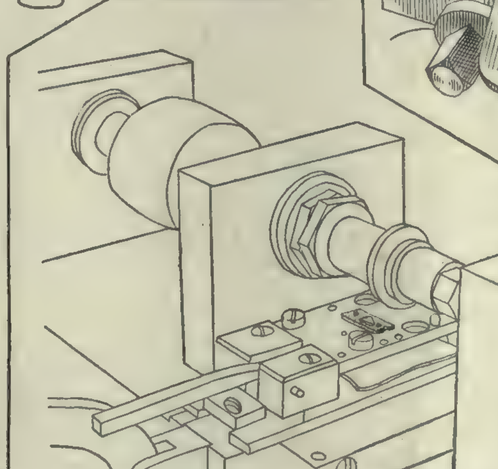


FIG. 1641 OPERATION 5


FIG. 1640

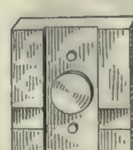


FIG. 1642

OPERATIONS ON THE DRIFT SLIDE, 0.05 PEEP

Operation
A Blanking
B Cold dropping
14 Hand milling rear end
10 Shaving field view
CC Removing burrs left by operation 10
3 Drilling pin and peep holes
AA Removing burrs left by operation 3
4 Reaming pin and peep holes
5 Stamping index lines
BB Removing burrs left by operation 4
9 Countersinking pin and peep holes and sighting notch
DD Removing burrs left by operation 9
GG Reaming burrs left by indexing and countersinking
13 Milling edges
EE Removing burrs left by operation 13
11 Milling front end
12 Milling rear end
FF Removing burrs left by operations 11 and 12
15 Filing, general cornering
16 Assembling with pin
17 Reaming peep hole
19 Bluing

OPERATION A. BLANKING

Transformation—Fig. 1632. Machine Used—Perkins No. 5, 1½-in. stroke, automatic rod feed. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Setscrew. Stripping Mechanism—Steel stripper curved to face of die. Average Life of Punches and Dies—20,000 pieces. Lubricant—Stock oil with cutting oil. Production—4000 pieces per hr.

OPERATION B. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after blanking. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Prod.—900 per hr.

OPERATION 14. HAND MILLING REAR END

Transformation—Fig. 1633. Machine Used—Garvin No. 3. Number of Operators per Machine—One. Work-Holding Devices—Held on mandrel and milled, 30 or 40 pieces at a time. Tool-Holding Devices—Standard arbor. Cutting Tools—Plain milling cutter. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—25,000 pieces. Production—900 pieces per hr.

OPERATION 10. SHAVING FIELD VIEW

Transformation—Fig. 1634. Machine Used—Snow-Brooks No. 0 press. Number of Operators per Machine—One. Punches and Punch Holders—Held in round shank. Dies and Die Holders—Fixture screwed to bed, Fig. 1635. Stripping Mechanism—None. Average Life of Punches and Dies—10,000 pieces. Lubricant—Cutting oil, put on with brush. Gages—Fig. 1636, size and shape of hole. Production—350 pieces per hr. Note—Work held on pins clamped by jaws.

OPERATION 4. REAMING PIN AND PEEP HOLES

Machine Used—Sigourney Tool Co. three-spindle 10-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, same as Fig. 1638. Tool-Holding Devices—Drill chuck. Cutting Tools—Reamer. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1639; sight is held on triangle while pins gage diameter and location of hole. Production—125 pieces per hr.

OPERATION 5. STAMPING INDEX LINES

Transformation—Fig. 1640. Number of Operators—One. Description of Operation—Rolling index lines. Apparatus and Equipment Used—Special machine on bench, Fig. 1641. Gages—Fig. 1642; locates slide on pins and gages location of lines. Production—600 pieces per hr.

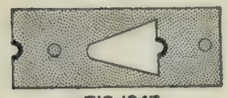


FIG. 1643

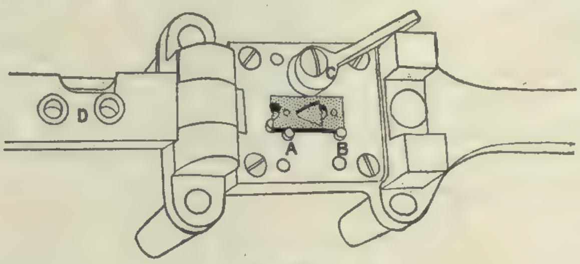


FIG. 1644

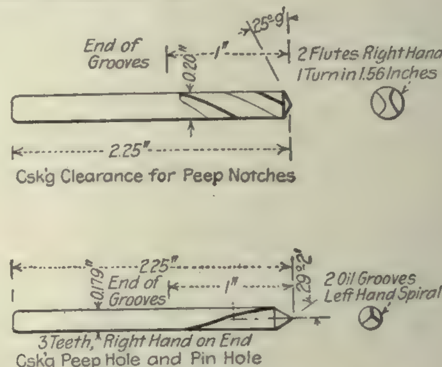


FIG. 1645

FIG. 1646

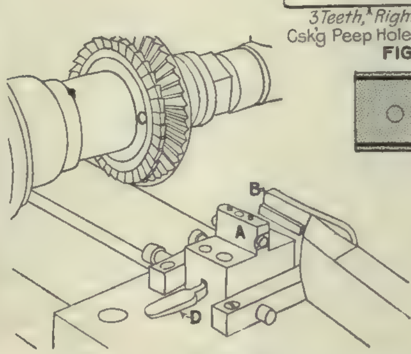


FIG. 1647

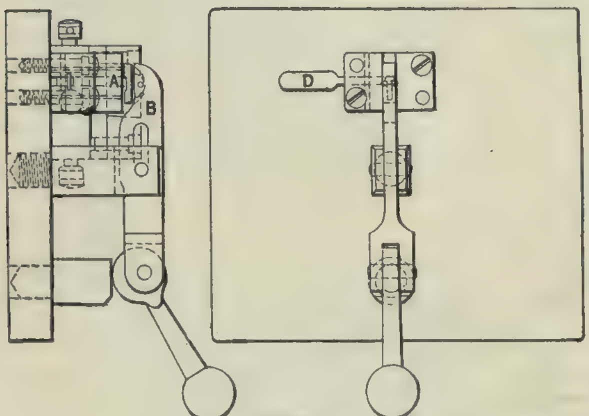


FIG. 1648

FIG. 1643, 1644 & 1645 OPERATION 9
FIG. 1646, 1647, 1648 & 1649 OP. 13
FIG. 1650, 1651, 1652 & 1653 OP. 11 & 12

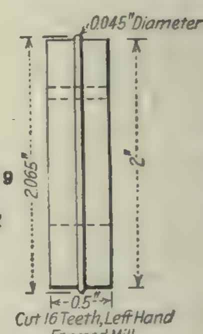


FIG. 1652

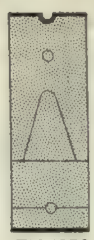


FIG. 1650

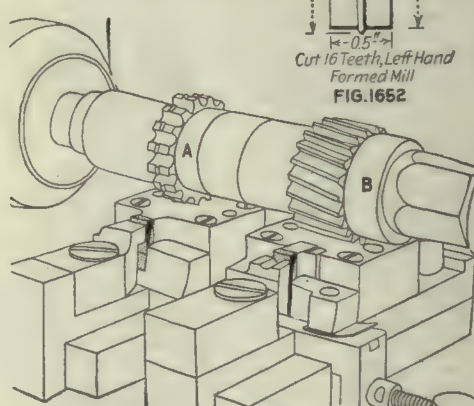


FIG. 1651

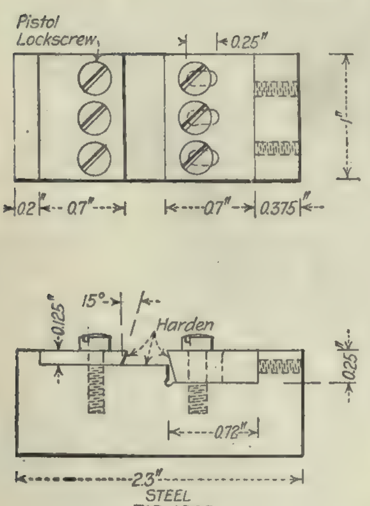


FIG. 1649

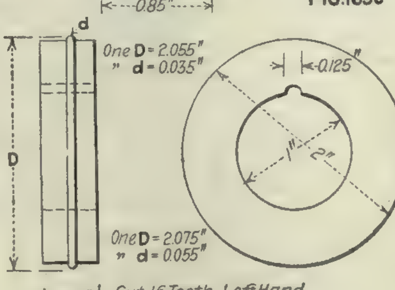


FIG. 1653

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 10

Number of Operators—One. Description of Operation—Removing burrs from operation 10. Apparatus and Equipment Used—File. Production—Grouped with operation 10.

OPERATION 3. DRILLING PIN AND PEEP HOLES

Transformation—Fig. 1637. Machine Used—Sigourney Tool Co. three-speed. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1638; work wedged against pins at back by cam A. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—None. Production—80 pieces per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 3

Number of Operators—One. Description of Operation—Removing burrs left by operation 3. Apparatus and Equipment Used—File. Production—Grouped with operation 3.

OPERATION BB. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs from operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 5.

OPERATION 9. COUNTERSINKING PIN AND PEEP HOLES AND SIGHTING NOTCH

Transformation—Fig. 1643. Machine Used—Sigourney Tool Co. three-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1644; work is held against pins A and B by cam C; bushings are carried in leaf D. Tool-Holding Devices—Drill chuck. Cutting Tools—Countersink, Fig. 1645. Number of Cuts—Two. Cut Data—1,200 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—None. Production—100 pieces per hr. Note—Sights are countersunk through holes in leaf of jig, then pin holes are trimmed out with leaf swung back.

OPERATION DD. REMOVING BURRS LEFT BY OPERATION 9

Number of Operators—One. Description of Operation—Removing burrs from operation 9. Apparatus and Equipment Used—File. Production—Grouped with operation 9.

OPERATION GG. REAMING BURRS LEFT BY INDEXING AND COUNTERSINKING

Number of Operators—One. Description of Operation—Removing burrs from pin and peep holes. Apparatus and Equipment Used—Hand reamer. Production—Grouped with operation 9.

OPERATION 13. MILLING EDGES

Transformation—Fig. 1646. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pins, clamped by finger clamp, Fig. 1647; pins are shown at A, holding finger at B; mills C straddle work and mill both sides at once; lever D operates a knock-off; details in Fig. 1648. Tool-Holding Devices—Standard arbor. Cutting Tools—Side-cutting rivets to give 15-deg. angle to sides of slide. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5,000 pieces. Gages—Fig. 1649, sides of dovetail. Production—120 pieces per hr. Note—This operation was formerly profiled.

OPERATION EE. REMOVING BURRS LEFT BY OPERATION 13

Number of Operators—One. Description of Operation—Removing burrs thrown up by operation 13. Apparatus and Equipment Used—File. Production—Grouped with operation 13.

OPERATIONS 11 AND 12. MILLING FRONT AND REAR ENDS

Transformation—Fig. 1650. Machine Used—Standard No. 4½ universal. Number of Operators per Machine—One. Work-Holding Devices—Located on pins, clamped by vise jaws, Fig. 1651. Tool-Holding Devices—Standard arbor. Cutting Tools—Two milling cutters, Fig. 1652, for upper and for lower end; a special cutter is shown in Fig. 1653. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—120 pieces per hr.

OPERATION FF. REMOVING BURRS LEFT BY OPERATIONS 11 AND 12

Number of Operators—One. Description of Operation—Removing burrs from operations 11 and 12. Apparatus and Equipment Used—File. Production—Grouped with operations 11 and 12.

OPERATION 15. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing and cornering. Apparatus and Equipment Used—File. Production—75 pieces per hr.

OPERATION 16. ASSEMBLING WITH PIN

Number of Operators—One. Description of Operation—Riveting in place. Apparatus and Equipment Used—Riveting hammer and block. Production—125 pieces per hr.

OPERATION 17. REAMING PEEP HOLE

Number of Operators—One. Description of Operation—Reaming peep hole. Apparatus and Equipment Used—Speed lathe and reamer, Fig. 1873. Production—1,000 pieces per hr.

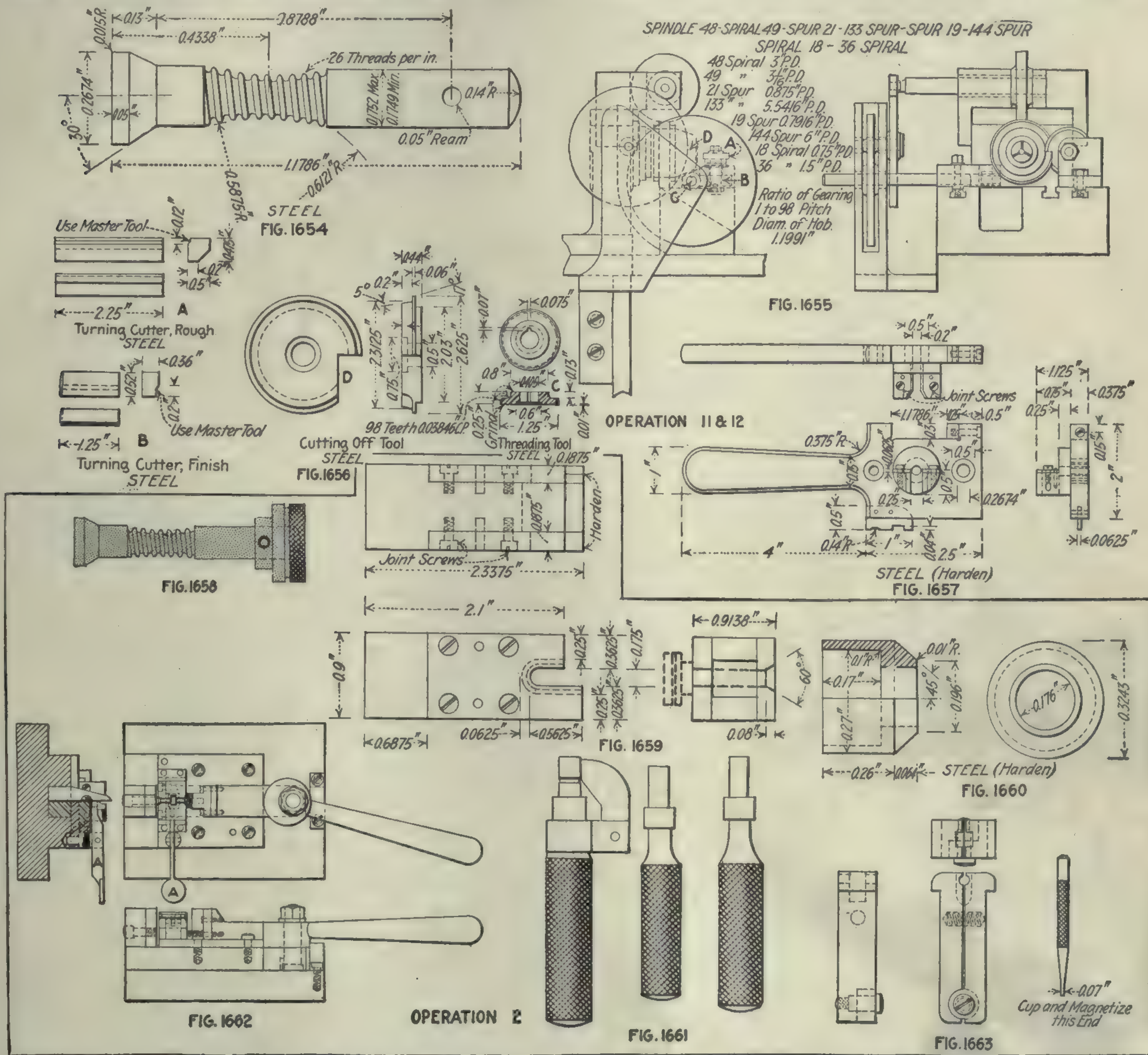


FIG. 1654 FIG. 1655 FIG. 1656 FIG. 1657 FIG. 1658 FIG. 1659 FIG. 1660 FIG. 1661 FIG. 1662 FIG. 1663

OPERATION 19. BLUING

Number of Operators—One. Description of Operation—Blue in niter at 800 deg. F. Apparatus and Equipment Used—Usual equipment.

OPERATIONS ON THE WINDAGE SCREW

Operation
1 Automatic
2 Drilling knob and screw
7 Windage screw collar on automatic
3 Pinning
4 Polishing
5 Bluing
6 Filing

OPERATION 1. AUTOMATIC

Machine Used—Pratt & Whitney automatic with special hobbing attachment. Number of Machines per Operator—Four. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Hobbing attachment, Fig. 1655; hob A is revolved by

worm and worm gear B and C, while screw is supported by back rest D; other tools in Fig. 1656; A and B, turning tools; C, hob; D, circular cutoff tool. Number of Cuts—Four. Cut Data—700 r.p.m.; ⅜-in. feed. Coolant—Cutting oil, ⅜-in. stream. Average Life of Tool Between Grindings—2000 pieces. Gages—Fig. 1657, length, diameter of body and head, rounded end, etc. Production—40 pieces per hr.

OPERATION 2. DRILLING KNOB AND SCREW

Transformation—Fig. 1658. Machine Used—Any drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, inch V-blocks. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills. Cut Data—900 r.p.m.; hand feed. Coolant—Cutting oil, 1/16-in. stream. Average Life of Tool Between Grindings—150 pieces. Gages—Fig. 1659, distance between collar and knob. Production—60 pieces per hr.

OPERATION 1. AUTOMATIC

Transformation—See Fig. 1882. Machine Used—Cleveland ⅝-in. automatic. Number of Machines per Operator—Four. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Regular layout. Number of Cuts—Four. Cut Data—900 r.p.m.; 1/16-in. feed. Coolant—Cutting oil, ⅜-in. stream. Average Life of Tool Between Grindings—1500 pieces. Gages—Fig. 1661. Production—60 pieces per hr.

OPERATION 3. ASSEMBLING AND PINNING KNOB

Transformation—See assembled rear sight in Fig. 1427. Number of Operators—One. Description of Operation—Pinning and assembling collar spring and knob, using the vise shown in Fig. 1662 for compressing spring and holding while driving the pin; lever A forces the assembled piece out of the vise. Apparatus and Equipment Used—Special vise, Fig. 1662; holder and set, Fig. 1663; the set is magnetized to pick up pin, and the end is cupped. Production—125 per hr.

OPERATIONS ON THE BUTT PLATE

Operation	
A	Blocking from bar and hot trimming
A-1	Pickling
B	Dropping
B-1	Pickling
C	Trimming
D	Dropping and bending tang
F	Annealing
F-1	Pickling
G	Cold dropping
1	Punching screw holes in tang
2	Punching screw and thong-case holes
3	Milling edges of tang
4½	Burring operations 2, 3 and 4 (5, 12, 12½, 11 grouped)
5	Milling top of plate, top and sides of hinge lug and top of spring-screw boss crosswise
6	Hand-milling both sides and slot in hinge lug lengthwise
7-B	Drilling for spring screw
10	Counterboring screw holes in plate and tang
11	Milling surface of tang lengthwise
7	Drilling pin hole in hinge lugs
14	Hand-milling thumb notch
9	Hand-milling slot in plate for tang of cap
17	Filing hinge lugs and spring-screw boss and fitting
18	Assembling butt plate with butt-plate cap
18½	Straightening and burring
12	Checking bottom of plate lengthwise
12½	Checking bottom of plate crosswise
13	Tapping spring-screw hole
8	Beveling edges of thong-case hole
19	Polishing
20	Assembling butt-plate cap spring to butt plate
20-A	Countersinking
21	Casehardening

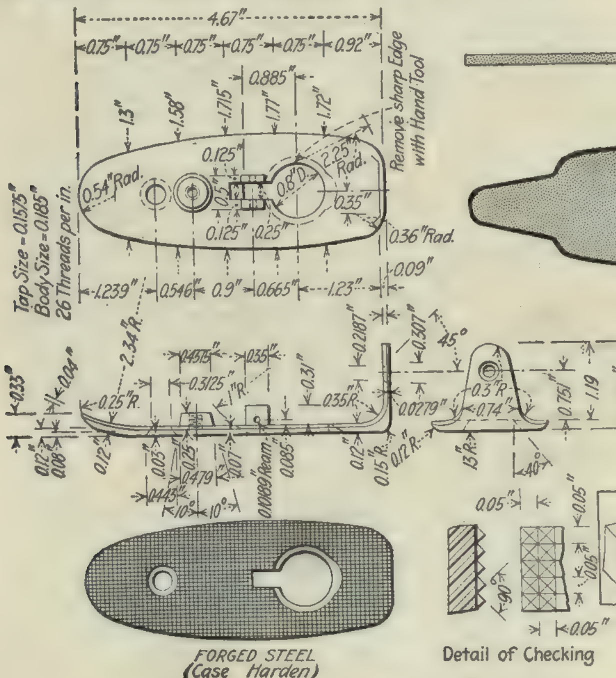


FIG. 1664

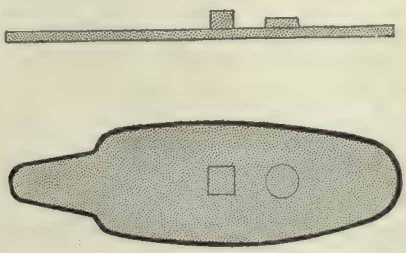


FIG. 1665, OP. A

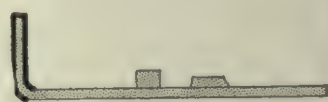


FIG. 1666
OP. D

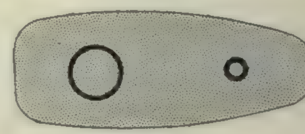


FIG. 1668

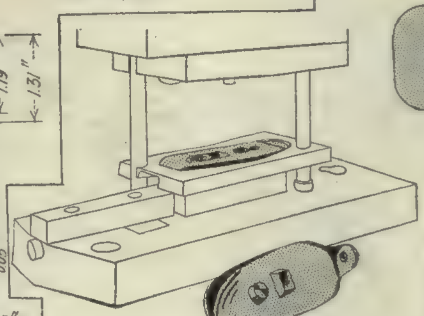


FIG. 1669
OPERATION 2

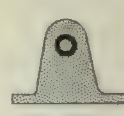


FIG. 1667
OP. 1

OPERATION 4. POLISHING

Number of Operators—One. Description of Operation—Polishing end of knob. Apparatus and Equipment Used—Polishing jack and wheel. Production—900 pieces per hr.

OPERATION 5. BLUING

Number of Operators—One. Description of Operation—Blue in niter at 800 deg. F. Apparatus and Equipment Used—Usual equipment.

OPERATION 6. FILING

Number of Operators—One. Description of Operation—Filing burrs. Apparatus and Equipment Used—File held in hand. Production—250 per hr.

Butt Plate

The butt plate, Fig. 1664, is made of Class D steel, of 0.88x0.48-in. rectangular section. The service of the butt plate is very severe, as the rifle is dropped several inches to the ground in many drill evolutions. It must protect the end of the gun stock from local stresses and shocks which would splinter it unless effectually covered in this way. The butt plate is checked by milling it in two directions, so as to prevent its slipping when in position against a man's shoulder.

OPERATION A. BLOCKING FROM BAR AND HOT TRIMMING

Transformation—Fig. 1665. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 800-lb. drop hammer. Production—100 pieces per hr. Note—Trimmed in old Bliss press, 3-in. stroke.

OPERATION A-1. PICKLING

Number of Operators—One. Description of Operation—Put in wire baskets and placed in the pickling solution, 1 part sulphuric acid and 9 parts water, and left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

OPERATION B. DROPPING

Number of Operators—One. Description of Operation—Same as operation A. Apparatus and Equipment Used—Same as operation A. Production—125 pieces per hr. Note—In this operation the tang is left straight; the plate is heated for this.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling.

OPERATION C. TRIMMING

Machine Used—Perkins press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe, by setscrew. Stripping Mechanism—Pushed through die. Average Life of Punches and Dies—15,000 pieces. Lubricant—None. Gages—None. Production—500 pieces per hr.

OPERATION D. DROPPING AND BENDING TANG

Transformation—Fig. 1666. Number of Operators—One. Description of Operation—Heating and bending tang. Appar-

atus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—130 pieces per hr.

OPERATION F. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots with powdered charcoal, heated to 850 deg. C. (1562 deg. F.), left over night to cool. Apparatus and Equipment Used—Iron pots, Brown & Sharpe annealing furnace, oil burners, powdered charcoal.

OPERATION F-1. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling.

OPERATION G. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening to shape. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—500 pieces per hr.

OPERATION 1. PUNCHING SCREW HOLES IN TANG

Transformation—Fig. 1667. Machine Used—Garvin No. 1, with 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Screwed to plate bolted to bed of press. Stripping Mechanism—Steel stripper screwed to face of die. Average Life of Punches and Dies—10,000 pieces. Gages—See Fig. 1673. Production—700 pieces per hr. Note—Speed, 120 strokes per min.

OPERATION 5. MILLING TOP OF PLATE, TOP AND SIDES OF HINGE LUG AND TOP OF SPRING-SCREW BOSS CROSSWISE

Transformation—Fig. 1674. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Located on pin A, clamped with vise jaws, Fig. 1675. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1676. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Work gage and inspecting-room gage for tang, etc. Production—35 pieces per hr.

OPERATION 6. HAND-MILLING BOTH SIDES AND SLOT IN HINGE LUG LENGTHWISE

Transformation—Fig. 1677. Machine Used—Reed hand miller. Number of Operators per Machine—One. Work-Holding Devices—Located on pin, clamped from sides, similar to Fig. 1675. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of three milling cutters, 1.625 in. in diameter, 0.25 and 0.375 in. wide, spaced as shown. Number of Cuts—One. Cut Data—200 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1678. Production—125 pieces per hr. Note—Same fixture as operation 9.


FIG. 1670

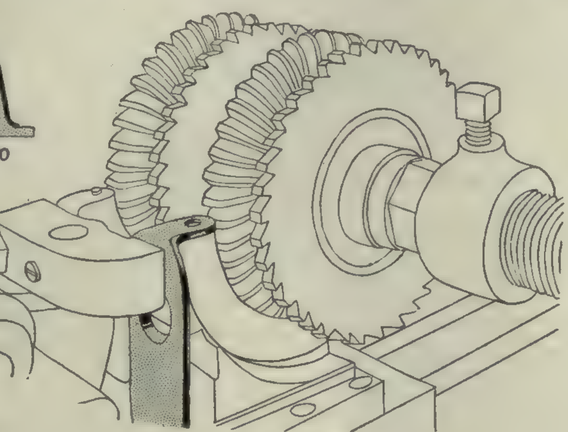


FIG. 1671

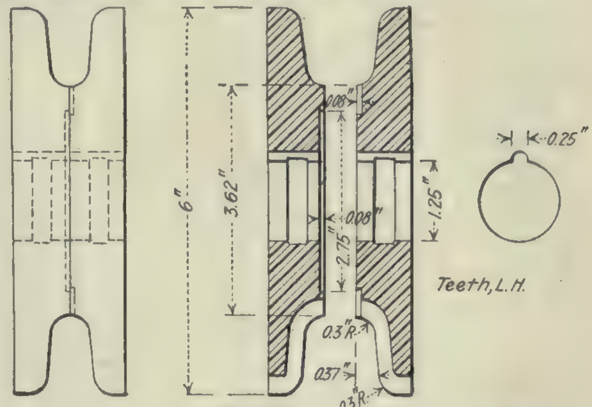


FIG. 1672

OPERATION 3

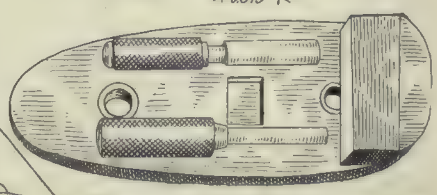


FIG. 1673

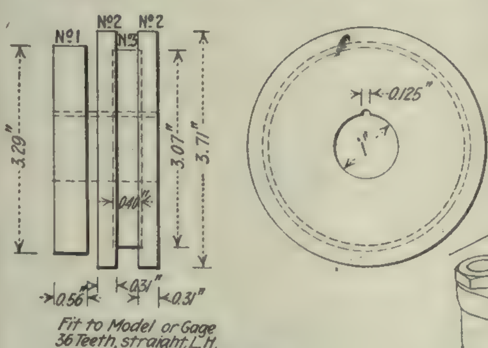


FIG. 1676

OPERATION 5

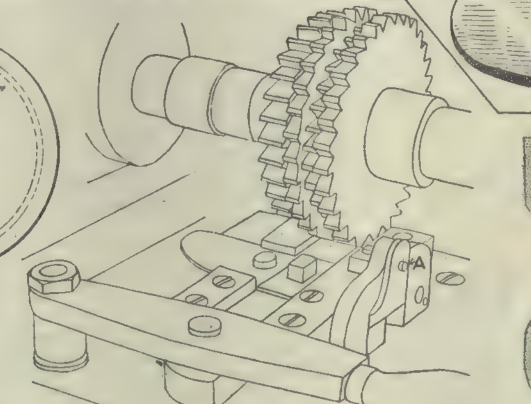


FIG. 1675

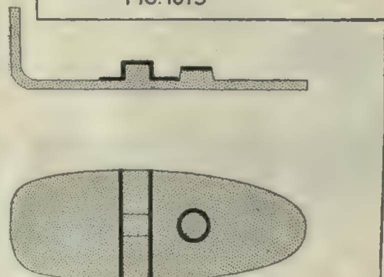


FIG. 1674

OPERATION 2. PUNCHING THONG-CASE HOLES

Transformation—Fig. 1668. Machine Used—Bliss No. 21 back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank, Fig. 1669; punch screwed to plate, plate bolted to bed of press. Dies and Die Holders—Die screwed to punch holder; trims the outside of butt plate. Stripping Mechanism—Plates are forced out of die and punch holder by pins, which are controlled by guide pins on the side of the die; these pins project down through the shoe with nuts and washers on the bottom end; as the press goes back into position, these pins force the plate down out of the die. Average Life of Punches and Dies—10,000 pieces. Lubricant—Punches oiled with cutting oil. Gages—Plug, for diameter. Production—300 pieces per hr.

OPERATION 3. MILLING EDGES OF TANG

Transformation—Fig. 1670. Machine Used—Pratt & Whitney No. 3 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Work located on pin, clamped with finger clamps, Fig. 1671. Tool-Holding Devices—Standard arbor. Cutting Tools—Pair of formed cutters, Fig. 1672. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1673, form of tang and holes. Production—25 pieces per hr.

OPERATION 4½. BURRING OPERATIONS 2, 3 AND 4

Number of Operators—One. Description of Operation—Removing burrs from operations 2, 3 and 4. Apparatus and Equipment Used—File. Production—Grouped with 5 and 12.

OPERATION 7-B. DRILLING FOR SPRING SCREW

Transformation—Fig. 1679. Machine Used—Dwight-Slate 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig of types previously shown. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill for 0.1575-in. tap, 26 threads per inch. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—None. Production—125 pieces per hr.

OPERATION 10. COUNTERBORING SCREW HOLES IN PLATE AND TANG

Transformation—Fig. 1680. Machine Used—Ames two-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Held in block, Fig. 1681, with hole in block to allow for counterbore; stop screwed to plate to hold work from swinging; block A counterbores tang, B the other hole. Tool-Holding Devices—Taper shank. Cutting Tools—Counterbores, for each hole. Number of Cuts—Two. Cut Data—250 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Fig. 1682, double-ended bevel. Production—120 pieces per hr.

OPERATION 11. MILLING SURFACE OF TANG LENGTHWISE

Transformation—Fig. 1683. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Work held upright, located on

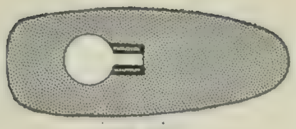


FIG.1677

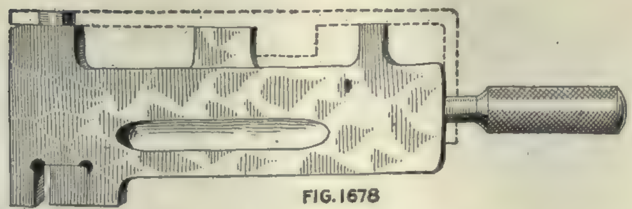


FIG.1678

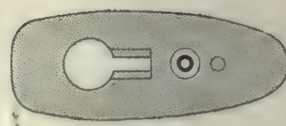


FIG.1679

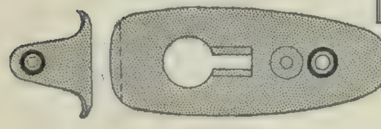


FIG.1680

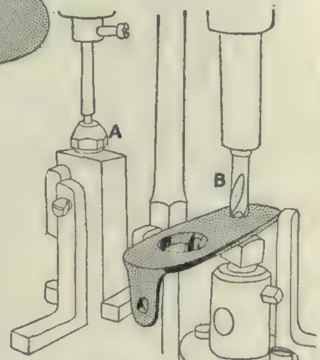


FIG.1681

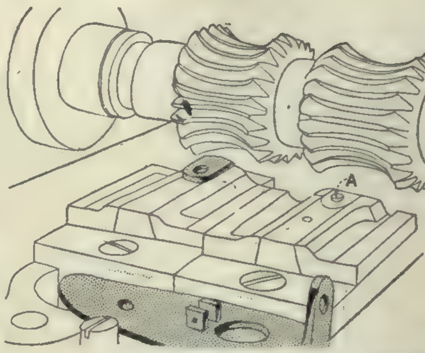


FIG.1684

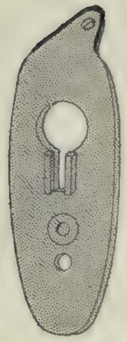


FIG.1683

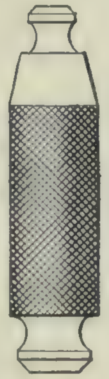
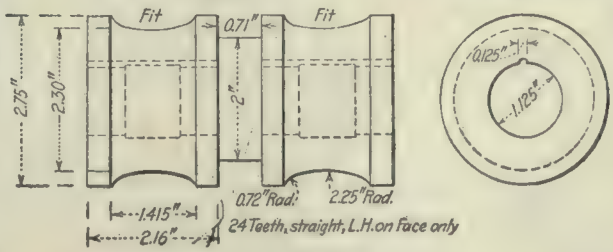


FIG.1682



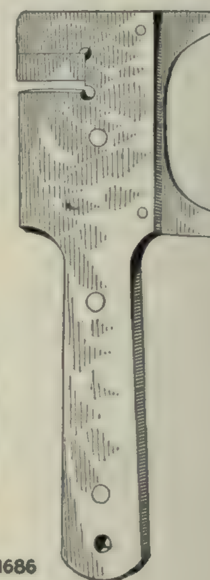


FIG.1686

FIG.1677, 1678 OP. 6
FIG.1679 OP. 7B
FIG.1680, 1681, 1682 OP. 10
FIG.1683, 1684, 1685, 1686 OP. 11

FIG.1685

pin A, clamped by jaws, Fig. 1684. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1685. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1686, contour and thickness of tang. Production—50 pieces per hr.

OPERATION 8. BEVELING EDGES OF THONG-CASE HOLE

Transformation—Fig. 1687. Machine Used—Ames three-spindle 16-in. upright. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1688. Tool-Holding Devices—Taper shank. Cutting Tools—Counterbore with pilot. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1689; two plugs, "go" and "not go"; plate is put over plug and straight-edge A used on the inside, also a workman's bevel plug gage. Production—120 pieces per hr.

OPERATION 7. DRILLING PIN HOLE IN HINGE LUGS

Transformation—Fig. 1690. Machine Used—Sigourney Tool Co. 16-in. three-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1691. Cutting Tools—Twist drill. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Plug for diameter and a location gage. Production—90 per hr.

OPERATION 14. HAND-MILLING THUMB NOTCH

Transformation—Fig. 1692. Machine Used—Garvin No. 2 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin by screw clamp B, Fig. 1693. Tool-Holding Devices—Taper shank. Cutting Tools—No. 4 taper-shank milling cutter, 1.03 in. in diameter by 0.75 in. wide; 12 left-hand teeth. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Coolant—Cutting oil. Gages—Fig. 1694, angle of thumb notch. Production—350 per hr.

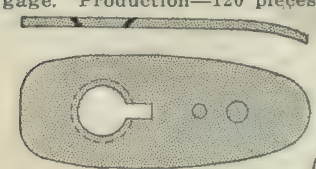


FIG.1687

FIG.1690

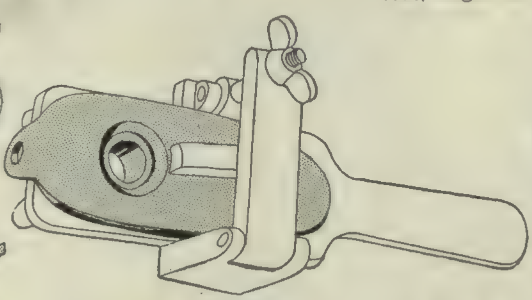


FIG.1688

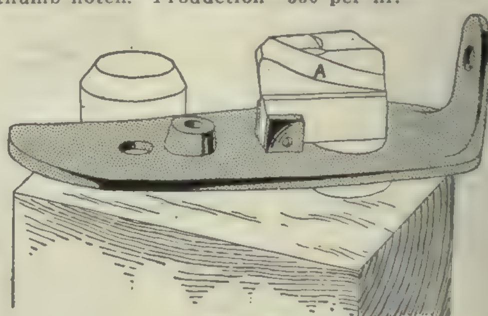


FIG.1689

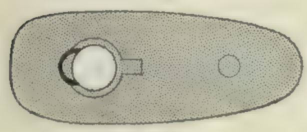


FIG.1692

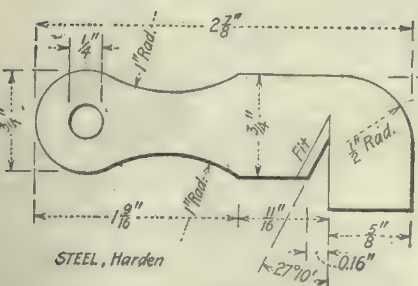


FIG.1694

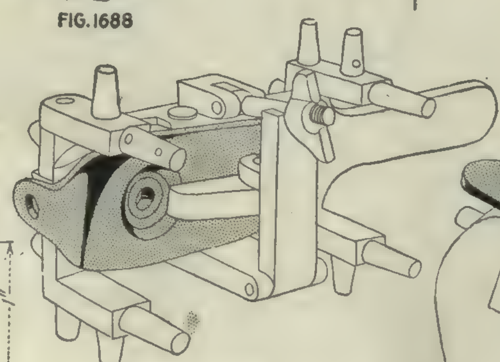


FIG.1691

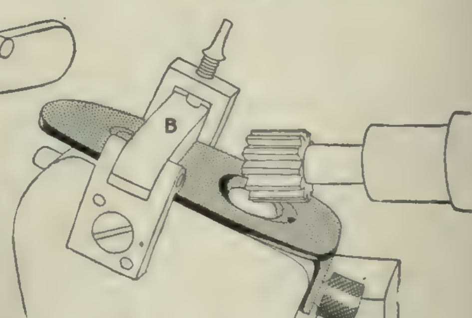


FIG.1693

FIG. 1687, 1688 & 1689 OPERATION 8
FIG. 1690 & 1691 OPERATION 7
FIG. 1692, 1693 & 1694 OPERATION 14

Central Control of Production Methods

By Francis J. G. Reuter*

SYNOPSIS—A plea for the concentration of all studies to improve production methods under one head, and a suggestion for an organization for this work. A specimen study on tapping operations on miscellaneous parts.

Few factories have anything like a systematic organization to take care of the development of production methods. Those who have it are not anxious to tell about it. In general, new methods and improvements are handled crudely. Sometimes this work is done by men appointed for such work and scattered in various departments without a central control to give proper guidance and practical advice and keep the records of all investigations and proceedings. Too often these men are working as they see fit and therefore duplicating efforts and wasting energy. In many instances these men are not prepared and educated to handle such work efficiently.

Some factories have a committee on improvements, to which suggestions are submitted and which either accepts or rejects by gaging the proposition from its appearance and pronouncing such sentences as these, "We do not think that this is better than that which we have," or "Yes, we think that it will be an improvement." What financial statement is connected with such a verdict? How much money is it safe to spend for tools and equipment to be able to use the accepted suggestion, and on what foundation are these statements made? Most always they are based on personal opinion or so-called experience and too often by men who have but a slight knowledge of other processes than those they have seen within the same four walls for the last 10 or 15 years.

In factories where improvements are entirely left to the various shop executives the methods and problems are decided by guess. Good efficient methods that have been rejected as valueless are legion. It is evident that if foremen or superintendents have developed methods of manufacture, in general, they hate to see a junior come along with a proposition that would eliminate their work; and in self-defense they tend to reject the proposal or keep it until its inventor is gone or until the suggestion is so old that they feel themselves entitled to claim its origination.

Developments Often Left to Chance

Here I can repeat the statement of an executive who said, "Nobody works for the company; everybody works for himself." In other words, everybody works for his own benefit. In many industrial establishments the development of methods is handled by the first individual who has the chance to discover some new process. It is not his specialty to follow such kind of work; but as it is his discovery, he is allowed to go ahead with it until he is convinced that it is something worthy of note. Often the question of initial cost is never considered; the rule of thumb is the only judge; no records are kept. When a similar process comes up for consideration, it is necessary to go through the entire development again.

The most uptodate procedure is the suggestion box. It has been very much encouraged; efforts have been made to obtain contributions by offering rewards. It has been recorded by some large factories that this procedure works well for the first year and then is rapidly ranked with relics. The contributors are mostly shopmen, employed on regular duties, and in the course of their activities they discover means by which they can increase production. The limits of such discoveries are merely better ways of handling machines or tools furnished to the workmen. Radical improvements requiring change of design are seldom offered. In general, workmen keep their betterments for themselves—it is their means to earn more than the average.

An Absurd but Actual Procedure

The most absurd proceeding to develop new methods that has come to my attention can be summarized as follows: As I was talking to the foreman of a large shop, in which improvements were needed due to the increased demand for the product and the impossibility of adding men or equipment, an authorized individual came accompanied by three tool makers, stepping abruptly between the foreman and me, and addressed the former thus: "Brown, meet Jack, John and Dick. They are first-class tool makers. What they don't know nobody knows. I brought them up to help you to improve your methods of production. Turn them loose on the floor and see what they can do."

The next day I came in contact with these three men. They were leaning against the bench. One had a piece of work in his hand, the others had some newly made sketches. They were discussing possible improvements. I inquired about the progress of their work and their method of attack. They were surprised when I asked if they had the manufacturing layout or list and description of the present operations on that part and were further surprised when I asked: "How much saving do you expect to realize in one year? What expenses will be necessary to change the tools and equipment?" They gave no answers. They were like navigators without a chart.

Many are the factories where efforts are duplicated and wasted, where more than one man is working on improvements that practically amount to the same thing, where different departments are searching along similar lines for the same purpose.

Organization Chart for a Methods-Improvement Department

To handle such work, there should be created an office for the central control of production methods. This will provide a headquarters where the work can be developed and recorded and where literature and instruments can be classified and kept. In addition to an office an experimental laboratory is necessary. Such an organization can be roughly represented by the chart shown in Fig. 1, which illustrates the various divisions in great detail. At the head is the works manager or general superintendent, as the case may be, depending on the organization and size of the factory. Under him are division chiefs.

*Production Supervisor, Winchester Repeating Arms Co.

In starting such an organization it may be well to begin with one man and to have him engaged in the development and improvement of processes for the production of parts of a single chosen class. He must be carefully selected, considering ability only. He must have education and experience.

A man who has been employed a reasonable length of time in several factories producing various articles will be found more efficient than one who has been at the same place producing one article. It is evident that the various articles must be related and that a man who has been employed on the design and construction of railroad equipment would probably not be much good on electrical apparatus.

Methods Vary with Product and Degree of Accuracy

The processes for working materials consist of cutting, forming, heat-treating, finishing and assembling. The method of application and the degree of accuracy on parts vary with the product. For instance, if brass is to be cut and made into various parts through cutting operations, it matters very little if the part is for a water meter or a bathroom fixture or brass valve. If, however, the part is for a timepiece, there is a difference in the degree of accuracy required. The degree of accuracy is a serious factor. The method of application varies with

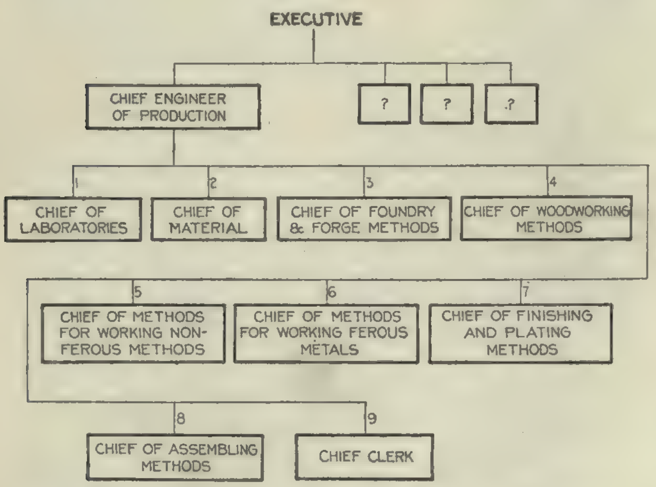


FIG. 1. ORGANIZATION CHART FOR A PRODUCTION-IMPROVEMENT DEPARTMENT

various shops, but more with the number of parts to be produced than with any other factor. Thus, to produce 10,000 parts on a punch press by piercing and blanking simultaneously, a single punch and die will be used—that is, a tool that will produce one piece at each stroke of the press. Should the demand for parts increase, say, to 20,000 parts, that single tool becomes inefficient and a multiple tool is necessary—a tool that will produce more than one piece at each stroke of the press. This part may be subject to several other succeeding operations, say six in all.

Let us suppose that the demand rises to 1,000,000 pieces per year. The multiple die then becomes inefficient and the proper procedure is to return to the single tool. In this instance, however, it will not be set on a single plunger press, but the blanking tool and those used for the subsequent operations will be arranged and adjusted to a multiple plunger press where such subsequent operations as blanking, cupping, drawing, reducing, trimming, forming, assembling, etc., can be done, thus producing one complete piece part at each stroke of the press. This instance illustrates the fundamental principle that the method of applying a working process is limited by the quantity of parts to be produced. A process that may be very efficient for producing a certain quantity of a given piece of work may be entirely wrong if the number required is either doubled or halved.

Jobs Must Be Carried Clear Through

A methods-improvement engineer must have the right to follow his work clear through. He must lay down the foundation, the combination of movements and general outline of his device, hand this to a competent draftsman and supervise his work. He will then follow the job until the desired result is obtained. In the meantime he keeps himself posted on the cost of the device. Each month the methods engineer should be furnished with a statement of his work, by which he can judge how near to the estimates previously made the actual costs of the jobs came.

I recently had occasion to read some reports that were simply erroneous, probably through lack of careful study. One, for instance, contained the statement that a certain piece could be made by a proposed process for a total cost of 85c. I was suspicious and started an investigation. The piece weighed 22 lb., and the material was purchased in carloads at $3.20 per hundred pounds. Thus, the material without the handling expense cost 70.4c. per piece. There was no scrap, and the difference of 15c. did not cover the expense of the first operation. The actual cost per piece was $2.37.

Specimen Report and Recommendation

Following is a report on a study of tapping operations on miscellaneous parts:

REPORT NO. (SYMBOL AND SERIAL NO.)
Mar. 19, 1916
Improvement in Manufacturing Methods
Tapping Miscellaneous Parts in Department (Symbol or Number)

General—An investigation of the method used in tapping holes in miscellaneous parts produced in Department (symbol or number) shows that an economy can be effected by converting an eight-spindle drilling machine, now standing idle in the storehouse, into a multiple-spindle tapping machine and using same in all cases where two or more holes in piece parts can be tapped simultaneously.

Present Methods—The present method is to tap these holes in a two-spindle drilling machine, tapping one at a time and raising and lowering spindle for each hole while work table remains stationary.

Proposed Method—The proposed method is to tap as many as eight holes at one time, if necessary, raising and lowering the work table while tap chucks remain stationary.

Estimated Costs and Savings—The following parts are affected, among others, and the costs and savings shown below are estimated and cover nothing but the present and proposed tapping operations: P-1, P-2, P-3, P-4, P-5, P-6.

	Costs per M. Present	Costs per M. Proposed	Save per M.	Estimated Yearly Requirements	Estimated Yearly Saving
P-1	7	5	2	40,000	$80.00
P-2	7	5	2	20,000	40.00
P-3	37	16	21	18,000	37.80
P-4	7	4	3	4,000	12.00
P-5	7	4	3	90,000	270.00
P-6	10	4	6	70,000	420.00
Total yearly savings (estimated)					$859.80
Estimated cost of new equipment					300.00

Remarks—Referring to the above report, this machine will be busy all the year around. The cost of transforming the machine, as recommended, will be absorbed in the first year, and a net saving of $559.80 will be realized. This seems to be a sound statement on which we may safely recommend that the necessary orders be issued to put this machine in suitable condition to perform the work, as described.

Letters from Practical Men

Producing Interchangeable Parts Without Special Tools

Quite often an order will be issued for some special part to be manufactured on which the quantity specified is too small to warrant the cost of designing and constructing a set of special tools, yet the essential dimensions are limited to small tolerances demanding accurate work on successive parts. On a job of this character, calling for turning, facing and boring operations, it is often surprising what can be accomplished on a modern lathe well equipped with attachments, in the way of turning out interchangeable work, either with no special tools at all or with such as can be made in a few hours on the machine tool on which the productive operations are to be performed.

I knew of a recent instance where a lot of only 500 drawn-steel parts came from the storeroom with a work faced and turned, and a pilot for centralizing the part when it should be assembled sized to a gage, with only 0.003 in. tolerance. Inasmuch as the threaded end had to be concentric and in alignment with the flange and pilot, this end was selected for the first operation.

For Operation No. 1 a three-jaw chuck belonging to the lathe, two special ground lathe tools and a tap that by good fortune could be borrowed from another job constituted the special equipment, in conjunction with the apron and cross-slide stops on the lathe. The set-up is shown in Fig. 2, the order of operations being: (1) Face end to apron stop (with 2-in. size block interposed), feeding from hole outward; (2) bore and chamfer hole, using regular apron feed and cross-slide clamp stop; (3) tap hole. It is necessary to interpose a 3-in. size block between the cross-slide and clamp stop, to enable the operator to bring the toolposts far enough forward to get clearance for the tapping operation. The tapping (not

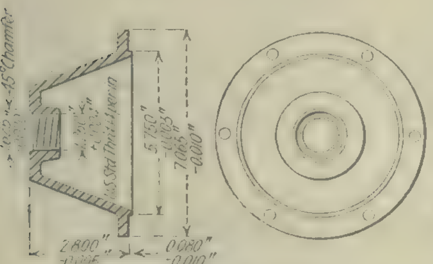


FIG. 1. THE WORK

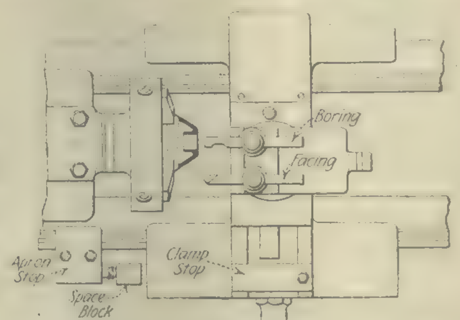


FIG. 2. FIRST MACHINE SET-UP

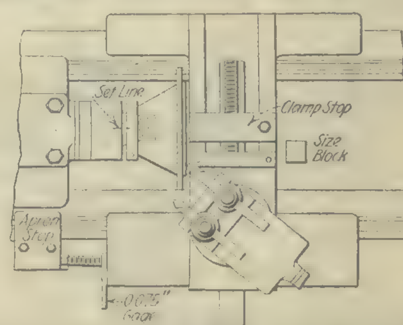


FIG. 3. SECOND MACHINE SET-UP

order calling for the machining of the parts. The order represented a shortage on a large order for the same component that had been manufactured outside, so it happened that there were several sets of gages for the operations, but no tools of any kind. The order lay idle for several weeks before it became apparent that, with so much more important work to be carried along, it might easily be months before the tool department could turn out any special equipment for this job. It was then suggested by the department foreman that the parts might be manufactured to gage at reasonable cost without any special toolwork other than he could do himself in the nature of setting-up the operations. To make a suggestion of that character in that shop was a good deal like kicking the props out from under the whole superstructure of their shop conventions. It was considered a crime aproaching felony for a production man to touch a job until the method had been "planned" for him down to the finest detail, and all the gages and tools had been provided. But the special condition had to be met, and the foreman was instructed to go ahead.

The part was in the form of a conical cup, as shown in Fig. 1, the larger end being flanged for bolting with six bolts to the part with which it was assembled. On the small end the surface had to be faced and the hole bored, chamfered and tapped. The larger end had to be double-shown in sketch) was done with a dog and handbar with tailstock center support. It was necessary usually to take two—often three—cuts both on the face and in the hole, as there was quite a wide variation in the height of the rough-drawn parts and the rough holes often ran eccentric. But the operator could use his judgment and take as many chips as he liked.

For Operation No. 2 a threaded mount was required, and after the left-hand threaded lock nut had been made, a chunk of steel was chucked in the lathe and the mounting and locking threads machined on. Inasmuch as a tolerance of only 0.005 in. was allowed for the height from the face of the flange to the top face, a set-mark was put on the shoulder adjusting collar for the operator to use as reference in locating the parts on the threaded mount. Besides the mount, there were required for Operation No. 2 two specially ground lathe tools. The set-up is shown in Fig. 3, the operations being: (1) Face off flange to height of pilot, using 0.075 in. gage sheet metal interposed between stop and apron, feeding outward; (2) size pilot and face bearing surface of flange, using clamp stop on rear end of cross-slide (with 1-in. size block interposed) and working to apron stop; (3) turn outside diameter of flange, using the clamp stop and the regular carriage feed. Operation No. 3 was drilling the six bolt holes in the flange, but this was easy, as the fitting part had always

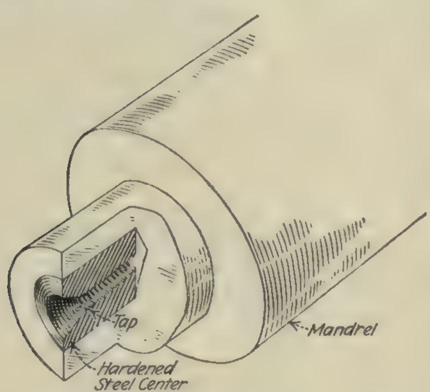
been manufactured in that shop and the drill jig used had only to be changed from female to male by the making of a simple adapter.

Two lathes were rigged up for the first two operations, and two of the department's brightest operatives put on the work. They completed the order with a loss of less than ten pieces for both operations, and the total cost for direct labor and the small amount of special work done was less than would have been spent in the drafting room in designing the tools, to say nothing of the expense of ultimate manufacture and use, which might not have proved any more satisfactory or economical than the makeshift arrangement described. F. H. Bogart.

Philadelphia, Penn.

Mandrels with Renewable Centers

In shops where large cast-iron mandrels are used, much difficulty is caused by the centers wearing away before the mandrel itself is marred to any great extent. To overcome this, inserted centers of hardened steel may be substituted. This combination makes a mandrel that will outlast several of the ordinary kind. The tapped hole allows a setscrew to be inserted to force out the steel centers for use in new mandrels. John A. Timmins.



ARBORS WITH RENEWABLE CENTERS

Longmeadow, Mass.

Annealing Hard Spots in Oxyacetylene Repairs

A frequent job is the repairing of broken gear teeth with the acetylene torch. The cast-iron filler is apt to have hard spots that cannot be machined, even with high-speed cutters. I tried burning sulphur on the part while it was still red hot and found that I could machine it easily afterward.

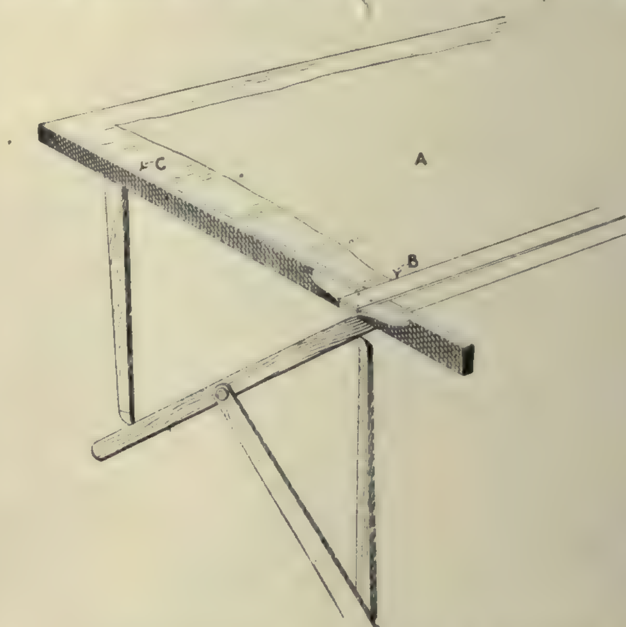
Burning sulphur on all welds anneals the cast iron, which otherwise is much too hard and brittle to work. The scale on cast-iron welds is also likely to be hard; but it can be filed easily if common soap is rubbed on while the weld is still red hot. G. Handyside.

Buffalo, N. Y.

[It would be of value to know positively that the sulphur does not injure the iron. We imagine it would have the effect of rendering the iron weak and brittle and the weld poor. When forging and welding *wrought* iron, the careful smith avoids coal with high sulphur content.—Editor.]

Drawing-Board Extension

When it is necessary to make drawings that are as large as the drawing board, it is hard to use the T-square at the bottom of the board. The illustration shows a method of overcoming this difficulty; *A* is the drawing board, *B* the T-square, and *C* is the straight-edge—an extension made of $\frac{3}{4}$-in. rolled steel, screwed firmly to the edge of the drawing board, as shown.



DRAWING-BOARD ATTACHMENT IN POSITION

Janesville, Wis. J. A. Raught.

Masked Tolerances

Two articles recently appeared in the *American Machinist* that interested me. One illustrated the method of cutting down working tolerances so that on final inspection, and with the full tolerance used, the rejections were eliminated as far as the gaging was concerned. The other dealt with an accumulated error that resulted in the rejection of the work on final inspection, although the working gaging had, step by step, come within the prescribed tolerances. Although in the shop where I am working, we had employed the system by which the fabrication tolerances were cut down, so that we would be well within the limits on final inspection, we even had to improve on that.

The French high-explosive shell is a solid-based shell, and for that reason more than any other is a difficult shell to make. After cutting off, rough-turning, boring and rough base-cutting, it is nosed; and it is from this point that conditions arise that have to be taken into consideration in subsequent operations.

When a shell is heated and then nosed it is hard to foretell with any degree of accuracy how the volumetric capacity is affected. It will vary—the heat on a shell may have gone a trifle farther toward the base, it may be a few degrees hotter, or the heat may not be even all the way around—and on this variation depend the diameter, inside depth, base thickness and total length of the shell when finished. These factors in turn affect the weight. After nosing, the capacity of the shell is tested

with water. We find that if a shell is turned on the outside to nearly the minimum limits and with a volumetric capacity near the maximum limit, such a shell will be light in weight; conversely, a shell that has minimum capacity and is turned to nearly maximum limits will be heavy.

For these reasons it was determined that the capacity, from maximum to minimum, be graded into five classes and that on each shell be stenciled its respective grade. The machines were then grouped and the gages lettered so that the operators did not know the exact sizes. Thus *A* shells were machined by *A* machines using *A* gages, etc.

The center of gravity of the shell was another factor that had to be taken into consideration in conjunction with the inside depth of the shell, as it has to balance on two knife-edges set closely together, these in turn being set a predetermined distance from nose and base. If a shell is cut to nearly maximum base thickness and has an interior depth nearly minimum, that shell will be heavy on the base end and will not balance on the knife-edges; conversely, a minimum base thickness and a maximum depth will give a heavy nose. Consequently, the laying-out gage was designed to lay off shells for the thickness of base. The working tolerance for the interior depth was split into three parts. Upon inserting the gage and sliding the indicator along the rod until it touches the nose of the shell the interior depth is noted. There are three spaces on one of which the line on the indicator will fall. The three spaces have corresponding lines indicating the thickness to which the base must be laid off and worked. The deeper the interior depth of the shell the thicker the base to balance the shell when on the center-of-gravity test

Since adopting this method of splitting tolerances our final inspection rejections have been materially reduced.

The foregoing will serve to illustrate how the shell game is beset with little problems that crop out here and there, these serving to give it more zest. A tolerance on a shell-print is to be carefully considered, as generally it is a "masked" tolerance; and to make a shell an acceptable shell, other factors must be taken into account than those that just appear as figures.

Moores, Penn. THOMAS A. PATTON.

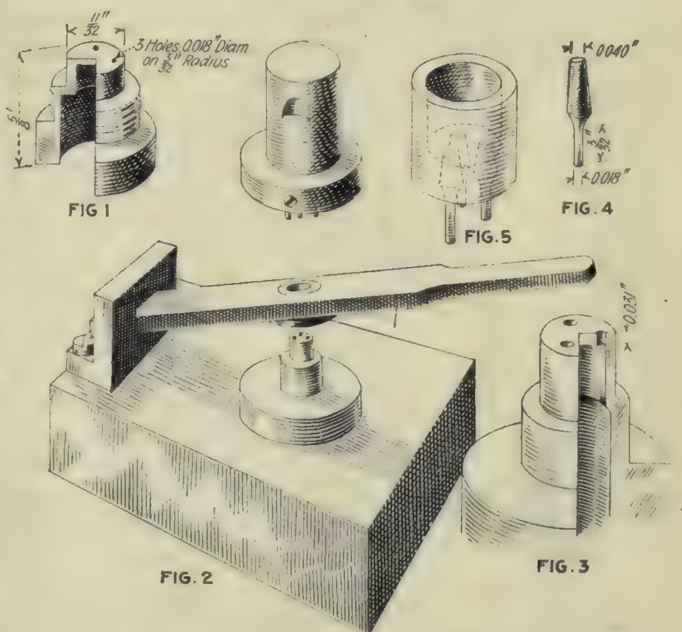
Tools for Punching Small Holes in Gas-Burner Nozzles

We were called upon, recently, to put three 0.018-in. holes in the gas-burner nozzle illustrated in Fig. 1, and the experience resulted in rather an interesting example of light tool making. The work, which consisted of about 250,000 pieces, was taken on contract. The firm that gave out the contract had itself been drilling the holes with the aid of a minute drill jig that fitted over the nozzle. An 0.018-in. flat drill was held by a special chuck attached directly to the axle of a ⅛-hp. motor. We also tried this method, but it proved a failure, as the time required to finish the piece and the average life of the rather expensive drills were in no proportion to the contract price. Being bound by the contract, it was up to us to discover a more economical way of performing the operation, and we finally decided to resort to a punch and die.

Here more difficulties were encountered. The die proved to be comparatively easy to make; but it took considerable experimenting before a satisfactory punch was evolved, the chief difficulty being to hold the interchangeable punches rigidly in the punch holder and at the same time permit them to be changed quickly in case they broke. The stripper also proved to be a troublesome part, as it had to be made in such a way as not to interfere with the rapid loading qualities of the die.

The tool, in its final successful form, is shown in Fig. 2. The die, which appears in detail in Fig. 3, was held by means of screws and dowels in a cast-iron plate.

The nozzle was supported on its top surface and on two places on the side as shown in Fig. 2. The die holes



FIGS. 1 TO 5. THE WORK AND THE TOOLS USED

Fig. 1—The gas-burner nozzle. Fig. 2—Punch and die used. Fig. 3—Detail of die. Fig. 4—Detail of punches. Fig. 5—Detail of punch holder

were straight, and the die was drawn to a medium straw color. The punches, Fig. 4, were turned out of drill rod in lots of 25 with a taper shank of 2½ deg. included angle and drawn to a medium dark brown. The punch holder, Fig. 5, was made of drill rod and drawn to a medium straw color. It was provided with taper holes that corresponded to the taper of the punches. The punches were placed in the holder, driven in with light blows, and the ends stoned down to the same length. In some cases this stoning had to be repeated after a few nozzles had been punched.

The punch holder was fitted snugly into the machine holder (shown in Fig. 2), the latter fitting the ram of the machine and being held in place by a V-point setscrew. In the event of a punch breaking, the punch holder could easily be removed, the broken punch knocked out and a new one inserted, driven in and stoned down, the change taking not more than 5 min. The stripper shown in Fig. 2 was made of 1½ x ¼-in. cold-rolled steel and had a brass bushing driven in that had ample clearance of the required shape. One end of the stripper was held loosely in a bracket fastened to the cast-iron die holder and prevented from slipping out by a pin. The other end was extended and used as a handle. The machine employed was an ordinary footpress. The stripper

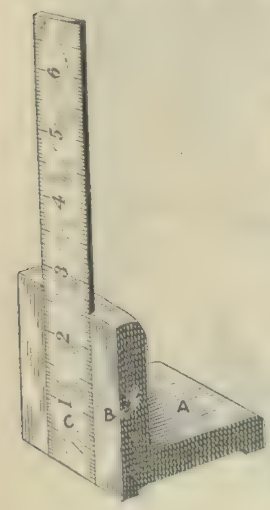
was swung out of the way by lifting it from the finished nozzle with the right hand, a new nozzle being inserted with the left hand. The stripper was then put back in place with the right hand and the ram lowered with the foot, the left hand preparing a new nozzle.

This punch and die did good and rapid work, 1000 nozzles being easily punched in 1 hour, while by the drilling process it took more than 8 hours to turn out the same number. The punches stood up very well, as high as 3000 nozzles being punched before a punch broke.

Kokomo, Ind. KURT SCHACHT.

Scale Holder

Machinists and toolmakers often use a common 12-in. scale in connection with a surface gage to obtain certain heights from the bench block. Sometimes a common combination square is used, which is very inconvenient. The lines on the scale cannot be seen, as they are covered by the square. A holder, as shown, was made and found to be satisfactory. The base *A* is made of cast iron or other metal, with a recess the width of the scale *C*, which is clamped in place by the clamp screw *B*. This arrangement is simple and allows clear and easy measurements to be taken from the bench block. If the bottom of the base is made flat instead of being recessed as shown in the illustration the device can also be used as a depth gage for gaging the depth of holes or slots and for measuring from a finished face to a projection or other member. In this use it is much more convenient than a combination square. G. W. PURDY.



SCALE HOLDER

Lynn, Mass.

Accurately Centering Crank for Turning

A short time ago I had a crankshaft to turn. The shaft had a 0.750-in. throw, and it was necessary that it be very accurate, also in perfect alignment. To obtain the centers for turning, I clamped the shaft firmly in the vise on the miller. After indicating the shaft true with the spindle of the miller, I put a drill chuck in the spindle and drilled center, then lowered the table 0.750 in. and drilled another center. I then turned the vise around and proceeded as before. After centering, I indicated the shaft on both centers in the lathe and found it to be out less than 0.0005 inch. D. F. BEEMER.

Peru, Ind.

Dies for Forming a T-Slot in Sheet Metal

The T-slot is generally associated with some part of a machine. However, it is also used for various purposes in sheet-metal work. The following is a description of a set of dies that have been made and successfully used to form a T-slot, $\frac{3}{16}$ x $\frac{13}{16}$ in. with a $\frac{1}{32}$-in. opening, in 24-gage sheet steel in lengths up to 2 ft. The dies were designed for use in an ordinary power brake commonly employed in sheet-metal work. They were held in the usual way, by projecting tongues fitting into slots in the machine. In Fig. 1 is a section showing the die closed, for the first operation; Fig. 2 is a section of the same die open, and the flat sheet in place; Fig. 3 is a section of the die for the second operation with the work from the first operation in place ready to be completed. The blades *B* are the only hardened portions of these dies, the remaining parts being of hard unannealed steel.

In Fig. 2 the flat sheet is laid across the jaws; the punch moving downward presses the metal between the

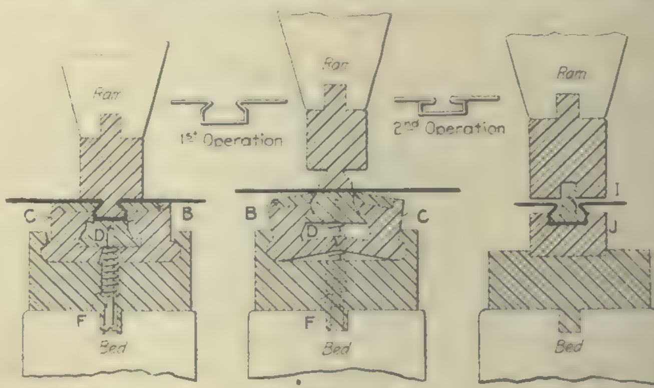


Fig. 1 Fig. 2 Fig. 3

FIGS. 1 TO 3. DIES FOR FORMING A T-SLOT IN SHEET METAL

blades *B*, which are fixed to the jaws *C*. The jaws are kept from closing by the center piece *D*. As the punch continues downward, it moves the center piece *D* against the lower portions of the jaws *C*, making them swivel in their sockets. This causes the jaws to close in at the top and presses the metal firmly around the punch at its lowest point of travel, as may be seen in Fig. 1.

As the ram rises, it causes the punch to draw the metal out of the die and opens the jaws at the same time. The center piece *D* is forced upward under the die by the springs *F*, which are spaced along the die as needed. The center piece *D* is kept from traveling too far upward by projections on the jaws *C*. It may also be seen from the drawing that the lower base controls the amount of rock of the jaws *C*.

The second operation is more simple. The mandrel *I* is slipped into the place formed by the first operation and placed in the lower die *J* of Fig. 3. The ram forces the punch downward and presses the metal around the mandrel, thus giving it the final form. The mandrel is then removed, the T-slot being thus completed in two strokes.

Indianapolis, Ind. CECIL H. STRUPE.

American Gear Manufacturers' Association Formed

An organization known as the American Gear Manufacturers' Association was formed at Lakewood, N. J., on Mar. 25 and 27. Its purposes are to advance and improve the gear industry by a standardization of gear design, manufacture and application. The officers are: President, F. W. Sinram; vice president, H. E. Eberhardt; secretary, F. D. Hamlin; treasurer, Frank Horsburgh. The executive committee is composed of F. W. Sinram, H. E. Eberhardt, F. D. Hamlin, G. L. Markland, Frank Horsburgh, Milton Rupert and Biddle Arthur. The next meeting will be held at Pittsburgh, May. 14 and 15.

Discussion of Previous Question

Which Is the Better Way To Impart Information?

Replying to Mr. Forbes' letter on page 1041, Vol. 45. I would say that the longer way would be the better way to impart information to most men, provided the story is properly and interestingly told.

On page 124, W. S. Ayars starts off by disagreeing with my view. He says, "Personally I do not like the story-telling method in the least," and then he goes on and tells a number of interesting stories in the most entertaining and instructive manner. It is a thousand-to-one bet that if Mr. Ayars can talk a story as well as he can write one his men have a splendid opportunity to learn from him.

I, for one, will never forget his story about the 20-ton piano, and in grateful appreciation of it I give him another with the same basis.

Some years ago I was mechanic in a plant where there was a large toggle baling press. The press was of the self-contained type with two large toggles at each end. These were connected by a large right- and left-hand screw. When the screw was turned the toggles were straightened out and pressed the goods that were to be baled. The press was located on the second floor of the building, which was an old dwelling house and not too solidly built.

About a week after I started to work, the boss called me into the office and said: "Morris, we are having complaints that the bales from the scrap press are not packed tight enough; just go and see what you can do about it. I think you will have to make some arrangements to shore up the floor."

Until that time I had paid no particular attention to the press; in fact, I did not know what type of press it was.

Between the platen and the upper member to which the top of the toggles was fastened were four 2½-in. steel rods. As I was looking the press over, the boss came up. When I finished my survey I turned to the man who operated the baler and said:

"Do you know the rating of that press; how much of a squeeze it is good for?"

"Twenty-five tons."

"Well, why don't you give it to her? Bring your toggles closer together!"

"Not on your life, you D. F. Do you think I want to land in the cellar? This floor wouldn't stand five tons, let alone twenty-five."

"That's right," chimed in the boss, "you want to go slow around here or you will be wrecking the plant; hereafter before you make changes of any sort you let me know."

I wrote that night to Cornell University, sending an illustration of the press clipped from a catalog, and asked them to tell me with the utmost candor who was the D. F., myself, or the man who was afraid of the floor coming down. At the same time I wrote the makers, asking what foundation strength was necessary for the press. I got replies from both by return mail. These I showed to the boss, and after that anything I suggested about that plant was done. I am sorry to say that some of my suggestions were not quite so good as I thought they would be when I gave them.

The really interesting part of Mr. Ayars' article is the part where he acts the story teller. At the end he refers to "taking leads." Probably less than one-tenth of 1 per cent. of the readers of the article will know just what he refers to, and this is a question I would like to ask, after explaining what "taking leads" is: Why is the taking of leads confined almost entirely to marine work?

In marine work, the engines are usually overhauled at the end of each voyage. That is to say, all the important bearings are looked at and the clearances either noted or corrected. Those bearings which have given trouble, if there are any—and there usually are—get first attention. Now the only way to find the clearance on such a bearing as the connecting-rod end (usually called at sea a "bottom end") is by slacking back the "bottom end" nuts, lowering the "top" half of the bearing into the crank pit, cleaning it off and placing several pieces of lead wire about $\frac{1}{16}$ in. thick. I have put the word top in quotation marks, because that is what it is called at sea; in reality, it occupies a bottom position. In other words, the cylinders of marine engines are inverted, and the part I refer to is the half of the crankpin bearing farthest removed from the cylinder.

After the leads are placed, the half-brass is hoisted up into place and the nuts set up tight with a short wrench and a sledge. When the nuts are slackened off again the brass is lowered, and the leads will be found flattened out. The thickness of the leads can be easily measured either with a micrometer or a wire gage. More commonly the engineer from his experience can guess whether the bearing is in the proper state of adjustment by the width to which the lead is squeezed. When driving the nuts up care is taken to scratch a mark on them and on the washer, which is pinned to the rod end so that it cannot turn. When the proper thickness of lead is obtained the engineer takes care to drive the nuts up so that the marks coincide. He then is sure that the clearance is the same as it was when the lead was "taken." Whether it runs well or ill depends to a very large extent on his experience and judgment.

And now, again, I ask why is this method of ascertaining the clearance of bearings confined solely to marine work? It may be that I am mistaken in this, but I have never heard of this method being applied on shore except by ex-marine engineers.

Mh. Ayars' experience with the right- and left-hand threaded stud is not unique. I have seen such studs in many exhibits of manual-training schools in the West. In fact it is the "standard" way to make a stud for exercise. While on the subject of exercises, I would like someone to tell me why the teachers in manual-training schools, who are often highly skilled men, invariably choose as exercises some useless thing that no mechanic would ever think of making. It seems to me that it is

just as easy to make a piece of useful work as it is to make an equally difficult piece of useless work, and yet these instructors will point with pride to the useless junk that their pupils turn out. I am no Latin scholar, as I never had the misfortune to learn it, but I had a run in with the teacher of one of my sister's boys over this thing; and his excuse may be the correct reply to the query about the useless work.

At my sister's instigation I kicked about the boy being taught a dead language. "Oh," said he, "I hardly expect you to understand, but it will be of great assistance to him if he ever wants to learn Spanish."

"Well," said I, "I assume that the two are somewhat similar."

"Very," he replied.

"Then," said I, "the chances are a million to one that he will need Spanish rather than Latin. If I were doing the job, I'd teach him Spanish, a language he might very easily have use for, a language that is spoken by millions: and later, if he joins the priesthood, he can learn the less useful language."

And so it should be with mechanical work. I heard once of a mechanic who made a perfect 3-in. cube with a perfect 1-in. hole through it. Into this perfect 1-in. square hole he fitted a perfect 1-in. cube. This cube was so perfect and the hole so perfect, that the cube could be entered in the hole from either end with any one of its six faces first; and when so entered, if the large cube were cooled, the small cube was held so tight that it could not be moved. Maybe there was such a mechanic and such a pair of cubes, but all of them were useless while that fool job was being made. There are thousands who would be glad to hire a man like that and pay him anything he might ask in the way of wages. And the work he would do for them would more than likely be really useful when finished.

If I wanted to teach a boy how to cut a left-hand thread, I would let him chase a left-hand tap. Left-hand taps are more or less used, and if he could cut a good thread in tool steel the chances are that he would have little trouble in cutting a thread in machine steel, if he ever had to cut a left-hand screw for a turn-buckle or some other purpose.

I have heard that in the East there are trade schools where the boys make parts of machines that are manufactured in the vicinity. That these parts are well made and suitable for use in such machines, I have no doubt. With good and careful supervision there is no reason why a boy in a trade school should not turn out better work than one who is an apprentice in the usual shop, run as it is today with the scantiest supervision and the attempt to drive the boys to make them produce. You can't make a good mechanic of a boy by driving him, but you can make a producer of a boy if you first teach him to be thorough and careful. Speed comes with practice only. When a boy or man is sure that every move he makes is right, then is the time he begins to put on speed; and his speed is dependent chiefly on his capacity for speed. I have seen shop speed records broken too often to say that so and so is the limit of speed at which this or that job can be turned out.

I hope that Mr. Ayars, who does not like to tell stories, will tell us a few more in the pages of the *American Machinist*. ROBERT MORRIS.

Hancock, Mich.

Shop School for Apprentices

In the remarks by Entropy, in his "Shop School for Apprentices," are statements that I heartily indorse. Some system should be worked out whereby we can educate our mechanically inclined boy. I taught the subject in a manual-training school and know of one instructor in chipping and filing who had never worked an hour in a machine shop in his life; another, in charge of the machine shop, did not know how to put on a belt. These appointments were due to favoritism and politics.

The curriculum adopted by manual-training schools is so varied and embraces so many subjects that it is a question as to whether it is of sufficient value to warrant having a boy spend four years in such an institution, especially so under such incompetent instructors and with at least 10 studies, of which shopwork is considered of least importance when considering averages for promotion or graduation. The manual work is divided into courses in chipping and filing, tinsmithing, woodwork and joining, patternmaking, molding, blacksmithing and construction, making it impossible to get more than three or four hours each week in the various branches.

The full course is about 30 weeks, which would give a boy who is in his last year and entitled to a course in construction just 120 hours, or 12 days, of instruction. Deduct from this amount the periods consumed in listening to lectures and class talks, time in changing classrooms, preparation and washing up, and you bring the actual study to not more than 10 days. The best that can be accomplished in this limited time is to teach the boy the most elementary principles of machine-shop practice.

As far as his value to the mechanical industries is concerned after completing such a course, I should rather take a boy in the rough and train him. I remember a graduate of one of these schools, who insisted that on account of his training there should be two years deducted from his apprenticeship time. I very soon found the applicant absolutely worthless, even as an experiment; he found fault with everything in the shop and demoralized the other boys by criticizing their work and methods.

I believe the best plan for each shop is to work out its own salvation, to take the boys as they come along and are needed, selecting from these the ones best fitted for the work. To those who show a peculiar aptitude and ambition, give all the help possible; train and teach them by gradually increasing the difficulty of their tasks and by encouraging them to study. Take an interest in their kit, and help them in obtaining one.

At the same time take and show an interest in their moral and physical well-being. These boys, when so trained and looked after, will become attached to the shop and will show very little inclination to leave. If they do migrate, you can count on a good percentage returning; and these will be found to have profited by their experience. Of course, boys so trained will be sought for by competitors.

No training school for machinists can do better than teach certain principles and practice. The dexterity and ability necessary to his advancement are acquired more or less slowly in the shop; but if the fundamentals are well mastered at the beginning, the acquisition of further knowledge becomes a much simpler process.

Anniston, Ala. C. L. ARTHUR.

Editorials

A Soldier Mechanic of France

Every red-blooded American is eager to rush to the support of the Stars and Stripes. The last few days have demonstrated that the spirit of 1776, the spirit that made the New England farmer drop his plow handles and seize his musket—or his pitchfork if his son had got to the musket first—still flows within every one of the 20,000,000 fighting men of America.

You machine-shop men of America are natural-born fighters. You are men accustomed to grapple with difficulties that demand red blood in the overcoming; you are men of aggressive spirit and stern determination. And many of you, at the first call for volunteers, will hasten to the nearest recruiting station to offer your lives for your country's honor.

We are proud of this fact—proud that you machine-shop men of America are real men and real Americans; but before you go, we want to tell you the story of a soldier mechanic of France.

Among the red-blooded men of France who felt the need of actively expressing their devotion to their country by fighting in the first rank, and who enlisted during the first few days of the war, was a mechanic who for years had been specializing in the working of brass and other sheet metals. Being a red-blooded mechanic as well as a man worth while, he had grappled with and overcome most of the difficulties connected with his calling. Among other things, he had made an exhaustive study of the manufacture of cartridge cases and perhaps knew as much of this particular branch of his art as did any other man in France.

When the call came for the first ten classes, this mechanic applied for enlistment and was accepted for active military duty. The whirling of belts and the clatter of machinery had seemed to him to be surroundings too prosaic while drums were beating and bugles calling. His ardent French temperament felt that the only way to express fittingly his patriotism was by shouldering a rifle and marching to the front with his comrades.

This, remember, was in the first few days of war, before France, with her marvelous adaptability, had settled down to the real business of winning by keeping plenty of ammunition in reserve. In a month or two, when soldiers with empty guns were forced to make a masterly retreat, France recalled from the front the mechanics upon whose specialized skill her success depended. One of them among many did not answer. He was this soldier mechanic who had already given his life and placed his skill beyond recall. It is said that 55,000 French mechanics were lost during the first three months of the war.

By such things as these France and England won many loyal soldiers, and thereby lost many battles.

During the first few weeks of enlistment, the mechanics of America, like the mechanics of France, will be tempted to let impulse guide instead of judgment, until Government organization can take care of this matter and make proper selection. And while it is impossible to draw a distinct line and say "*your* abilities are needed at the front, and *your* abilities may best serve us in the shop," still there are certain facts that may help one in arriving at a decision.

It is possible to make, with the right material, a good soldier in a year's time. It is impossible with excellent material to make a good mechanic in less than four years' time. A good mechanic can win more battles for his country in a machine shop than he can at the front. Bear in mind that the way America is going into this war will tax mechanical industries to their utmost. In addition to what we have been furnishing and will furnish to the Allies, these shops will be called upon to meet a tremendous output of munitions and material for the arming of America. And there have not been too many of these good mechanics available to meet the demands of the last two years.

If you are skilled in making munitions, in directing the skill and efforts of others, in designing and developing new mechanisms, in making tools, jigs and fixtures, in the use of measuring instruments or inspection gages, there is no question that you can best serve America by shouldering your portion of her industrial task rather than by shouldering a rifle.

That these words of advice are needed in America at the present moment is proved by the actual case of the superintendent of a large munition factory, who, in his enthusiasm and desire to give physical expression to his patriotism, joined a local motorcycle corps. To him it meant actively serving his country by risking his life in the field. To thoughtful Americans it meant trading a captain of industry for a dispatch bearer and actively serving the enemy by depriving America of vitally essential skill and experience.

Shop foremen—the men who through years of training have learned to command divisions in the industrial army—will be almost as necessary to war's industries as soldiers are to war's activities. You can make a soldier in a year, but it takes a long while to make an officer who can lead and direct; and still longer to make a capable machine-shop foreman who can direct properly the activities of others. We will need more foremen than there are in America today, but we should not add to the burden of this need by unnecessarily sacrificing those who are already available.

We will need more toolmakers than there are in America today. The toolmaker is the skirmishing party of the industrial army of war. His activities come far in advance of the actual manufacture of munitions. And while he serves in advance, he must also support the main industrial body by caring for and maintaining all the tools, jigs and fixtures that are vital to a supply of munitions.

The automatic screw machine has proved to be a vital factor during the last two and one-half years by conserving the supply of much needed skill and assuring a large output of duplicate parts. Mechanics who through train-

ing have the ability to set up automatic machines are needed in our industrial army, and not at the front.

As it is difficult to draw the line between those who should enlist for active service and those who will be needed for industrial service, so is it difficult also to distinguish between manufactured articles—munitions that will and will not prove essential in war. This country will need every square foot of machine-tool-building capacity in its machine-tool-building shops. It will need all the capacity of its automobile shops. It will need all its gasoline marine-engine-building capacity for mosquito boats and submarine chasers. All our resources, industrial and otherwise, are pledged toward the successful accomplishment of the task we have undertaken. The Government, through its Council of National Defense, knows what these resources are and is prepared to use them when the time comes. The industrial army will be mobilized and ready to support fitly our military forces; but the first call for volunteers, in the absence of an individual census of skill and experience, is likely to cripple the industrial army unless each man in the machine shops of America uses intelligence in his patriotism.

So we say to you, think carefully, Mr. Mechanic, Mr. Superintendent, Mr. Designer, Mr. Toolmaker and Mr. Inspector, before you decide just *how* to serve your country. And after deciding—whether you put your shoulder to the wheel of industry when the call comes a little later or shoulder a rifle at the present call—here is more power to your brain and to your arm in the cause of freedom.

Frank A. Scott Heads Munitions Board

The importance of the machine-tool industry as an element of modern warfare could have no more forceful recognition than in the appointment of Frank A. Scott as head of the General Munitions Board. Well known as the general manager of the Warner & Swasey Co. of Cleveland, Ohio, he brings to his new position a wide business experience and an exact knowledge of the necessity of machine tools in the manufacture of all kinds of war supplies; for without machine tools we should have no rifles, no machine guns, no cannon, no projectiles, no transport on land, in the air or on the sea.

With the task of supplying the army and navy with munitions and equipment in the hands of a committee headed by a man who understands the foundation on which these supplies rest, the work is sure to go forward systematically and without unnecessary delay. The country is fortunate not only to have such men available, but to have the men who decide on such appointments broad enough to recognize merit entirely apart from political affiliations or preference.

The remaining nineteen members of the board are also experts in their line and can and will render the best service possible. The other civilian members are Howard E. Coffin, Bernard M. Baruch, Julius Rosenwald and Dr. Franklin Martin, all well known and men who have already done splendid work in the matter of preparing the country for the conflict that it has long been evident was being forced upon us. The army members are Brig. Gen. Thomas Cruse, Col. F. G. Hodgson, Col. H. Fisher, Lieut. Col. J. E. Hoffer, Maj. P. E. Pierce, Maj. Charles Wallace and Capt. A. B. Barker, with Rear Admiral H. H. Rousseau, Rear Admiral W. S. Capps, Commander R. H. Leigh, Commander T. A. Kearney, Dr. R. C. Holcomb, Paymaster J. H. Hancock, Lieut. W. B. Lemly and L. McHowe, representing the navy.

The establishment of this board puts in the hands of its members practically the same task that was given the Minister of Munitions in Great Britain. It creates the machinery for a Government department of munitions, which would be headed by a member of the cabinet, if the conduct of the war should bring out such a need, as is more than likely to be the case when naval and military participation becomes an accomplished fact.

American Airplanes Abroad

Much has appeared in the daily papers and elsewhere reflecting on the quality and particularly on the speed of the American airplanes that have been sent to the fighting armies on the other side. Some, with a desire to belittle the product as much as possible, delight in stating that the American airplanes are used principally for instruction purposes and not as fighting machines.

Admitting this to be so, although it is not borne out by all reports, is it not rather complimentary than otherwise? For the instruction of aviators is a very important matter, and machines which are so designed and built as to be safe and which are easily handled by beginners need no apologies.

As a matter of fact, however, many American machines are in actual service, particularly those built for naval use. These have proved very successful, and more are being built as rapidly as possible. When it comes to the faster scouting machines, our airplanes are not widely selected, and for a very good reason.

Excessively high speed demands extreme lightness. To secure this, the builders of these small machines have reduced the factor of safety below the point considered prudent by our builders. For example, the lowest factor in use in this country is given as from 5½ to 6, while 7 is very common, even on some fairly high-speed machines. The extremely light machines of the battlefront are, however, said to reduce this factor to 3 or even less in some cases, thereby greatly lightening the machine and making higher speed possible with the same motor.

There are perhaps good reasons why our builders have thought it wiser to bear the slurs and innuendoes, both of competitors abroad and critics at home, rather than to run the risk of accident due to the failure of any part of the machine. They know too well the tendency to decry failure in others and to gloss over similar shortcomings of our own; that the crumpling of an American plane would be heralded as an example of "shoddy" work and credited to our desire to make huge profits.

It is time we stopped apologizing for shortcomings that do not exist. We have, in common with all others, unfortunately, plenty of faults both of omission and commission. But while we should not blind ourselves to faults of any kind, let us be sure that they really exist before we grovel too humbly before our critics. Let us say frankly that we do not build machines as light, and consequently as fast, as some others, because we hesitate to risk life and service unnecessarily by using such a low factor of safety; that if the purchaser will publicly assume this risk, we can meet any specifications that others can fulfill. Let us continue trying to be fair to others and also cultivate the habit of being fairer to ourselves than we have been in the past.

ADVISING EMPLOYEES HOW TO ACT UNDER PRESENT CONDITIONS

Many machine-shop owners and managers are desirous of advising their employees, both citizens and non-citizens, how to conduct themselves under the present conditions. And on the other hand, many employees are anxious to be informed on this subject.

For the aid of both employer and employee the "American Machinist" has constructed the following notice, which is reproduced on this page in small scale. This has been printed in the form of a large poster suitable for hanging up in the shop, and any number of these are available for the machine shops that care to have them. They are supplied free of charge upon request to the Editor.

Notice

Appreciating the fact that American mechanics are patriotic, the following suggestions are made to avoid misunderstandings and unintentional wrong conduct. Acts and words permissible in peace times may be treasonable in war time.

To American Citizens—

1—Avoid arguments and discussions. They lead to disturbances and serious trouble.

2—Act considerately toward non-citizens and citizens of foreign birth.

3—Be on the alert to safeguard American interests by reporting to us at once any suspicious actions or words.

4—Avoid all waste of time and material. Wars are won by economy at home and in the shop as well as by soldiers in battle.

5—Guard carefully against fire. Report carelessness in the use of inflammable and dangerous materials, and the accumulation of waste matter. Keep fire buckets and barrels filled.

6—Wherever you can be of most value to our country is the place for you. A skilled mechanic, draftsman, experienced machine operator, tool and gage maker or inspector, may serve his country best by helping to make what his country needs.

To Non-Citizens—

You came to this country voluntarily and have made your living among us. Act during these times so that the citizens of America will welcome your countrymen in the future. Avoid any act or word that may arouse suspicion.

Obey the law, talk English if possible, and don't argue.

An Nicht-Bürger!

Sie kamen in dieses Land freiwillig und erwerben Ihren Lebensunterhalt in unserer Mitte. Handeln Sie in diesen Zeiten derart, dass die Bürger Amerika's Ihre Heimatsgenossen in Zukunft willkommen heissen werden. Vermeiden Sie Handlungen oder Worte, welche Verdacht erwecken könnten. Unterwerfen Sie sich dem Gesetze, sprechen Sie wenn möglich nur englisch, und streiten Sie nicht.

A Nem-Polgárokhoz!

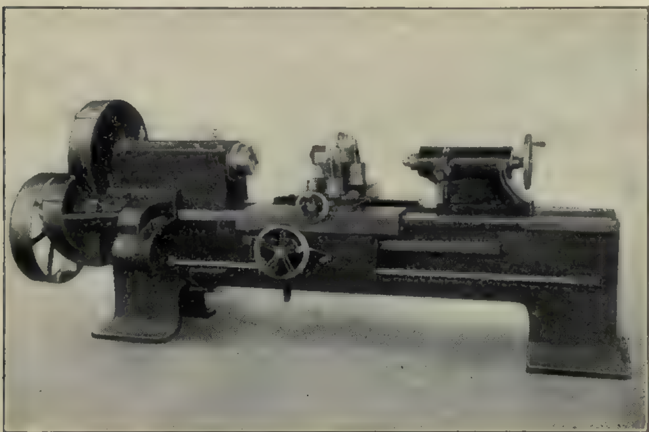
Önök kik önszántukból jöttek ebbe az országba és keresik meg kenyerüket mi közöttünk, viselkedjenek e napokban olyan módon, hogy Amerika polgárai, örömmel fogadják polgártársaikat a jövöben. Kerüljenek el bárminemü cselekedetet vagy oly szavak használatát, a melyek gyanut ébreszthetnek. Engedelmeskedjenek a törvényeknek, beszéljenek angolul ha csak lehetséges és kerüljenek minden vitát.

Signed..

Shop Equipment News

Heavy-Duty Lathe

The illustration shows one of a line of three heavy-duty lathes being marketed by the Pottstown Machine Co., Pottstown, Penn. The machine shown is for 12-in. shells,



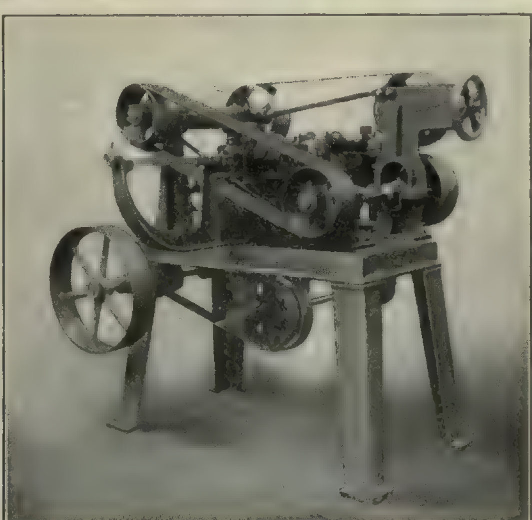
HEAVY-DUTY 24-IN. LATHE

Diameter of head spindle, 6 in.; diameter of tail spindle, $3\frac{13}{16}$ in.; maximum distance spindle head to tailstock, 4 ft. 9 in.; driving pulley, 28 x 6 in.; diameter spindle gear, 28 in.; swing over bed, 24 in.; feeds, $\frac{1}{16}$, $\frac{1}{8}$ and $\frac{3}{16}$ in. per revolution; length of carriage on ways, 36 in.; width of crossbrace on carriage, 12 in.

while the other two made are for the 3- and 6-in. sizes. The carriage has two toolposts and a longitudinal power feed, but is not equipped with a crossfeed. Three feeds are used. They are obtained through a gear box placed at the front of the machine at the left of the operator. The drive from the high-speed shaft to the spindle is by means of a gear and the pinion.

Rod Polishing and Grinding Machine

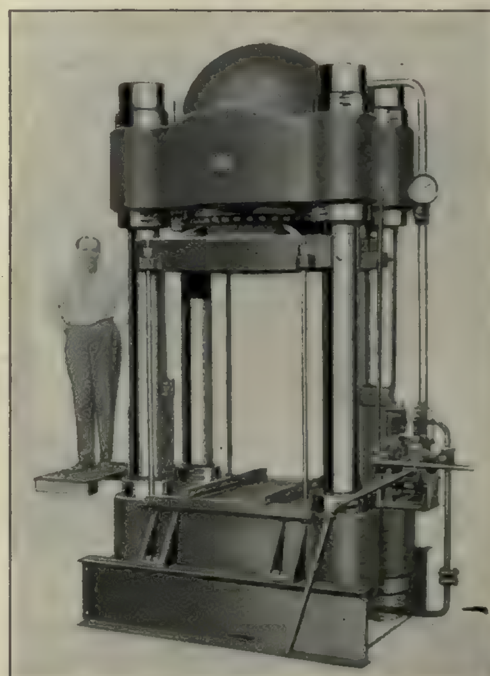
The automatic polishing and grinding machine shown is for handling rods or tubes from $\frac{1}{4}$ to $\frac{5}{8}$ in. in outside diameter. The work is fed into and out of the machine through hardwood bushings to prevent any scratching of the polished surface. They may be easily changed in case of wear or for adapting the machine to various sizes of work. The feed rolls for forcing the work through between the two polishing belts are of hardened steel. All bearings are of the self-oiling type. The machine is being made by Kane & Roach, Syracuse, New York.



GRINDING AND POLISHING MACHINE FOR RODS

Hydraulic Press

The 1500-ton hydraulic press shown has been built by the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, for the purpose of forming asbestos shingles 42 in. square, but is equally adaptable for other purposes where a press of this capacity is needed. The strain rods are of heat-treated forged steel machined to a diameter of 9 in., the heads being forged integral. Two small push cylinders are used to return the main pressure ram after the stroke is completed. They are located on the base of the press between the strain rods. The diameter of the push rams is 5 in. All operations are controlled by a 2-in. four-way poppet operating valve. For operating purposes either an independent pump installation or an accumulator system may be used.

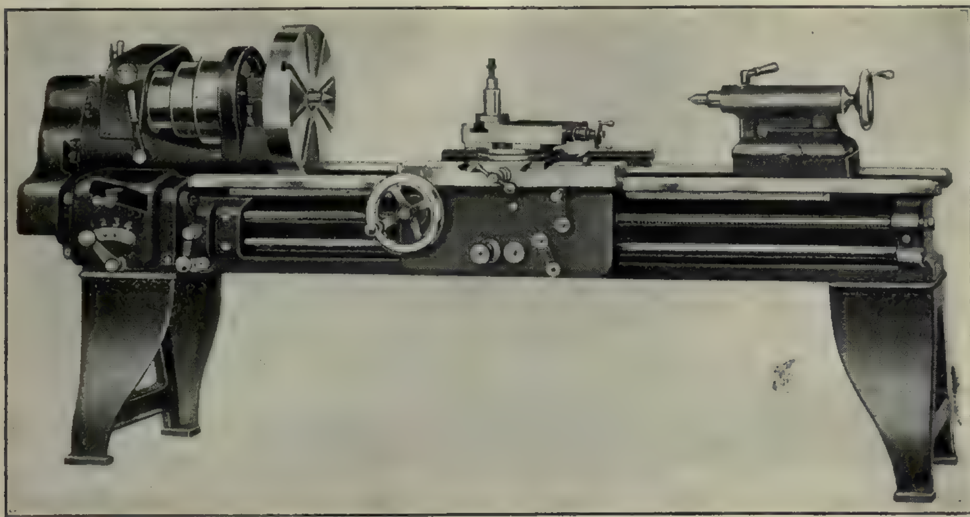


LARGE HYDRAULIC PRESS

Engine Lathes

The Universal Machinery Co., Milwaukee, Wis., is marketing a line of engine lathes made in both the standard and quick-change types in 16-, 18-, 22- and 24-in. sizes. The illustration shows a machine of the 18-in. quick-change type.

It has a spindle of crucible steel, running in bearings of phosphor bronze. The feeds are contained in the apron and are friction driven. A rod and screw feed is also included. The carriage has three bearings on the bed, two V's and one flat. It is equipped with a compound rest. On the quick-change machine, the gear box provides 32 speed changes with two operating levers. A taper attachment, furnished when specified, clamps directly to the carriage. The guide-bar slide is graduated to read the taper in inches per foot. By using a double friction countershaft 18 spindle speeds may be obtained.

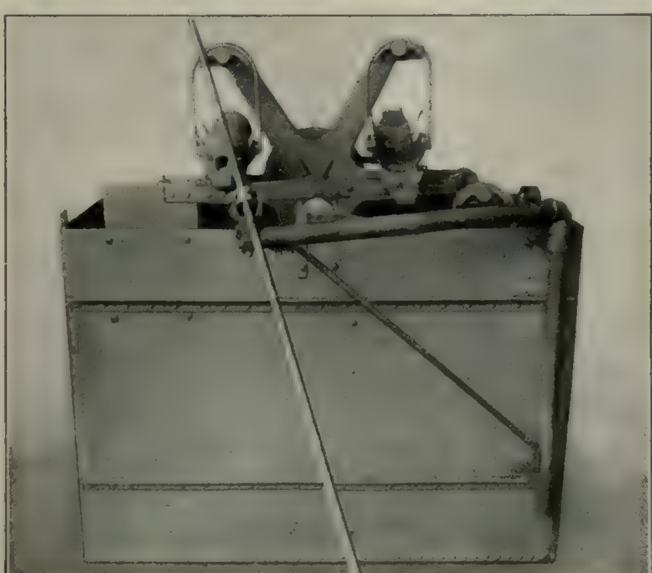


QUICK-CHANGE ENGINE LATHE

Swing over bed, 18$\frac{1}{2}$ in.; swing over carriage, 12 in.; length of carriage bearing, 25$\frac{1}{4}$ in.; length of tailstock bearing, 12$\frac{3}{8}$ in.; diameter of headstock cones, 11, 9 and 7 in.; width of belt, 3 in.; friction-clutch pulleys, 12 x 4$\frac{1}{2}$ in.; distance between centers, 3 ft.; front spindle bearing, 3$\frac{3}{16}$ x 5$\frac{1}{4}$ in.; rear spindle bearing, 2$\frac{7}{8}$ x 3$\frac{9}{16}$ in.; hole through spindle, with No. 4 Morse taper, 1$\frac{9}{16}$ in.; diameter of threaded spindle nose, 2$\frac{5}{8}$ x 6 in.; cut threads, 2 to 32; size of lathe tool, $\frac{5}{8}$ x 1$\frac{3}{8}$ in.

Shell-Washing Machine

For the purpose of washing shells after the completion of the machine work, the Pottstown Machine Co., Pottstown, Penn., has placed on the market a line of shell-washing machines, the one for the 220- to 270-mm. sizes being shown in the illustration presented herewith.

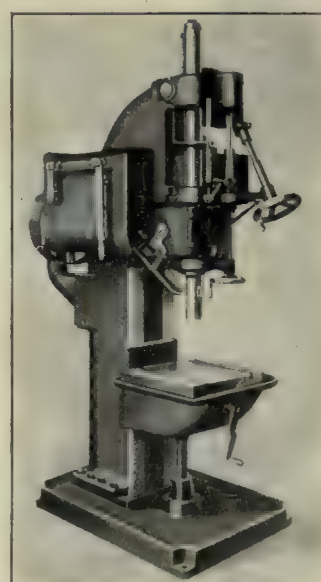


SHELL-WASHING MACHINE

The six-armed spider carries shell cradles of suitable size and revolves in such a manner that the shells are carried down through the hot soda water with which the tank is filled. As the shell enters the water, it is tipped so that the mouth points upward, allowing the air to escape; but after traveling downward about a foot, it is again tipped so that the mouth points downward, allowing the chips to drop out. The inside is cleaned further by a jet of steam located at the stopping points of the spider, and the shell emerges from the water, mouth down, in order to allow it to drain thoroughly by the time it reaches the charging position. The shells are placed in position with the swinging fixture shown at the front of the tank and the spider when started travels to the next position and stops automatically. The machine requires from 1$\frac{1}{2}$ to 2 hp. On the large machines the tank is sunk in the floor slightly to bring the top to a convenient level for placing the shells in the cradles.

Heavy-Duty Drilling and Boring Machine

In answer to a demand for heavy-duty drilling and boring machines the Medina Machine Co., Medina, Ohio, has placed on the market the one shown in the illustration. The column is of box-type construction, the front ways being of such length that special boring heads may be fitted for multiple-spindle drilling operations. The operating levers are placed within easy reach of the operator, and all gears are guarded. The spindle and spindle sleeve are ground to size, the sleeve having conical bearings. The drive and feed gears are contained in the spindle head, the more important ones running in grease. A double friction clutch is included. S K F ball thrust bearings are used on the spindle and the large bevel driving gear. The feed clutch is arranged to be disengaged automatically at any point desired. The table is raised or lowered by telescopic screws.



DRILLING MACHINE

Diameter of spindle, 3$\frac{1}{2}$ in.; spindle traverse, 14 in.; center of spindle to face of column above knee, 12 in.; table, 19 x 20 in.; spindle speeds, 54, 85, 108, 132, 170, 207, 265 and 414 r.p.m.; feeds, 0.06, 0.011, 0.016 and 0.032 in. per revolution

Annual Convention of S. A. E.

The Society of Automobile Engineers, which has been coöperating with the Government in matters regarding standardizing motor trucks for war purposes and other activities, will hold its annual engineering convention the last week in June at Ottawa Beach, on Lake Michigan. Heretofore, this society has chartered a large lake steamer and held its engineering conference on Lake Huron; but during the last year the society has grown very rapidly and several other engineering organizations have amalgamated with it—namely, aviation engineers, farm-tractor engineers and motor-boat engineers—so that today the society represents practically all engineering professions using the gasoline engine.

Ottawa Beach is located on the east shore of Lake Michigan, approximately 100 miles from Chicago, and has been selected because it offers an excellent place for demonstrating hydroplanes, as at this point on Lake Michigan there is a connection with Black Lake, a small body of water six miles in diameter and ideally suited for airplane demonstrations. It is possible that a daily airplane mail service will be maintained with Chicago during the four days of the engineers' convention. Black Lake is also well suited for motor-boat exhibitions.

This will be the first summer convention at which engineers representing all the various automotive aspects of engineering will meet together. All are vitally connected with the question of military protection and defense. The Society of Automobile Engineers has been the leader in the standardizing of automobile parts, and it is due to this standardization work that the great production in the automobile industry has been possible. This standardization work has also been responsible for the low prices of American cars.

What the society has accomplished in the automobile industry by way of standardization it has already started to do in the aviation field. Airplane production is at present hopelessly handicapped because parts are not standardized. If they were standardized as are automobile parts, a production of 10,000 airplanes would be a matter of small consideration.

The society has also vigorously taken up the work of standardizing farm tractors, so that the production of farm tractors will be greatly increased, as has been made possible with automobiles. This standardization of farm-tractor parts was started by the society in Kansas City in February. Farm tractors are as important in war as guns. The annual grain yield of the Mississippi Valley can be greatly increased by farm tractors as compared with horse tillage. Greater production in tractors is needed. Last year the demand was greater than the supply for small tractors, and this year production will be needed as never before.

The various committees, including the meetings committee, of which David Beecroft is chairman, and the papers committee, which is conducted by H. G. McComb, have all plans well advanced. Papers will be presented concerning aircraft, watercraft, farm tractors and motor cars.

The name of the society after Apr. 19 will be the Society of Automotive Engineers.

Trade Catalogs

Crucible Tool Steels. Cyclops Steel Co., 120 Broadway, New York. Catalog. Pp. 16; 3½ x 6 in.

Cranes. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 127. Pp. 48; 6 x 9 in.; illustrated.

Drop Hammers, Plain and Automatic. Standard Machinery Co., Auburn, R. I. Catalog. Pp. 62; 6 x 9 in.; illustrated.

The Watters Bucket. Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 126. Pp. 12; 6 x 9 in.; illustrated.

High-Speed Ball-Bearing Drilling Machines. Langelier Manufacturing Co., Providence, R. I. Catalog. Pp. 8; 9 x 12 in.; illustrated.

Oil Tanks, Pumps and Storage Systems. Gilbert & Barker Manufacturing Co., Springfield, Mass. Set of bulletins; 8 x 10 in.; illustrated.

Samson Suspension Stool. American Engineering and Equipment Co., New Haven, Conn. Catalog. Pp. 8; 4 x 7 in. Illustrations showing the stools in use in machine shops are given.

Reducing Vibration and Noise. Armstrong Cork and Insulation Co., Pittsburgh, Penn. Booklet. Pp. 32; 5 x 7 in.; illustrated. This describes the application of Nonpareil cork to machinery, motors, fans, etc.

Gears, Sprockets, Chains, Bearings, etc. Boston Gear Works, Norfolk Downs (Quincy), Mass. Catalog F7. Pp. 92; 3½ x 6 in.; illustrated. This includes list of new stock of hardened-steel helical or spiral gears.

Thor Pneumatic and Electric Tools. Independent Pneumatic Tool Co., Thor Building, Chicago, Ill. Catalog No. 10. Pp. 94; 6 x 9 in.; illustrated. Describes piston air drills, pneumatic riveting, chipping calking hammers, etc., also air hoists, electric drills, grinders and other devices.

Personals

J. E. Henry has been elected secretary of the Medart Patent Pulley Co., St. Louis, Missouri.

W. H. Thauvette, formerly superintendent of the Kelly Reamer Co., has taken a like position with F. W. Strachle & Co., Cleveland, Ohio.

J. H. Marlotte has become connected with the J. R. Stone Tool and Supply Co., Detroit, Mich., as manager of the machine-tool department.

E. H. Huntington, chief inspector of the Barber-Colman Co., Rockford, Ill., has resigned and has taken a position with the Russel Motor Car Co., Ltd., Toronto, Canada.

Norman Bell, formerly sales engineer of the automobile division of the Lunkenheimer Co., Cincinnati, Ohio, has joined the Norma Co. of America in a similar capacity.

F. L. Hess has resigned as assistant production manager of the National Brake and Electric Co. to become general manager of the Mulkern Garage Co., Milwaukee, Wisconsin.

J. F. Pullan, formerly of the Taft-Peirce Manufacturing Co., Woonsocket, R. I., has secured an interest in and will become superintendent of the Dover-McDevitt Co., Providence, Rhode Island.

D. S. Brooks, for the past five years secretary and purchasing agent of the Peru Auto Parts Manufacturing Co., Peru, Ind., has severed his connection with that company. **K. F. Rausch** has been appointed a member of the purchasing department.

Business Items

The Victor Die Casting Machine Co., formerly of Wayne, Mich., has moved its factory and office to Ypsilanti, Michigan.

Muller & Phipps, Ltd., Englewood, N. J., have recently incorporated their branch office at 35 Robinson Road, Singapore, under the name of Muller, Phipps & Sellers, Ltd. Their business is the representing of American manufacturers, H. A. Sellers being in charge.

The Alvord Reamer and Tool Co. has purchased the property of the Alvord Reamer Co. and the Millersburg Fifth Wheel Co., both of Millersburg, Penn., and will continue the business heretofore conducted by these companies. The officers are F. T. McGuire, president; G. H. Kurrie, vice president; J. B. Coates, secretary; J. C. Boltz, treasurer.

Forthcoming Meetings

The Society of Automobile Engineers will hold its annual convention at Ottawa Beach on Lake Michigan during the last week in June.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The National Metal Trades Association will hold its next convention on Apr. 25 and 26 at the Hotel Astor, New York City. A meeting of the administrative council of the association will be held on the day preceding that on which the convention opens.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

The Society for Electrical Development, Inc., will hold its annual meeting in the United Engineering Societies' Building, New York City, on May 8.

The American Society of Mechanical Engineers will hold its annual spring meeting at Cincinnati, Ohio, May 21 to 25. There will be a joint session with the National Machine Tool Builders Association on May 21. The headquarters will be at Hotel Sinton.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

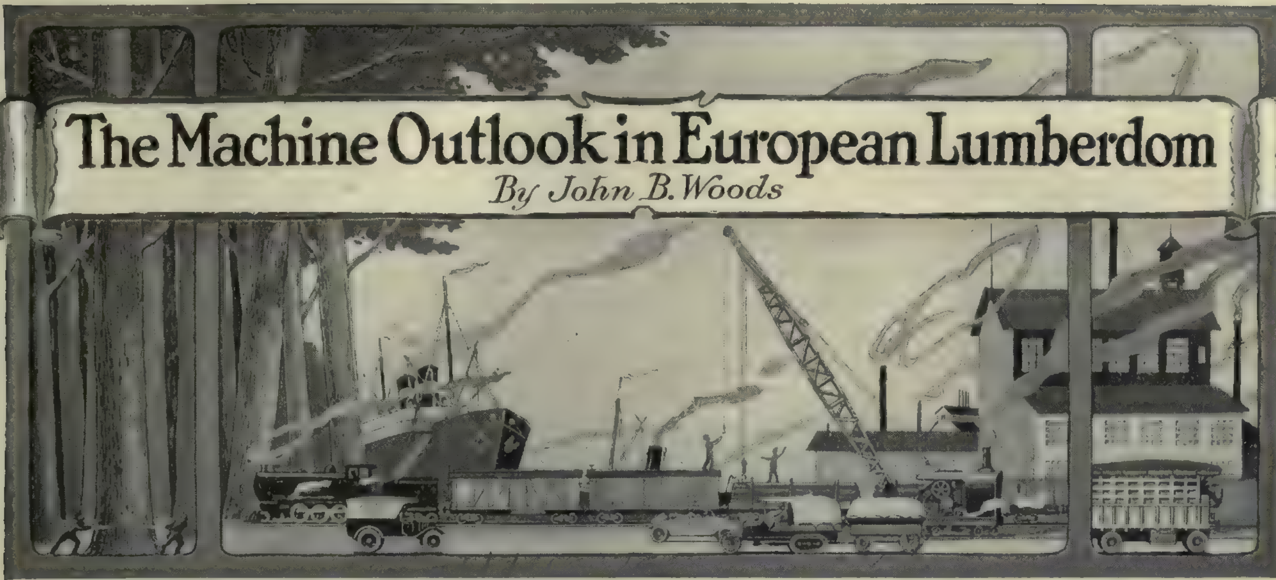
Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1735 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.



The Machine Outlook in European Lumberdom

By John B. Woods

SYNOPSIS—The war and the ending of the war have had and will have marked effects on machinery building. In this article Mr. Woods, who has visited practically every sawmill district in America, and many in Europe, tells what is coming for builders of woodworking machinery after peace is declared.

One of the favorite topics of conversation this spring is, "What will happen when the war ends?" Of course, its popularity is not a new feature, for the question has been discussed by brilliant journalists and country store sages with equal fervor these many months. It appears that almost all of us are bound to feel the reaction in some manner when the big guns cool at last, and aside from the genuine relief that will be experienced when the terrible waste of life and property is at an end, there will be material evidences of change in our business conditions whether we raise hogs or build machinery. For certain industries the change may bring lean times, notably those that have been leaders in the profit-taking during the war, while for others that have been outside the happy circles of war-baby families the dawn of peace will herald a day of prosperity and world trade.

LUMBER WILL BE IN DEMAND FOR RECONSTRUCTION

Take the matter of building materials. We know that lumber is bound to be the greatest factor in the first rush of rebuilding operations, and we have reason to suppose that the warring nations have been obliged to strain their resources to the limit during the war. In other words, the demand for underground timbers and for surface structures of a temporary nature has called for about all the lumber they had to spare, except as they cut over and above the growing limit. It is quite possible that after peace comes the owners of timber lands in the European states—the Governments in a good many instances—will consider that the need is great enough to justify denuding their forests far beyond the power of growth to replenish in many years. And it also is quite probable that the vast forests of Russia will become the scene of intense lumbering activity, an activity that will in many instances mean new enterprises.

It is a foregone conclusion that lumber cannot be made without machinery. The place of manufacture does not matter so much as it did a decade ago, but the matter of equipment grows more important every year. And if the inability of European mills to meet the demand at first results in a great outflow of American lumber, there will be an improvement in the realm of woodworking machinery in this country. Again, if the opening of a rebuilding era brings with it an awakening among the European lumbermen, as certainly it must, the need of good machinery to be furnished at once will open up another avenue of possibilities for the machinery folk of this country. And, fortunately, the realm of lumber machinery is but one of the angles that this new situation is likely to possess, although it happens to be the one in which the writer is interested just now.

The custom among experts who write for publication upon the subject of American export trade is to dwell at length upon our common fault of looking at the matter only from our standpoint and overlooking the fact that our prospective customers have ideas of their own in regard to their requirements. In other words, we are prone to believe that whatever suits us must suit the other fellow, when really he has good reasons for desiring some-

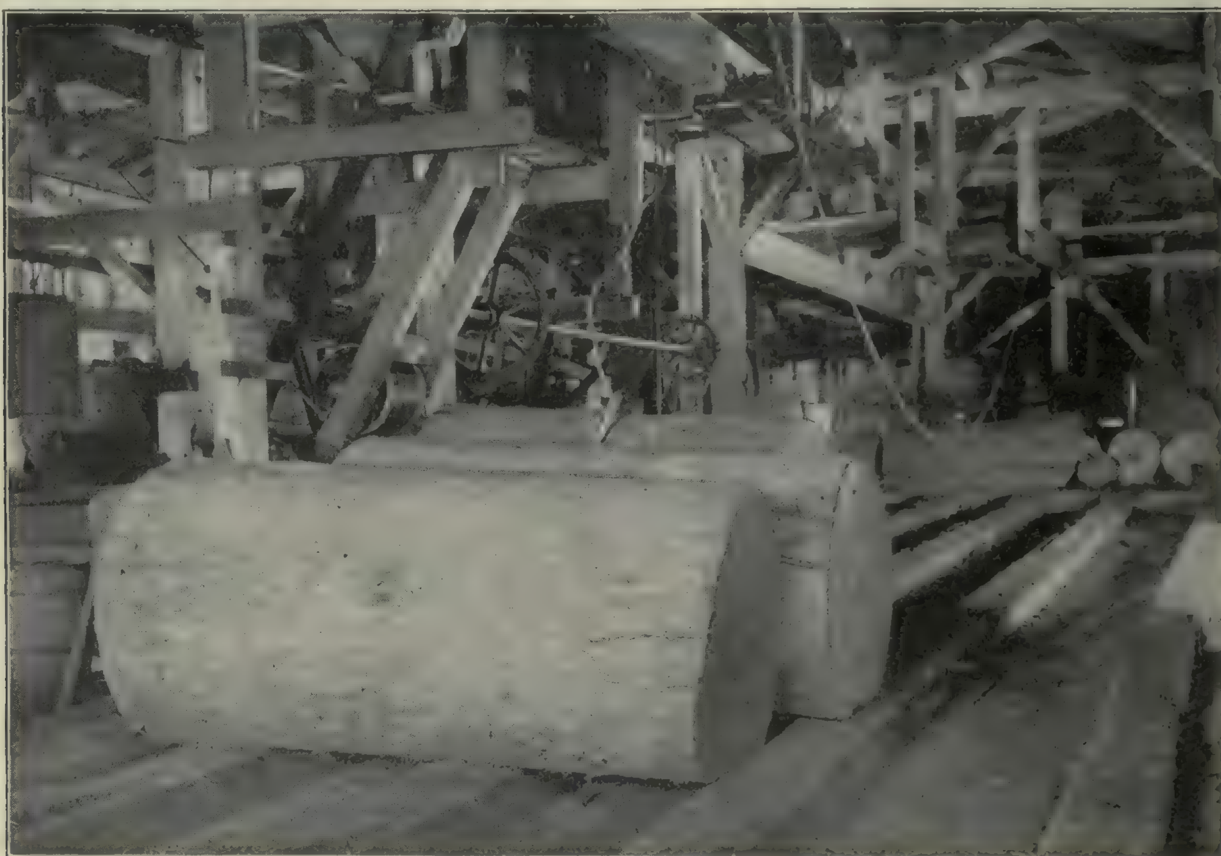
thing different. This being the case, there may be a measure of value in a brief sketch of the woodworking-machinery business as it was conducted before the war by one of Germany's foremost manufacturers, even though the years of strife may change certain conditions that formerly influenced the industry.

The Gebrüder Schmalz plant is located at Offenbach, really a suburb of Frankfort-on-the-Main, and although it was a family property, at last reports it was managed by one Schmalz, who knows German and European methods and requirements thoroughly, and American almost as well. After spending several years in our country, during which time he progressed from a humble apprentice whose expenses were paid by his firm to the superintendency of a great American shop wherein sawmilling equipment was manufactured, this practical and open-minded German went back to his own country possessed of first-hand knowledge of and respect for our methods and products. Also, he had added to his vocabulary an expletive that he frankly considered more expressive than any word in his own language and one that he could use in his plant without being criticized.

Differences of American and European Machines

Speaking to a group of Americans about four years ago, Herr Schmalz discussed a few of the differences between American and European machines, classifying these reasons as economic, psychologic and historical. Under the first head we must remember that wages when applied to machinery are much lower in the old countries than in the newer, and that human efficiency is not so great a consideration, while the item of power is a serious proposition. The value of raw material is great, therefore they can better afford to waste labor than lumber, and accordingly build machines that work slowly but with wonderful precision. Slow-running equipment does not require so much power as our faster types, which reflects the difference brought about by the power factor.

In America we specialize upon the different steps of woodworking with a resultant device for every product, even to chair-leg lathes, and divide the manufacture of these various items among a number of producers. This is possible because the consumption of wood products is so great as to make wonderful markets for each and every one. The fact that we often glut the market does not greatly change the situation. But over there, a first-class manufacturer builds equipment for all lines of woodworking activity, from gang saws down to devices that clean the interiors of beer barrels so that the pitch will not crack off and allow the precious contents to deteriorate. And he makes them to order, thus avoiding the maintenance of large stocks of assembled machines.



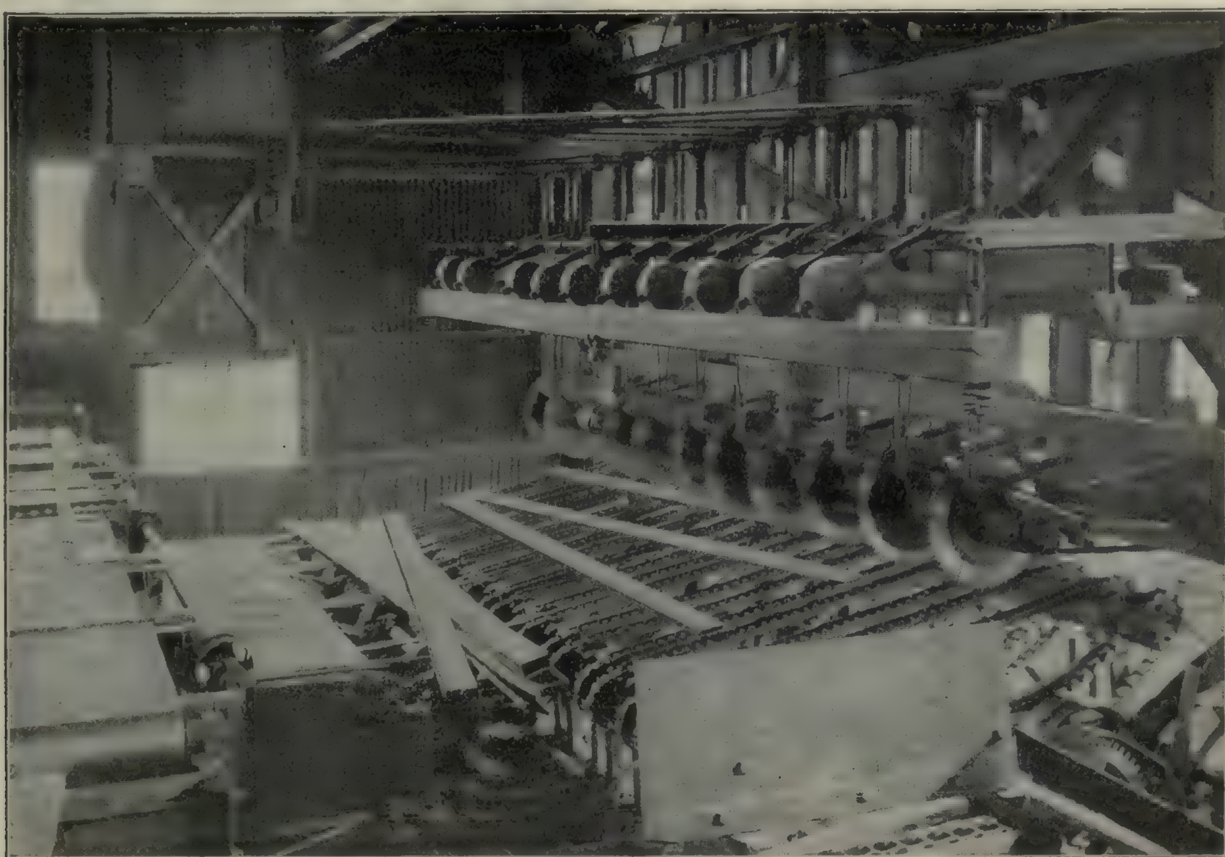
THE TRANSFORMATION OF LOGS INTO FINISHED PRODUCT CALLS FOR VARIOUS TRANSPORTATIONS

German View of American Machinery

Entering the realm of psychology, we find that in the German eye we are visioned as a race which desires always that which is newest and most efficient, which is in direct contrast to their method of installing mill machinery to last several generations. There also is the question of markets; for while the European makes his goods for a limited clientele, depending upon the good will and personal acquaintanceship of those who use his goods to extend his market, we on this side of the water are given to buying that which we believe will give us the best service regardless of the maker's name or locality. At least so thinks Herr Schmalz, and he concludes that

such practice stimulates continual development to rise above the common level of machine design.

Surrounded as they are by other nations, the Germans cannot but feel the effect of their neighbors' ideas in woodworking lines. Then, too, they have been grinding away at the game for many generations and have certain fundamentals of design that are typically European. For example, in planning machines they started with the use of fixed knives and have worked along these lines almost exclusively, while we pit our faith in movable cutterheads. Another divergence of ideas may be found in sawmill equipment, for where we use band mills they stick to horizontal and vertical gang saws that operate in the same jigging manner as do the crosscutting drag saws of our farmers' woodpiles. Band saws they have not, for where could they find the talent to keep such equipment filed and in condition for service? There's the rub, according to the German maker. And their carriages are simple devices, for the difference between values in the various grades of lumber is so slight that it does not pay to turn a log between saw cuts, as is done in a large percentage of American sawmills.



AMERICAN SAWMILL MACHINERY IS BUILT WITH THE IDEA OF SAVING TIME

Old-World Machines Generally Designed for Very Long Life

Thus, in general, we find that the old-world machines are designed for long life, all bearings and working parts being constructed with the greatest of care from the best materials. And then they are intended to last a lifetime, which generally they accomplish. Add to these characteristics the items of low power consumption and cheap labor that makes speed a secondary consideration, and the outward features of the situation are revealed.

It may be found that after war has taken its toll there are not enough men to labor cheaply as before. That would call for speed from other sources. Again, the demands made upon European manufacturers may be far in excess of their possibilities in many lines. The conversion of war munitions plants to their original natures may be attended by numerous delaying difficulties. There are many good reasons why American woodworking and other machinery should be in demand across the water in quantities hitherto unapproached, not only because they are capable of great speed and otherwise qualified as labor savers, but because the makers will be first in line to deliver the goods. Perhaps the American machinery people will revolutionize industrial methods over there in a way, injecting a modicum of pepper into so leisurely a business as theirs has been in the past.

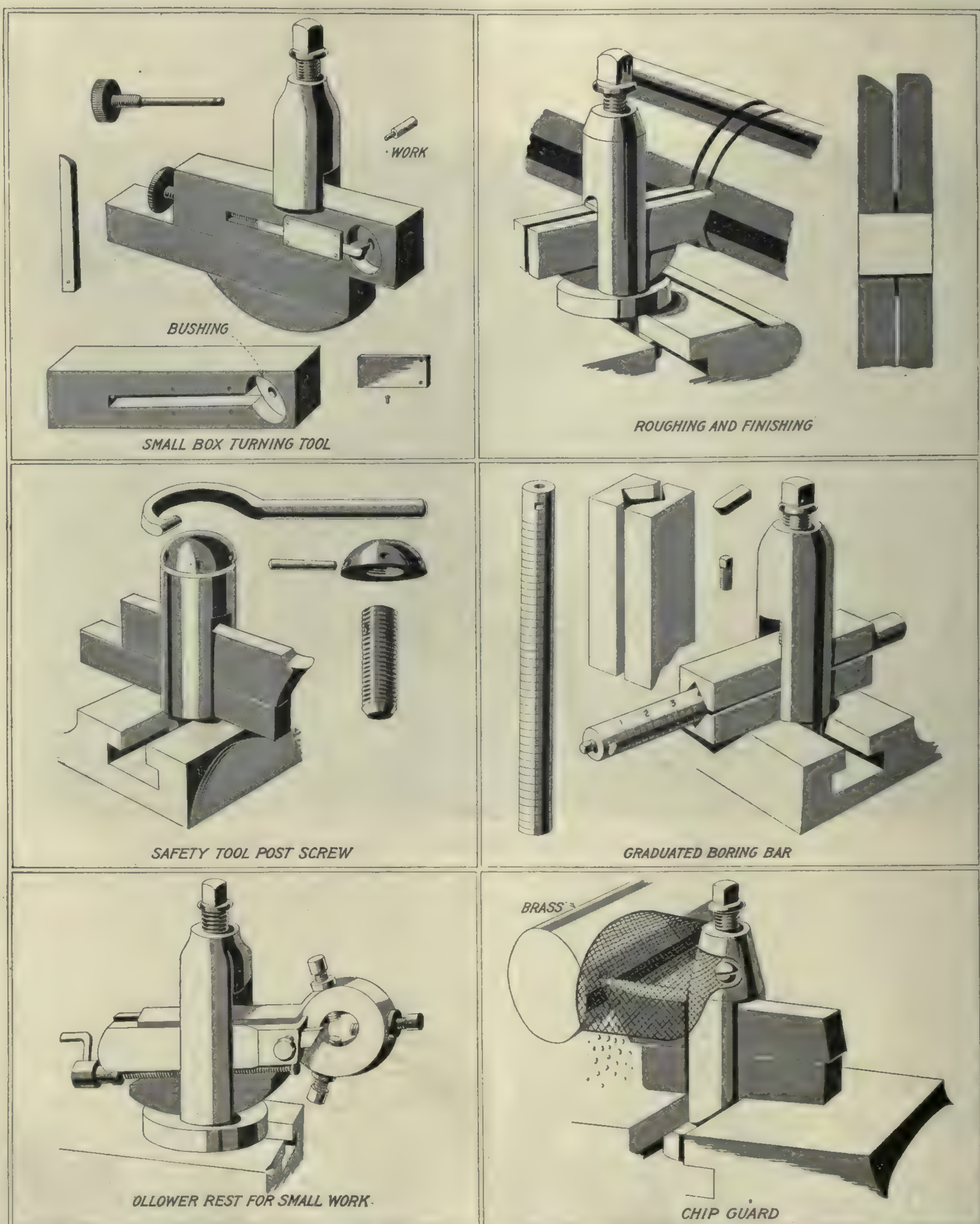
Woodworking Machinery in Peru

According to the United States *Commerce Reports*, Peru offers a considerable market for small woodworking machinery.

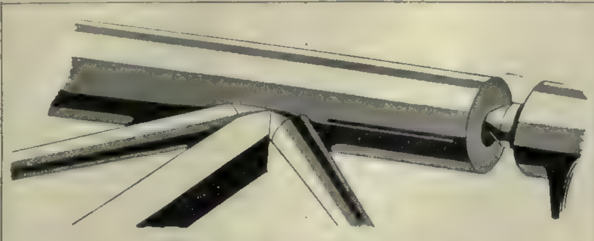
While this market is a limited one, it might be developed for American machines and machine tools, because of their superior quality; but since the field is so limited, it is not believed that it would be profitable for any one firm to spend a large amount of money on any one line. These goods could probably be best handled by a house carrying other lines of machinery and tools as well. The names of two Lima importers in position to handle such machinery may be had upon application to the Bureau of Foreign and Domestic Commerce by referring to file No. 2390.

From a Small-Shop Notebook

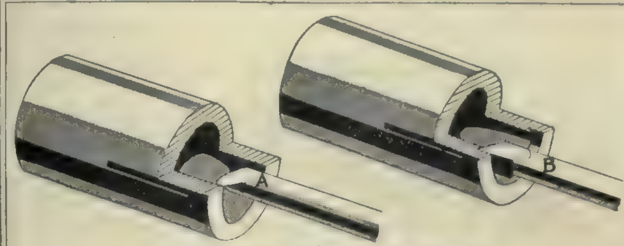
By John H. Van Deventer



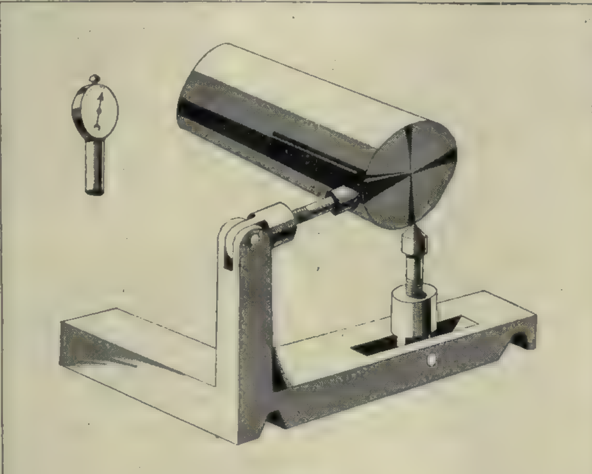
SLIDE-REST KINKS AND CUTTING-TOOL STUNTS



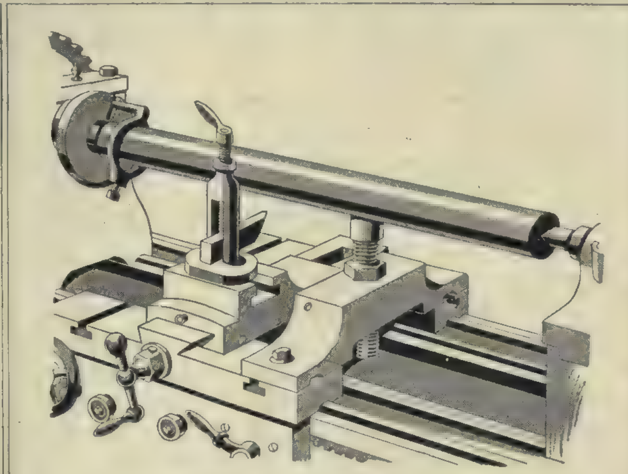
SETTING THE TOOL WITH CENTERS



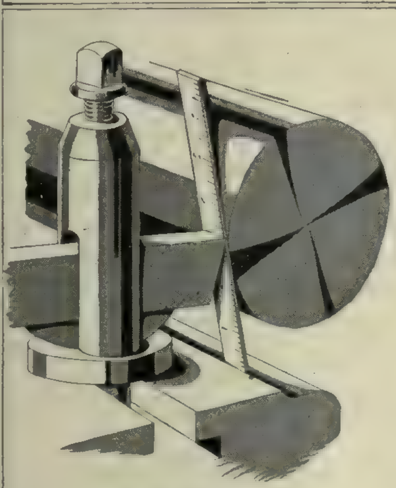
IF A SKIDS, B WILL GET UNDER SCALE



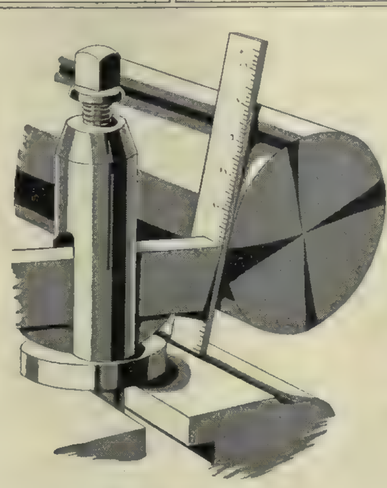
LATHE TESTER



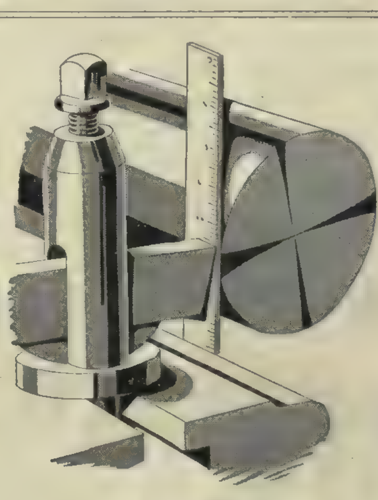
SUPPORT FOR BAR STRAIGHTENING



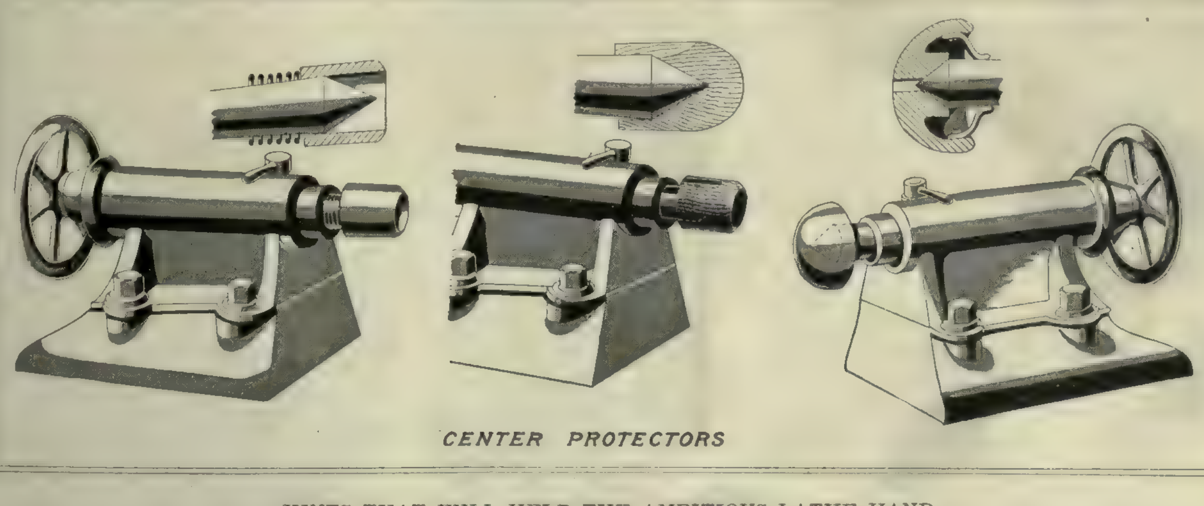
TOOL BELOW CENTER



TOOL ABOVE CENTER



TOOL ON CENTER



CENTER PROTECTORS

HINTS THAT WILL HELP THE AMBITIOUS LATHE HAND

Hiring a Draftsman

By Charles M. Horton

SYNOPSIS—Draftsmen have their peculiarities, like all other human beings; perhaps, if anything, they have more. A chief who does not understand these peculiarities or know how to adapt them to the end in view is neglecting opportunities, incurring expense and getting himself disliked at the same time. This article should interest not only draftsmen and their chiefs, but all who come in contact with them.

"What do you think of that guy?" asked the chief draftsman of his assistant, as the "guy," who was a candidate for a position at the board in the drafting room, made down the hall for the door. "He's at least healthy."

The chief and his assistant, being "regular fellows," frequently permitted themselves irregular—undignified—speech. The organization was a large one, with a drafting room that carried a force of some 35 men; and up to three years ago there had been no difficulty in keeping the boards all occupied. Beginning with the outbreak of the war, however, things had changed. Men came and went and came again, following the call for self-betterment. This form of shopping one's services about until the right job was landed was possible, because the plant was located in a large city. But it kept this drafting room, as it kept other drafting rooms, in a continuous state of upheaval. In consequence, the chief was getting a fine insight into the characteristics of drawing-room labor—and growing sarcastic.

He repeated his question, emphasizing one of his words this time—an emphasis that was eloquent of conditions under which he was writhing.

"What do you think of *that* guy?" he queried, as the door closed behind the applicant.

Interrupting the Slide Rule

The assistant did not reply. He was absorbed in working out a calculation on his slide rule, and evidently he had failed to hear his chief. Anyway, he continued with his calculation. The chief, who was a fat man, sniffed good naturedly. Also, he sneaked a small bite of Piper Heidseick into one side of his face. He continued to stare down the hall at the door through which the candidate had disappeared. He had stared in this fashion a good many times of late—since the European War broke, to be exact—and this staring, like the emphasis to a certain word in his question, was eloquently indicative of his frame of mind. He answered his own question.

"I kinda like him, myself," he declared, wheeling in his swivel chair toward his desk and seemingly unmindful of the lack of interest shown by his assistant. "I told him to come to work Monday morning. He's got pep, and I think he'll be a good man."

The assistant laid down his slide rule. "I didn't pay much attention," he said, wheeling in his own chair and facing the chief. "I didn't even give him the once-over. It wouldn't have done me any good if I had. I've given up trying to judge a man by his appearance. I used to think that a man who was my opposite in appearance possessed my opposite characteristics. But not any more. I'm coming gradually to agree with my grandmother in her saying that you can't tell by the looks of a toad how far it'll jump. If that man comes in Monday morning; *if* he does, I say (you don't know *what* you've got coming these days), we'll know, I hope, by Wednesday evening whether he's worth keeping, but not a minute sooner!" He turned back to his desk and squinted speculatively at his slide rule. Slide rules do sometimes lie. After a moment he picked it up and began a series of calculations again. Presently he interrupted his work to make a concluding observation: "We're lucky to get anything that can push a pencil along a straight-edge, these days."

The chief sat back reflectively in his chair. "I hunted a good many jobs, myself, before I finally got settled here," he declared thoughtfully. "And the things I got peeved over in a possible boss upon our first interview I try to cut out now when hiring a draftsman. For instance, whenever I struck a man who shoved a pad and pencil at me the first thing, then asked me to write down my name and address, and then went on, himself, to write down the number of places where I had worked, how long I had remained with each one, what my salary was and my reasons for leaving—all under my own handwriting—and then, having all this information, wheeled pleasantly and faced me and asked what I wanted as a salary, and upon hearing it held up his hands in holy horror—I say, such a man always got my goat and never my services. Such a proceeding is useless; it is even nonsensical. The man's viewpoint was biased. What he sought, and deemed of primary importance, was that he should be pleased—not I; and he almost invariably got peeved himself when I asked into the nature of his work, how much of it he had, when the paymaster got around—how often—and what the hours were. I don't do that, myself, now, and I never will. That is one type of chief draftsman who cannot see the woods for the trees. And there are others.

Who's Your Great-Grandfather?

"Show me the man who is willing to fill out one of those who-was-your-grandfather blanks, in applying for a job, and I'll show you a man who needs a job mighty bad. He may be a good man for all that, but the chances are against him. A good man will not fill out such a blank—he doesn't have to. Moreover he is justly suspicious of the organization that asks him to fill out such a blank. The whole process is too mechanical. There is nothing of the human in it. He feels that he will go into that organization like a tagged piece of machinery, a miller or a lathe, and be so regarded all the while he stays there. He feels that he will be numbered—tagged and numbered—and enjoy about as much human relationship with the organization as a machine tool. Then there may be reasons why he left some previous employer which he is willing to state in language, but which he refuses to put down in black and white for the delectation of those over him for all time to come. He doesn't have to do these things and he doesn't do them, because he's a good draftsman and he knows it; he keeps pushing along

until he strikes what he is after in the shape of a job, but principally in the shape of an employer.

"That's the keynote—human relationship," went on the chief, waxing enthusiastic in his speech and as yet blissfully unmindful of the inattention shown by his assistant. "We've had our troubes here in shortage of labor since the war, the same as all other concerns. But I doubt that we have been so short-handed as many of the others. The big companies are advertising all the time. It shows that there is something the matter with their methods of hiring. Big concerns offer many attractive reasons for coming to them. The work usually is steady, and the chances for advancement are almost unlimited. That's the way the draftsman looks at them, anyway; and when you see these big organizations crying for help, it's a safe bet that they lose a number of their prospects. Almost invariably the large organizations thrust at the applicant one of those long blanks to be filled out; and as I say, under present conditions the good man won't even read these blanks. The employer who wants his services and who is willing to judge of their character by what the draftsman does in the first week or two, and not by what some previous employer says of them, is the man the draftsman wants to work for.

Little Things That Make Big Differences

"Then there are other things—not so big in their way, but just as important. I remember once writing to a man who had advertised for a draftsman. His concern was well out of the city, yet the distance was not an alarming or a forbidding one, and I felt strongly attracted to the job. His letter back to me, however, after citing what he had to offer, wound up with the remark that, if I cared to make the trip for an interview at my own expense, he would be glad to talk with me. That phrase—at my own expense—stopped me. Not at first. It just didn't please me when I first read it, though I found myself planning as to when I could arrange to take the trip. But the more I thought of it the more it annoyed me; it seemed to forebode ill of some sort in connecting myself with that organization, and I finally rejected the offer. Perhaps I was a little sensitive about it, too much so. Then again, perhaps I wasn't. Had he neglected to make that statement, I should have taken the trip without thought as to expense—in quest of jobs, I had taken longer journeys at my own expense—and the thing would have passed off naturally. But when that man set out to inform me in a matter of some five or six dollars, I concluded that he might always quibble in that direction and passed him up. A very decent chap, too, no doubt. He just hadn't taken my pulse correctly; that was all.

"Then I knew of a chief draftsman once who turned an applicant down because the latter couldn't talk English that was easily understandable to the chief. He figured it out this way. As he listened to the applicant, the chief draftsman found that he was paying too much attention to how the man was talking and not enough attention to what he was saying. The chief decided that that would mean a loss of valuable time in the drafting room. In a sense he was right. The man might have the best ideas in the world, but because he expressed these ideas naïvely—peculiarly, perhaps—the chief, attentive more to the way the man was expressing himself than to what he was expressing, would lose time in getting to the kernel of the thing—the idea. So he let the man go—or rather, he refused to engage him. Still, that man might have been a wizard at the board. The chief never learned, because he never gave himself the opportunity to learn by engaging the man. Any man ought to try anything once, for the good of his soul in determining what and what not to avoid later; and any chief ought to try any candidate for a job once at least. The cost of the experiment well pays for itself afterward in judging candidates, especially of the type he is compelled to discharge.

"Take my own force here," went on the chief. "I try, as you have noticed, to keep the gang balanced. When I lose an especially good mathematician, I try to fill his place with a good mathematician. When I lose an embryo inventor, I look for such a man to succeed him. Draftsmen run like that. Some are good at mathematics, some are born inventors, some are hogs for detail, and a few, a very few, fill in wherever and at whatever they are put. But the balance runs in other things, too. I try to keep a Hungarian as far away from a Roumanian as I can get him, and no sane man will place a Norwegian next to a Swede. Likewise, the Yankee likes to work alongside of a Yankee—for reasons nobody need explain.

"It's a peculiar thing—this hiring a draftsman. More so than in most other trades. Draftsmen are sensitive as men, and to maintain satisfaction in a force of draftsmen calls for an exercise of talents not generally specified in a letter calling for the services of a chief. It may not be as bad as the difficulties of an impresario trying to hold a company of artists to their contracts; but in many ways the situation is about as difficult, since in their work draftsmen have time and the opportunities to mull over their real or fancied grievances. The result often is that these grievances mount from the size of molehills to that of mountains, and the first thing you know you've got a vacancy to fill. These difficulties expand in direct ratio to the prosperity of the country, and never were they worse than they are now. It sometimes makes me hot under my horse-collar; but then, I was once a draftsman myself, and that thought, with the memories it brings, soothes me.

Difficulties That Owners Rarely Understand

"Owners rarely understand these difficulties. For instance, the Old Man, when he engaged me, talked nothing but output. Output was his first and last word. All the while he was talking output I was figuring mentally on fat men and lean men and nationalities and education and drafting-room light and number and easy accessibility of reference tables, just what quantity of supplies—rubbers and pencils and the like—the organization would stand for, how often the ghost walked to the workmen, and things like that. They count, you know; they count a lot. Output is all right, and it's all right for the Old Man to think only of output; but output depends much on other things, things which nobody but the secretary gives a thought to, and he generally begrudgingly, so I couldn't help but let my thoughts drift that way a little.

"Draftsmen nowadays quit their jobs for reasons that few organizations get 'hep' to. Some let go because the light is poor or because their tables are located in such a way as not to take advantage of what good light there is. Some are machinery men by taste and training and quit when they find the work taking on more and more structural form. Some are structural men who hate machinery and take the job merely to tide themselves over

into a machinery plant. Some—creative minds—want a steadily increasing difficulty in their work, must have it in order to be held interested; and they ought to have it, for these are good men and rare, but they will quit if they don't get what they want.

"And so it goes. Hiring a draftsman! Good Lord! Hiring brains is what we mean. And hiring brains is like hiring souls—it can't just be done. Souls can be invited to come in and help out, but that is about all that can be done about it. A draftsman knows his worth to an organization, even if the owner does not. The days of the 'rule of thumb'—let's make it six inches long, John; that ought to be strong enough!—are gone, and gone for good. Your draftsman decides, sets it down for all time; question and argument and consequent loss of time in the shop are thus obviated. Does he earn his money? I am strongly inclined to believe that he does. Just how much waste of valuable time he obviates in the shop has never been figured out, and so his exact worth to an organization has never been figured out; and so, to continue, he remains a sort of questionable and puzzling factor in the personnel. He himself knows, however, and the longer he remains in the game and the more efficient he becomes the more independent he becomes.

Value of a Draftsman's Time

"He figures it out—whether right or wrong I can't say, because of my job here—that the draftsman never got what was coming to him in wages. This is due, perhaps, to the inability to figure his time, the true worth of it, on a job. A machine sells for so much money. A machinist's part—or a molder's or a patternmaker's—in the production of that machine can readily be ascertained. But not the draftsman's part. In the making of the drawings, to be sure; that's easy. But the draftsman's worth to a concern does not stop there, nor does his value to an organization begin and end with the turning out of a drawing. If anything, it begins with the finishing of the drawing. From the patternmaker to the erecting man that particular drawing spells value in saved time. It is a manifolding proposition; its value builds up and steadily up as time goes on, till fire or flood or failure terminates its existence and therefore its value.

"And so," continued the chief, "I try to be human above all other things when hiring a draftsman. I know his viewpoint, because I once had it myself. No, I haven't got it now. Being a boss changes that somewhat. I show him what he will be up against—to use his own language—if he cares to come to work here. I show him the drafting room; indicate, if possible, where he will work; explain our line in detail; what our hours are; when we pay off; what he may expect in the way of a future, if he makes good, though I never raise this point in my speech—that he may possibly fail with us. Altogether, I say to win his friendship and through this his interest and loyalty in and to me and through me to the organization. I even try—"

"Say!" interrupted the assistant, somewhat impatiently, "I am trying here to work out the probable strains in that big connecting-rod, and I can't do it with your gassing like that. If you must talk," went on the assistant, grinning, "go engage the use of an auditorium—in other words, hire a hall!"

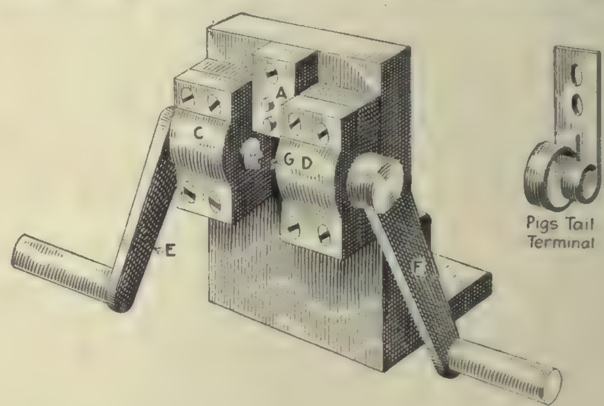
The chief himself grinned, bit off another chunk of tobacco and shut up.

Terminal Winder

By Jan Spaander

The winder shown in the illustration was used to form the eyes of so-called pig's-tail terminals for two different sizes of wires. The thin copper blanks were punched and split before forming the eyes; this was done by laying the blanks on the anvil A, while the cranks shown on either side of the baseplate were moved to the outside. The baseplate is a flat piece, and to it were fastened the anvil and the bearings for the side cranks E and F. These cranks were provided with two pins G each, and these pins were of different diameters. One was at the center and the other was spaced slightly more than the thickness of the copper blanks from the central pin.

An eye was formed by gripping the blank on the anvil between the two pins and turning. The operation was



THE TERMINAL WINDER

repeated on the other side, this producing the second eye, differing in diameter, because of the difference in the pins.

Casehardened Jig Bushings

By H. W. Johnson

Why are jig bushings almost always of tool steel, hardened, ground and lapped? If a man who makes bushings from soft steel and casehardens them is open to censure, then I am a double-dyed sinner beyond hope, for I have made, or caused to be made, hundreds of them. I have put them in jigs, side by side with tool-steel ones. I have put them where no bushing could last long, and I have put them on easy jobs. For the most part they have been successful. When they have failed, it was due to lack of skill in hardening.

I favor their use because they can be left glass hard on the surface, with no fear of breaking. In the larger sizes there is a considerable saving in material cost. In all sizes there is a good saving in labor, due to higher cutting speed possible with soft steel. Casehardening does not seem to cause much change in size in the fire, and on small bushings for ordinary work I have left out grinding without causing trouble.

In making these bushings two points have made themselves manifest: Do use a pyrometer, and do not depend on potassium cyanide. Cyanide will not go more than skin deep, no matter how long you cook it. I like the prepared hardening compounds best, and I believe more uniform work will be had than can be secured with home-made raw- and burned-bone mixtures.

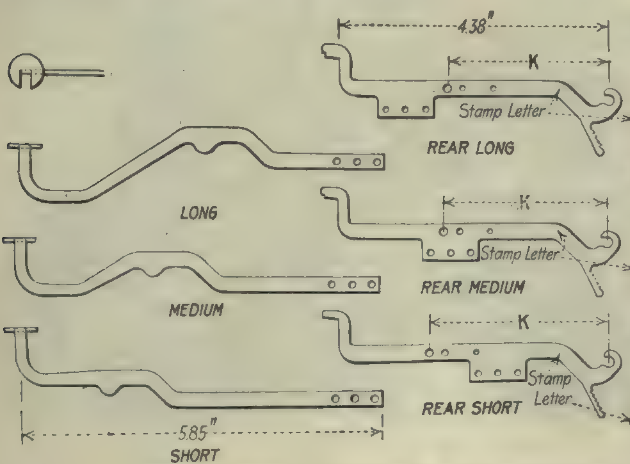
Press Tools for Typewriter Key Levers

BY FRANK A. STANLEY

SYNOPSIS—Details of design and use of tools for blanking, piercing holes, bending and extruding pins in typewriter key levers. Comb-cutting tools and punches, and dies for making copper clips are also shown.

The key levers used in the Noiseless typewriter consist of two main parts: The front lever carrying the circular keys, and the rear lever attached to the front lever proper, and having at its rear end a fulcrum hook by which it is suspended in the machine and on which it pivots when the key is depressed by the operator. These two parts are put together in correct position by a series of short pins. These pins are formed by extruding the metal from the side of one of the levers and forming corresponding seats or blind holes in the other member, into which they fit tightly. In addition to the three pinholes, other holes are pierced for the purpose of securing a copper clip.

There are twenty-eight key levers in each typewriter. The twenty-eight front levers and the twenty-eight rear levers are uniform throughout the set for overall length, but each lever differs from the others in respect to the location of rivet holes and a lug underneath the front lever. The levers, front and rear, are shown in the drawing, Fig. 1. It will be seen that they are classified in each case as long, medium and short. Of the long levers there are nine; of the medium length there are nine; and of the short there are nine, as indicated in the drawings. The front levers are made of sheet steel 0.040 in. thick, the rear levers being also made of the same material, but with the thickness increased to 0.057 in. Fig. 2 illustrates the press tools used in the production of these levers. The blanking tools for the front key lever are shown at *A* at the right-hand side of the group. It will be seen that these are of simple design, requiring practically no explanation. There are, of course, three sets of tools for the three lengths of levers, as these levers differ in their general shape. The short lever is practically straight for its entire length; the medium is lowered at the middle; and the long lever is dropped at the front below the center line to such a point that the key pad is practically in line with the rear end of the lever. Blanking tools for the rear lever are shown at *B*, Fig. 2. These also are made in a set of three punches and dies of the same general type as the pair illustrated, but differing from them in that the rectangular portions of the die for the rivet holes are not positioned the same from the pivot hole at the rear end of the lever.



Lever	K
Z	2.609
X	3.208
C	3.616
V	3.862
B	3.926

Lever	K
N	3.799
M	3.478
•	2.990
·	2.401

Lever	K
A	2.433
S	3.090
D	3.560
F	3.873
G	4.005

Lever	K
H	3.938
J	3.683
K	3.215
L	2.646

Lever	K
Q	2.245
W	2.930
E	3.494
R	3.878
T	4.081

Lever	K
Y	4.081
U	3.878
I	3.449
O	2.901
P	2.245

FIG. 1. DETAILS OF SIX STYLES OF KEY LEVERS

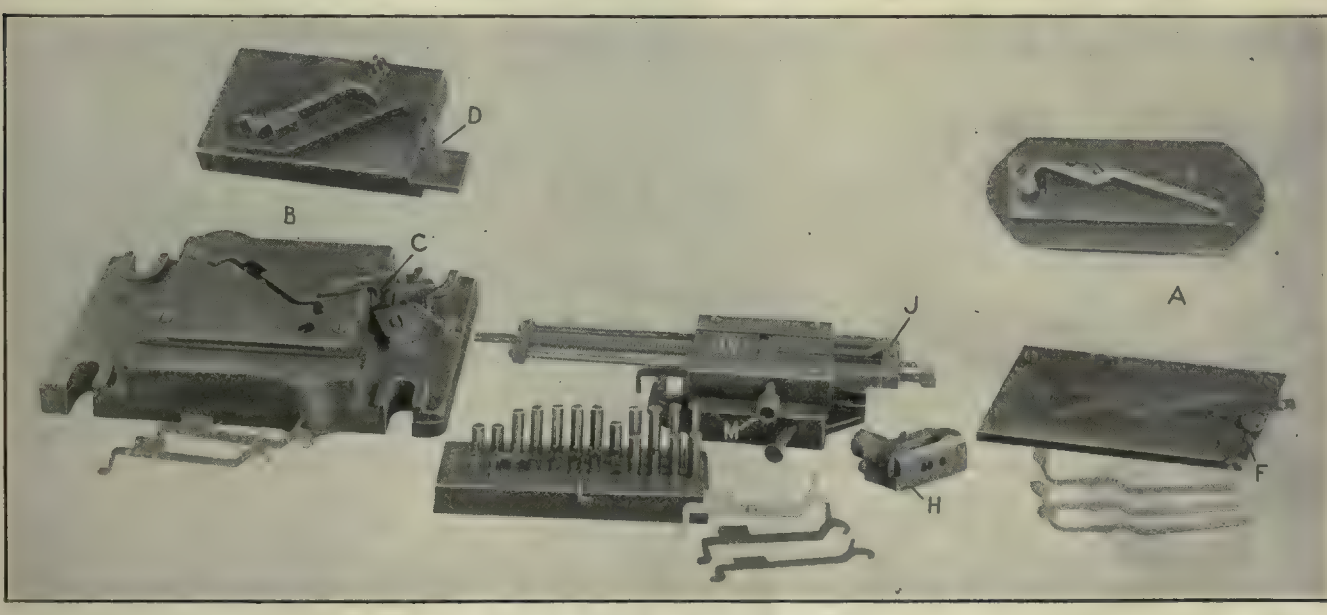


FIG. 2. PRESS TOOLS FOR KEY LEVERS

With both the front lever and the rear lever the punch and dies are laid out obliquely, so that the work is punched out of the strip of stock at an angle which allows the offset portions of the work to interlock closely, thus

avoiding any particular waste in the material. The tools at B for the rear levers have an interesting form of stock stop. This consists of the bell crank C, which normally is held down to working position by a spring on the rear end of the lever that causes the inner end to be depressed on the downstroke of the press. Compression spring D, carried by the punch block, strikes the rear end of lever C, and when the punch travels upward again after the blanking operation, this spring D holds the stop open for a sufficient length of time to allow the stock to be fed and is then stopped by the throwing down of the stop C through the action of the compression spring E under the rear end of the stop.

A stop operating on somewhat the same principle is carried on the front lever tools A. This stop is pivoted at F so as to be operated automatically by the downstroke of the punch block.

An Adjustable Piercing Die

The tools at G and H, Fig. 2, constitute an adjustable piercing die and punch for the holes through the levers. Referring to Fig. 1, which shows the dimensions of the long, medium and short rear levers, it will be seen that dimension K varies throughout the series of twenty-eight levers. This means that the two smaller rivet holes on the right also vary in position throughout the whole series. These three holes taken together are pierced in twenty-eight places in this one set of tools.

It is of great importance that hole K be pierced the exact distance specified from the center of the hook fulcrum at the rear end. This must be held to less than a thousandth of an inch of the center distance called for in the table under each lever. In order to secure this degree of accuracy in the piercing process the die is arranged so that the lever is located from the hook fulcrum. It will be seen thus placed in the die G, with the hook slipped over the locating pin at J, Fig. 2. In this position the lever is held against end motion by suitable stops. The round dies; that is, the piercing dies proper, have a fixed position in the die block. The die member which carries the work is adjusted longitudinally so that the lever may be placed over these dies at any distance desired either to the right or to the left.

The adjustment to position for each of the twenty-eight settings referred to is obtained with the requisite degree of accuracy by a set of end gages in the block at L. In setting the carrying member of the die correctly for a given lever, the proper end gage is placed in the open frame at J, with one end in contact with the end of the inner side of the movable member and the other end bearing against the end of the die block. Knurled screw M is then tightened to hold the lever-nesting member in this correct position. It will be seen that there is a long helical spring carried on a guide rod at the left-hand side of the guide block, this spring always acting against a yoke connecting the two rods tapped into the rear end of the movable nesting member of the die. This spring always tends to draw the nest toward the left, so that in setting the device with the end measuring gages the movable carrying nest is drawn back with practically a fixed degree of pressure, with the result that the gaging in the setting process is always conducted under the same conditions as to contact with the die parts and the gage itself.

The piercing punch at H carries three round punches that are guided in the stripper plate, the plate being mounted upon guideposts and acting in its descent against two rubber cushions, this procedure supplying the pressure required for stripping work from the punches upon the upstroke of the press.

Extruding the Pins

Referring again to the drawings, Fig. 1, it will be seen that the rear ends of the front levers have three holes pierced through them measuring 0.102 in., while three holes of similar diameter are punched half through the lower lugs on the rear levers. In piercing these holes half through, the pins of the same size are forced out of the back face of the levers to a sufficient height to form locating plugs, or rivets, to fit the holes pierced through the rear of the front levers. This is in reality an extrusion process and makes possible a very neat joint between the two holes. It is accomplished with the piercing dies already described in connection with Fig. 2.

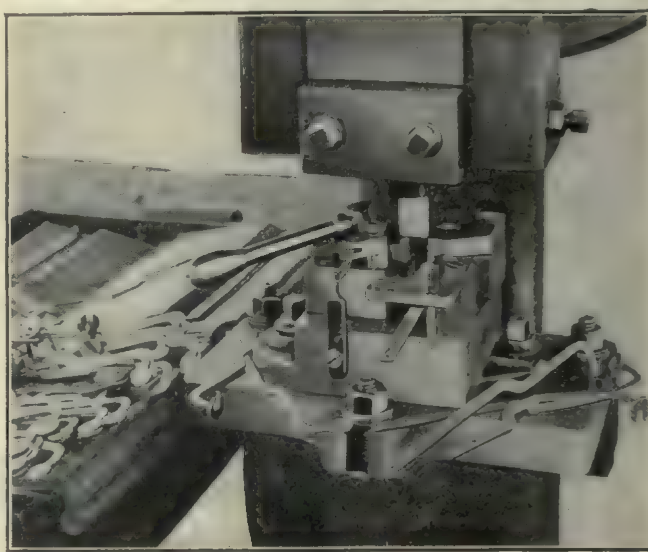


FIG. 3. KEY-LEVER BENDING TOOLS

A Set of Bending Tools

The front ends of the key levers are bent at right angles to receive the finger disks, in the tools shown in Fig. 3. These are used in a small press and consist of a die in which the front lever is slipped flatwise, with the disk to the left, where it rests upon the base of the die. The punch, in coming down, notches the disk at the side by pressing the disk down at right angles to the end of the key lever proper on the center line of the disk. The work before and after bending is shown on the bed of the press.

When the key lever is slipped onto the die it is held in place by a movement of the hand lever to the left, which, when it is swung to the left, draws down the stiff clamp seen directly under the punch. After the bending operation the hand lever is moved to the left. This releases the clamp, and the bell crank shown at the front of the clamp is operated by its spring to swing the lower end forward and sweep the key lever out of the die.

The press tools at the left in Fig. 4 are for making the comb shown in detail in Fig. 5. This comb has twenty-eight slots of uniform dimensions, so far as width and depth are concerned. At the extreme right-hand end there are three slots of different depths and 0.060 in. in width, while the twenty-eight main slots are 0.040 in. in width and 1 in. deep.

The comb is made from material of the same width as the finished part, so that no stock is wasted on the outside of the blank. The strip simply feeds through the die guided by its two edges and is positioned against the end stop shown at the back of the die. The punch carries a complete set of shear blades that are held between spacing blocks, and the whole line of blades and blocks is secured by the setscrews at the right-hand end and along the side of the die.

The punch and die for the comb are of the pillar type, with substantial guideposts that maintain positive alignment between both members to make it impossible for the punch blades to shear into the sides of the die. The angle on the end of the punches is sufficient to make a free cutting tool, and as these strike first against the bottom of the slot and shear toward the open face, there is no tendency for the work to be deformed under the cutting action of the tools. The punch block carries at one end a shearing blade to cut the comb to the right length, so that after the first series of slots have been punched in the first blank, and the strip of stock has been fed forward to the stop, the next downstroke of the press shears off the first comb at the moment it punches the slots in the second comb. The slotting punches, in addition to the end shear, also have considerable side clearance, and the cutting action is a free one.

The punch block is so built up that any one of the thirty-one cutting blades can be readily removed for replacement when required, or for sharpening in case it has become injured and requires attention before the entire series is to be resharpened.

The stock used for this comb is 0.045 in. thick and the stock width is 0.141 in. The comb as cut off is 8.90 in. long.

The tools shown at *A*, Fig. 4, are for manufacturing copper clips that are later on attached to the key levers. These clips are about 1 in. in length and $\frac{1}{4}$ in. in width and have a hole about $\frac{3}{32}$ in. in diameter pierced at one end, and are offset at the other end by $\frac{1}{16}$ in. Near this offset they are indented to form a detent projecting $\frac{1}{32}$ in. below the face of the clip. They are blanked, pierced and formed six at a time in the tools referred to. These are of the pillar type with guideposts located at diagonally opposite corners.

It will be noticed upon inspection of the photograph that the tools are arranged so as to punch half of the length of the clip at one blow, after which, when the stock feeds forward, the second half is finished—which means that after the first stroke a complete set of clips is produced on each stroke, the bending of the offset, the forcing down of the depression for the detent, the piercing of the holes in the ends and the cutting off being accomplished on the first set of six with the same blow that forms the next set of blanks.

This arrangement of the tools cuts the scrap across in the form shown by the specimens at the front of the dies.

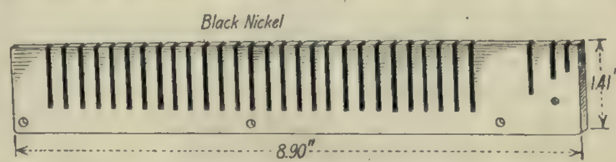


FIG. 5. DESIGN OF TYPEWRITER COMBS

The work feeds in from the right-hand side under the stripper plate, and when the punch descends, the six piercing punches pass through the ends of the blanks and the outside of the clips is cut out by the punches immediately opposite the piercing tools. When the stock feeds forward against the stop at *B*, and the punch again descends, the bent offset is formed at the front end of the clip, the depression forced in, and the rear ends cut to the correct half circle, thus completing the first set of six clips and at the same time forming the outside and piercing the six holes in the next set of six.

This makes a rapid operation, and the cutting of the scrap into short lengths keeps the tools clear of material. The upper die punch carries a stripper that is spring-actuated to hold down the six blades as they are cut off from the main part of the strip.

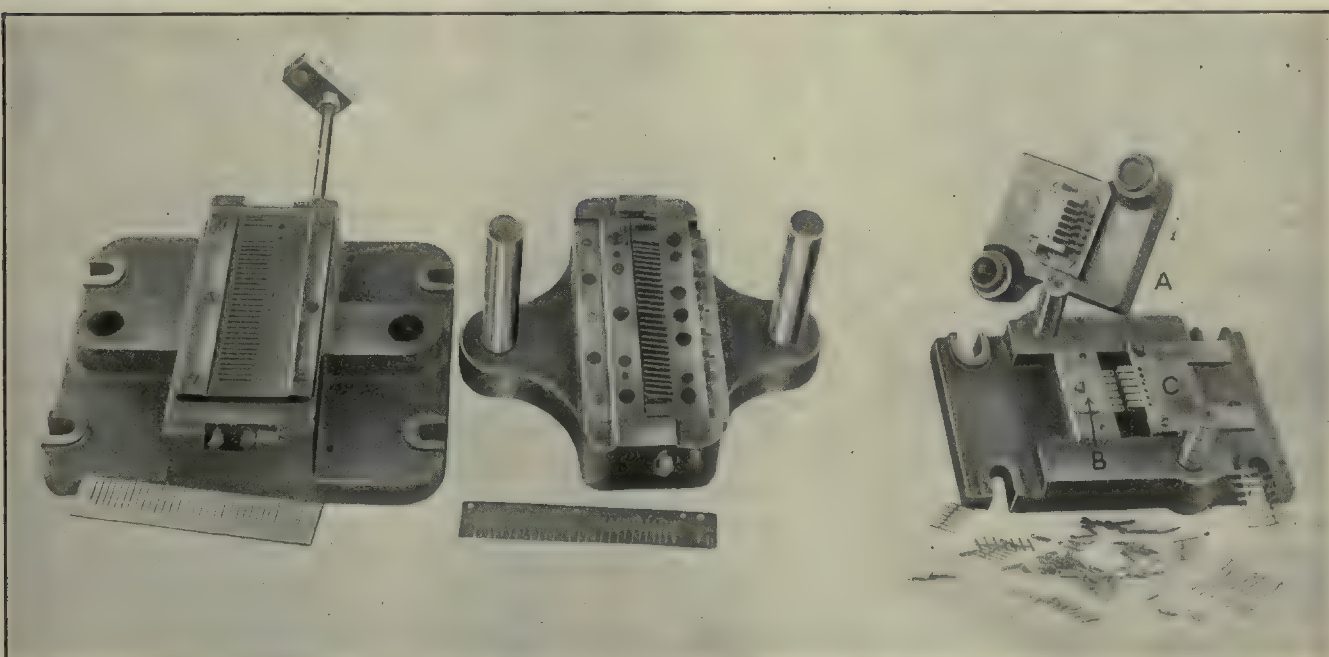


FIG. 4. PRESS TOOLS FOR KEY-LEVER COMBS AND CLIPS

The stripper plate on the die at *C* holds down the strip of stock. At the same time the holes that admit the piercing punches are sufficiently enlarged at the top by bellmouthing so that the punches can be made with enlarged bodies above their piercing sections to insure stability and long life in operation.

Early Recollections of Thomas A. Edison

By William H. Harrison

At this time, when Thomas A. Edison, although 70 years of age, is actively engaged in means for national defense, it seems appropriate that one who knew him in his earlier days of struggle and experiment give a few facts.

I first met Mr. Edison in 1874, when he was located on the top floor of the old Gould Brothers building on New Jersey Railroad Ave., Newark, N. J. We became well acquainted so that I had free entry to his workroom, and he often spoke to me of his ideas and desires. He was then bringing out a machine with a keyboard like a typewriter, whereby any person without telegraphic knowledge could press out a word by means of the letters on the keyboard and transmit a message that was printed at the opposite end. What became of this machine I do not know.

After that, he and a Mr. Unger opened a shop on Ward St., Newark, and it was my custom to call on him nearly every morning on my way to New York. Here he could be found busy, often having kept his corps of men working 22 hours. There was no let up while they were experimenting on matters that were then pending—the telephone transmitter, the quadruplex telegraph system, etc. Later, it being too much of a strain on him, Mr. Unger had to give up.

Then J. T. Murray and Mr. Edison formed a copartnership, called J. T. Murray & Co., which also located at the Ward St. address. This company developed and brought out the Gold and Stock Co. ticker. I know what hard work they had and also know the comments made by others, who told me that Edison was up against an impossibility. Two little gear cutters, which were necessary to the work, had cost ten times what they could afterward be manufactured for. But the impossible was overcome and success attained, for when the ticker was finally tried out Edison had won, and today the stock ticker is doing its work. After they had fulfilled their contract and delivered the machines, the firm of J. T. Murray & Co. was dissolved and the machinery disposed of. One-half of it was put in my hands for sale, and I sold the two little gear cutters for considerably less than they had cost Mr. Edison.

By that time he was working on the electric light, now made famous as the "Light of the World." He started a shop and laboratory at Menlo Park as, he told me, he did not want to be disturbed by any one. I was well acquainted with a number of the men who assisted him there and who with him worked out the telephone and the phonograph. They were all kept busy with very little let up; it was the survival of the fittest.

When he strung a line of wires from his shop to the depot at Menlo Park and hung on it the little glass bulbs, and the power of the dynamo was turned on, he was able to do what many people said was impossible. After a long series of discouragements, which were only overcome by persistent, hard-working, determined experimenting, he had accomplished another impossibility, according to those who did not perceive the ability and perseverance of the man. Some thought he was a cranky inventor; I always found him a pleasant, quiet man, and had the highest regard for him in every respect. I remember Mr. Edison told me long before the wireless was brought out that some day we would find people talking without wires, and while he had not been able to think of the matter some one would, without a doubt, find the way to do so.

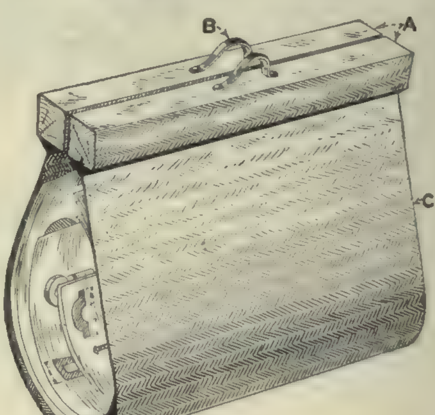
He afterward started in Goerck St., New York City, a plant wherein he made dynamos, motors and transmission machinery. Finding that taxes and other expenses in New York were getting burdensome and that there was no chance to expand, he began looking for some place where the necessary room could be had. Through a mutual friend the Schenectady location was decided on and purchased. The change to the General Electric Co. came later, when the merger of a number of other companies with the Edison was made.

In the meantime, Mr. Edison had developed the phonograph and started the works at West Orange. Here I had the pleasure of calling on him in his laboratory and found him the same hard-working, pleasant man as before. The immense popularity of his phonograph for commercial, musical and other purposes shows what a degree of perfection it has attained, due to the care bestowed on it by him and his efficient helpers.

A Handy Carry-All for the Drafting Room

By F. E. Potter

It is customary for drafting rooms to place their drawings, either every night or once a week, in a vault for safe keeping. The device shown in the illustration has proved



THE ASSEMBLED CARRY-ALL

satisfactory for carrying the drawings. It is easy to make, two pieces of white pine *A* 37 x $1\frac{1}{4}$ x $\frac{3}{4}$ in., two black japanned door pulls *B*, and one piece of unbleached cloth *C* 37 x 30 in., being fastened together in the manner shown. If desired, a small hook and eye may be attached at each end of the wood crosspieces to hold them together and prevent the loss of drawings when the carry-all is laid down.

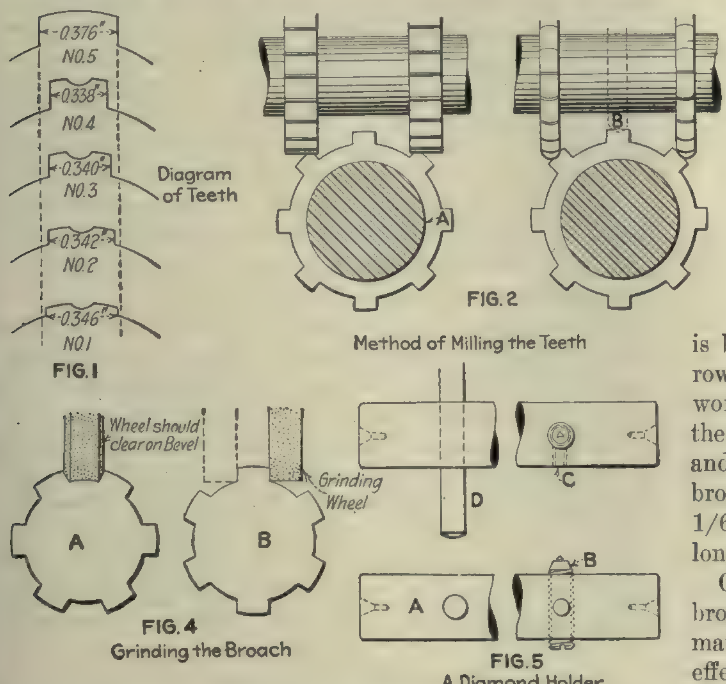
Design of Spline Broaches*

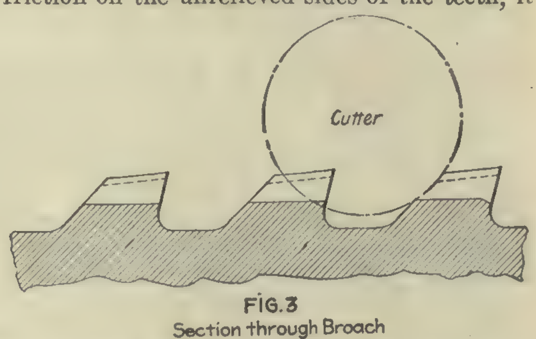
By Walter G. Groocock

SYNOPSIS—The chief point to consider in the design of spline broaches is the even distribution of work to the various teeth. In this article, the question of how to do this is discussed at length. The practice of staggering teeth is described and a sample broach data sheet presented.

Much that has been said of the solid type of double keyway broaches is applicable to spline broaches. The main point that has to be considered here is the best method for a proper distribution of the work. There are several ways of designing the teeth, and of these methods two will be discussed. First, the splined teeth of the broaches may be made all one width; that is, if it is desired to have the finished spline ⅜ in. wide, then all the broach teeth will be made to this width or just as much larger as will give a splined hole the keyways of which will be slightly under the predetermined maximum limit.

There are several objections to this method. In pulling out the hole, particularly if the broaches are loaded up—and this must be done, if it is desired to get the maximum output—there will certainly be occasional drags along the side of the spline. Further, with very tough steels there may be undesirable drags at the end; sometimes pieces will pull out. Again, with this method all the teeth must be of exactly the same width; and the dividing of the teeth—that is, their angular spacing—must be accurate, or ridges will show on the work.





FIGS. 1 TO 5. MACHINE OPERATIONS ON SPLINE BROACHES

Fig. 1—Diagram of teeth. Fig. 2—Method of milling the teeth. Fig. 3—Beveling the teeth. Fig. 4—Grinding the broach. Fig. 5—A diamond holder

This extreme accuracy applied to every broach in the set adds to the expense of making them. Apart from this, the question of holding the work to close limits will be more difficult of attainment because of these ridges, and the fact that all the broaches are of the same width generally results in keyways that are more or less tapering toward the hole.

The alternative method is to make the spline teeth of different widths. Suppose that a set of broaches are to be designed to give a hole suitable for a 2 x 1¾-in. shaft having eight ⅜-in. splines. Then the broach teeth will be as follows. Assume that five short broaches are required. The first four broaches should be so proportioned as to diameter that they will bring out the splineways to the full depth, the fifth broach being used to bring them out to the required width; that is, the fifth broach should just take a light cut up each side of the splineways.

To insure that the roughing broaches work easily, without undue friction on the unrelieved sides of the teeth, it is best to have each successive broach with slightly narrower teeth than the preceding one. The sizes that will work successfully for such a set of broaches are given in the diagram, Fig. 1, which shows the teeth exaggerated and superimposed. Some designers give the finishing broach more to do on either side, but I have found that 1/64 in. per side produces cleaner results together with longer broach life.

Of the many different ways of arranging the roughing broaches so as to take a maximum cut for any given material without loss of efficiency there is no other so effective as that of staggering the teeth of the broach; that is, arranging for successive teeth to cut alternately at the center and corners of the splineway.

The best practice is to have only the last few teeth of the broach, which bring the hole out to the full depth, left unnotched. These unnotched teeth should never have much load and should only be used to give an even appearance to the top of the splineway.

Advantage of Notched Teeth

The greatest benefit derived from the system of notched teeth is found in the fact that less room is required for the chips. It is generally recognized that the longer the hole that has to be broached the wider must be the spacing of the teeth. There are two reasons for this: First, the total load on the broach may be more than the cotter will stand without shearing, if too many teeth are in action together without reducing the load per tooth; secondly, the longer the hole for any given load per tooth the greater the required chip space. Now, for maximum life of the broach a minimum load per tooth is necessary, and consequently for any given length of broach the aim must

be to divide the work among the largest number of teeth that is consistent with ample chip space. This, then, is why the notched-tooth system is so effective.

When the teeth are not notched—that is, the chip is full width—the chips pile up in front of the cutting tooth and only about one-half of the space provided is actually used to accommodate chips. On the other hand, when the teeth are notched, the chips do not stay in front of the teeth, but will fall on either side. Thus, for any given load of tooth and length of hole a shorter pitch can be used for notched teeth than for teeth that are of full width. This means fewer broaches to the set, or the same number of broaches may be provided and the load per tooth decreased, thus insuring a longer life.

Staggering the Teeth

The staggering of the teeth may be accomplished in several ways, but the following methods have been well tried out and can be recommended as easy of application and rapid in action. The corner may be quickly removed by means of a pair of straddle mills, as illustrated in Fig. 2.

The mills are set at the correct distance apart to take off two corners at once, as shown at *A*. As the width of the tooth that is left should be constant, then as the height of the teeth is gradually increasing by a definite amount, the knee of the miller must be lowered to allow for this difference in height. For this reason it is best to notch all the corners of each tooth before proceeding to the remaining teeth. The method is as follows: Set the cutters central over the first tooth and take a trial cut; lower the knee and divide; then follow the same process all around, noting the setting of the knee.

If the corners are notched sufficiently, move the table of the miller a distance equal to two pitches and repeat the notching, taking care that at each successive row of teeth the setting of the knee is diminished by the amount of the rise of the teeth. This small amount may be calculated, or it can easily be determined by trial on the first few teeth. By this method the cutting portions of the teeth are of approximately the same width, and this is a very important factor in the cutting efficiency of the broaches.

One setting of the mills—as to distance apart—will do for the set of broaches, because although the chordal distance between each successive set of corners is increased, the width of the straddle mills will cover this difference.

Using 45-Deg. Angle Mills

Another way is to use two 45-deg. angle mills, but the disadvantage of this method is that on the first and second broach, where the height of the tooth is small, unless the mills are quite narrow, enough is not taken off the corner of the tooth. With a pair of mills made specially for the job this disadvantage disappears, but it entails a change in width—spacing of the cutters—to complete a set of broaches.

The groove in the center of the teeth—even numbers—may be cut in a similar manner, but here the varying chordal distance will have its effect. Consequently, the setting of the two half-round cutters should be altered for each broach, as the groove must be approximately central. If the broaches have only a few splines—say of the order of four or five—it will be best to put this central groove in with a single cutter, as shown dotted at *B*. For an eight-spline broach the difference apart of center of the teeth is negligible. For broaches having narrow splines this central groove is best put in with a narrow grinding wheel, dressed to the required shape, after the broaches are hardened and finish-ground on their periphery.

There is another operation in connection with making spline broaches that is worthy of mention, because if it is not properly attended to, the result will be poor holes. Spline broaches work best in holes that are a good fit on the broach bottom. Should the hole be over size, then the weight of the work would take it over to one side of the broach, with the consequence that the spacing of the splines would not be accurate with the axis of the work. When the next broach is put through, the work may be put on the other way up; and this broach would then probably bind along the side of the spline.

However, the worst feature of badly sized holes is that occasionally some will be small, and then the front of the grinding portion of each tooth may try to take a cut. As there is no relief on this part, naturally, the result of a tight hole is almost invariably a bad tear. For this reason holes that have to be broached with spline broaches should be kept to fairly close limits. As a large number of splined holes have to be ground out after hardening, there is a tendency in such cases to allow a wider limit in the hole than is desirable; but for the reasons given, it is unwise, and it is sound practice to hold all such holes between grinding size and minus two-thousandths of an inch. With such limits the broaches must be made so that the minus-sized holes will go on.

To prevent any possibility of the guide portions of the teeth tearing, the front of each guide should be rounded or beveled off. This can be readily accomplished by dropping a small milling cutter—of the right curvature—on the front of each guide, as shown in Fig. 3. This puts a distinct bevel on the front edge and entirely prevents any tendency to drag. The beveling done by the cutter may be supplemented by forming a radius with a file; but this is a slow process, and unless the rounding off is well done, it will disappear when the guide portion of the broach is ground.

Grinding Spline Broaches

To grind spline broaches, no special machinery is needed, but accurate and careful methods are necessary. Where spline broaches are required, a Bath spline grinder is most useful. When such a machine is available, the grinding of the broaches is considerably simplified. On this machine there is provision for dividing and indexing the broaches, and there is also an attachment for giving the grinding wheel the correct curve. The wheel-truing attachment will also bring the sides of the wheel to the shape required to grind the sides of the splines, but in the case of broaches the wheel should never be allowed to work on the body of the broach and the sides of the teeth at the same time.

The reason for this is as follows: When the grinding wheel passes along the broach, there is sure to be some slight springing of the broach. As the wheel passes off a tooth, the broach rises slightly, with the result that if the grinding wheel is grinding the sides of the teeth, these will be somewhat smaller back and front than in the middle; that is, there will be a high place on the center of

the tooth. This means of course that the teeth will bind in passing through the work and will need to be relieved before they will produce the desired result. The best way to grind the broaches is to grind the body first, as shown at *A*, Fig. 4, and then to grind each side of the teeth with the flat side of a wheel, as shown at *B*.

After grinding one side of all the teeth with the wheel in the position indicated by the full lines, the wheel should be reset to the position shown dotted and the other side end of the broach. This is shown to a larger scale at *A*, Fig. 7. Both in making the broaches and in subsequently grinding them this plain portion will be found convenient for the application of the carrier to drive them. When broaches are made without this piece, the end teeth frequently get damaged by the carrier.

To prevent mistakes it is best to paste on the sheet an end view showing the correct number of splines. An auxiliary tracing should be made, showing all these end

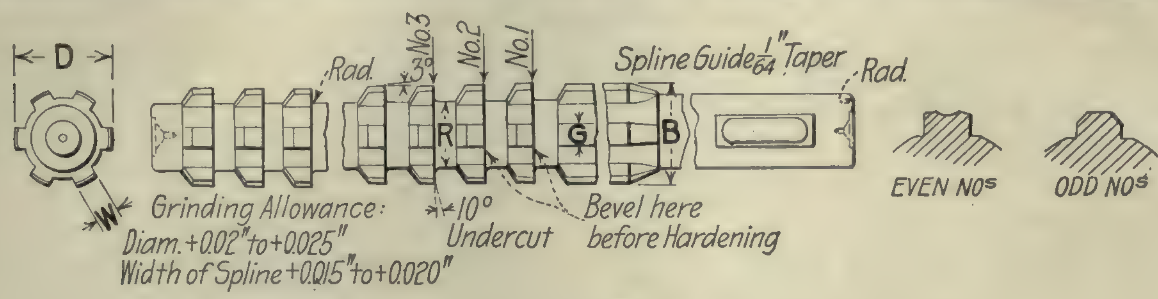


FIG. 6. STYLE OF DRAWING FOR BROACH

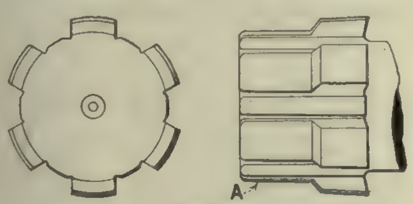
of the teeth ground. As there is a possibility of some of the teeth being scant—owing to distortion in hardening—it is always advisable to go over the teeth twice, first roughing them down to within a few thousandths of an inch of size, then with a nice true clean-cutting wheel bringing them to size.

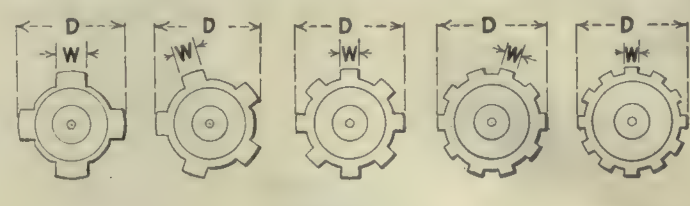
But while a Bath spline grinder is a convenience in making broaches, it is not absolutely necessary, because the grinding may be done on any tool grinder that has a table of sufficient length. The requirements are means of accurately indexing the broach and some arrangement for turning the wheel to the desired curve for the body. The dividing head of a miller may be readily adapted to the grinder for indexing the broach. The diamond holder shown in Fig. 5, although crude, will true the wheel to the desired radius.

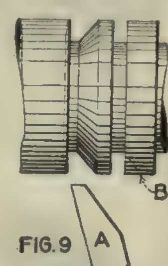
In this device the bar *A* is a piece of cold-rolled steel drilled and tapped at one end for the screw *B*, into which a small diamond is set. When the diamond is set to the required radius, the grubscrew *C* locks it in position. The length of the stock *A* should be the same as that of the broaches to be ground. There is then no need to move the views, to the same scale as the standard sheet; and one of the blueprints from this can be cut up and the correct view pasted in position. The auxiliary sheet would look like Fig. 8. The slope for the back of the tooth may be expressed as a dimension, but it has been found more convenient to express it as an angle. This really depends on the method of turning the broaches.

The method used by the writer is shown diagrammatically in Fig. 9 and is as follows: After the broaches are turned, the teeth are spaced by means of a parting tool taken down to the full root depth. After this slope is put on by means of the tool *A*, Fig. 9, which is fed in the correct angular direction, the side of the lathe is set to the angle given on the standard sheet. The final operation on the teeth, which is turning the 10-deg. undercut on the face of the teeth, is performed as indicated by the tool in Fig. 9, the tool being fed in at 10 deg.

A table of dimensions may be filled out in various ways. One method is to give the dimension of every tooth so that at any time by counting the number of teeth on the broach its dimensions may be taken directly from the







FIGS. 7 TO 9. SEVERAL FEATURES OF BROACH DESIGN

Fig. 7—Enlarged view of broach end. Fig. 8—Auxiliary broach sheet. Fig. 9—Method of making the blank

centers of the dividing head in order to use the diamond. In utilizing this device the broach is removed from the centers and replaced by the wheel-truing fixture. The grinding wheel is brought directly over the diamond and the radius is swept out by oscillating the diamond by means of the pin *D*, driven into the other end of the stock.

In Fig. 6 is shown a standard sheet for spline broaches. It will be noticed that a short plain piece is left on the table. Another way is to figure the first tooth and the last effective tooth, also the few idle teeth at the end.

The method of grinding the tops of the teeth is as follows: The last few, or idle, teeth are ground parallel, and the first tooth is ground to size. The grinder is then set for a taper that will join these teeth in one slope. Afterward the table of the grinder is set to 3 deg., and each tooth is backed off to a cutting edge. By applying Prussian blue to the teeth before starting to back them off, the

relieving can be performed expeditiously, because the blue is distinctly visible while the work is revolving and forms a good guide as to when the tooth has acquired a cutting edge. This is of course when the blue is just about to disappear.

The experience gained from previous sets of broaches, taken in combination with the conditions to be met, is the best guide in designing new sets. Experience is always valuable, but tabulated experiences are the most reliable, as they do not depend on memory. For this reason ample notes of each set should be taken, together with the conditions under which they worked and how they performed. The data sheet I have used for some years is shown above. It gives the size of broach and number of splines, number of broaches to a set, load per tooth, and is filled in with the data of a few successful sets.

DATA FOR SPLINE BROACHES

Nominal Size of Splined Hole: Inner Diameter, In.	Nominal Size of Splined Hole: Top of Splines, In.	Number and Width of Splines: Number	Number and Width of Splines: Size, In.	Number of Broaches in Set: Roughers	Number of Broaches in Set: Finishers	No. of Teeth per Broach	Pitch of Teeth, In.	No. of Effective Teeth	Total Length of Broaches, In.	Diameter of Root or Bottom of Clearance Space, In.	Approximate Diametral Load per Tooth in 0.001 In. Number of Broach: 1	2	3	4	5	6	7
1¼*	1 21/32	5	7/16	4	2	32	⅝	30	31	15/16 to 1	4	4	4	3	7	7	.
1½*	2 1/32	5	9/16	4	3	32	⅝	29	31	1 1/16 to 1¼	4½	4½	4½	4½	6	6	6
1⅝	1 61/64	4	⅜	4	1	32	⅝	29	31	1⅛ to 1 5/16	2½	2½	2½	2	10	..	..
1 13/16	2 1/32	8	⅜	3	1	33	⅝	29	31½	1¼ to 1½	2½	2½	2½	8	..	..	.
1⅞	2 5/32	6	½	3	1	32	⅝	28	31½	1¼ to 1⅜	3½	3½	3½	10	..	..	..

* Twice the usual depth.

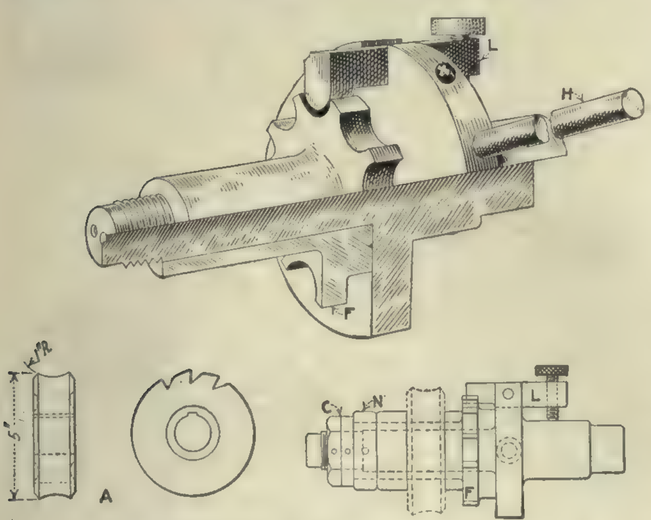
To use this data sheet when a new set of broaches are made, the details are entered on the sheet. Each fresh set is given a reference number on the data sheet, and this reference number always prefaces any entry that is made in regard to the operation of the broaches, the length of the work and the material broached. By such a procedure all notes relating to any particular set are brought together; and used in conjunction with the data sheet, they form a reliable guide for the design of any subsequent set.

A Relieving Mandrel

By H. B. McCray

Not all shops are equipped with a relieving attachment for their toolroom lathes, and various expedients must be devised to overcome that difficulty when special jobs come up.

We had two dozen spline milling cutters like the one shown at *A* to make, and no relieving attachment, so the only way out was to make up some sort of an eccentric mandrel for backing off.



THE RELIEVING MANDREL AND WORK

We developed the indexing relieving mandrel shown in the illustration. It worked out well in this instance and proved indispensable for formed cutters until the attachment for the Hendey lathes arrived. Even now we use it for grinding after hardening.

The mandrel proper has a double center. The flange is slotted and carries the index latch *L*. The thumbscrew serves to draw the semicircular end into corresponding slots in the flange of the bushing *F*, on which the forming cutter is held. The bushing is keyed to fit the milling cutter keyway; the single nut *N* and suitable collars hold it securely in position. The two threaded collars *C* take up end play on the mandrel, but permit indexing. The flange of *F* is slotted with the same number of notches as the cutter has flutes. The handle *H* is heavy and long, as this is the business end of the outfit.

In operation, the fluted blank is clamped securely in place on the bushing *F* and the collars *C* tightened so that the bushing can be indexed but has no end play. The mandrel is pivoted on the outer centers between the miller centers, and a side or end mill of the proper radius used for removing the stock. The blank is indexed from tooth to tooth, first being roughed down and then a final finishing cut taken to true up and polish the work. The grinding is handled in the same manner.

The mandrel may be utilized for relieving cutters of irregular form where milling is impossible, by using it between centers in the lathe, with a master forming tool, in the same manner in which the regular relieving attachment is operated.

As might be imagined, a good-sized handle is necessary, as the operation time depends entirely on the width of the cut and the strength of both handle and operator. It may be adapted for various amounts of relief by varying the position of the centers and the handle.

Cutting an Internal Gear in the Lathe

By W. B. Rollins

An internal gear was required in a hurry, and not a shop in the entire city was equipped to cut such a gear. To make a jig for the shaper would have been quite a job. To get the work out quickly, we decided to cut it on the lathe. The gear, which had 90 teeth, was 14 in. in diameter inside, and the face measured 4½ inches.

The gear was chucked in a 20-in. lathe. After boring to size, 90 teeth spaces were laid off on the chuck; and a pointer was made so that the chuck could be turned to the same place every time. Two roughing and finishing tools were then ground and placed in the boring bar. Cutting was started by pulling the carriage back and forth by hand, the tool being relieved each time the same as when cutting a thread. With the assistance of a helper the gear was cut in nine hours.

A Method of Machining the "85" Fuse Body

By F. H. Bogart

It has been unfortunate for the prestige of American mechanics that there was so much hurry and bustle connected with the planning of equipment, tools and operations on much of the munition materials contracted for in this country. In many cases what would have to be classed as very poor workmanship has been turned out by our factories under conditions which our mechanics could not control.

It has proved doubly unfortunate, however, because time has shown that a large part of that hurry and bustle was misplaced energy. It is already being realized that less than nothing was gained by it, and after this particular chapter of American industrial activity is closed, it will be more apparent than it is today that plunging ahead on an unfamiliar line of products, without first carefully planning every detail of the operations from first to last, has resulted ultimately in prolonging the time necessary for the completion of many of the contracts and caused heavy financial loss.

The chief drawback that has confronted the master mechanic, when the problem of devising tools and fixtures has been finally put up to him, has been the necessity of fitting his tools and operations to a nondescript equipment which had been grabbed up on "delivery" rather than quality or adaptability to any specific purpose. The result has been a compromise between what he would like to do if he could work out each operation according to his best ideas and what he has had to do to meet the demands of a management clamoring for speed, with such equipment to work upon as has been secured and installed for each class of production.

In devising the special tool equipment for performing the operations on any particular manufactured part, there are two essentials necessary to success even before a start is made. They are a rigid, well-designed and accurately built machine tool on which the special equipment is to be mounted and operated, and sufficient time not only to design the tools with full consideration for every detail, but to have them properly made in the toolroom.

Given the second essential, a good toolroom equipment and time to make good tools, but production units of poor quality, the master mechanic still has a chance to produce an accurate output, by designing a set of tools that are "foolproof." In the initial use of this term, it applied only to the operator, and meant the safeguarding of the tool equipment by various means, so that operators of different degrees of skill and physical strength would get uniform results on the same machine with the same setting of the stops. It is a fact now universally recognized that on all hand-operated machines none of the stop devices is absolutely rigid. A variation of pressure on a stop, or coming against it with a jerk, instead of a steady pressure, will cause some variation on the machined part, and it is rare indeed that one operator can relieve another on a machine set up and properly adjusted for any job without its being found necessary to make some readjustment of the stops or tools to suit the peculiar characteristics of the second man's method of operating. As soon as this fact was recognized, features began to be added to the special tool design to equalize this variation in the "weight" of operators, and it is only carrying this principle one step farther to add features to equalize inaccuracies in the machine tools themselves.

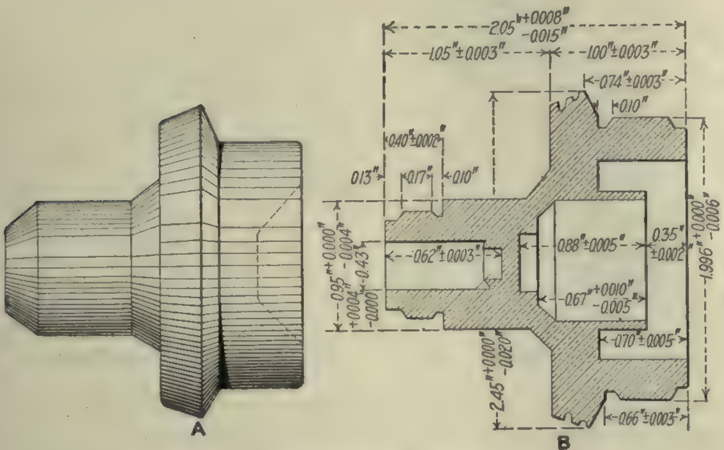


FIG. 1. DIMENSIONS OF 3-IN. CASE-PRIMER BODY

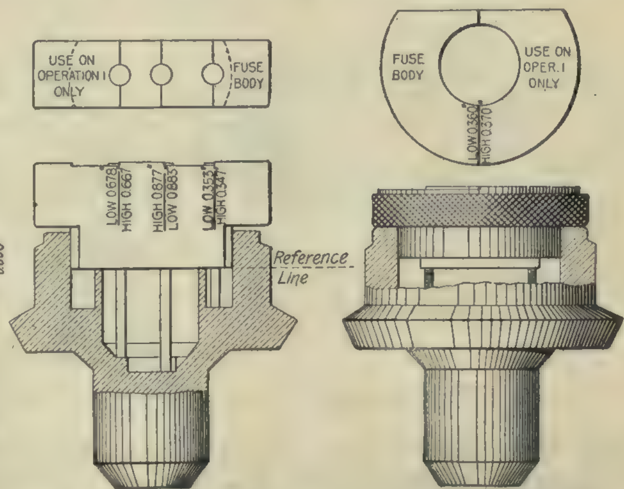


FIG. 2. FORM AND DIMENSIONS OF NO. 85 FUSE BODY

As an example of a method which in some respects follows the principle of foolproofing both against the operator and the machine, I submit a method of machining the "85" fuse body through the operation necessary to reduce the rough forging to the finish sizes called for in the specifications.

It is assumed that the body will first be roughed out in two operations on some standard make of automatic, and later finished to size on a hand or automatic turret lathe. Whether started in this way or not, almost every producer of fuse parts has by this time given up trying to finish all dimensions to gage in a first and second operation. It was not a question of whether or not it could be done; it was found it did not pay. It has become a well-learned lesson that, while multiple spindle machines are big producers while they are running, they are likewise big production cutters while they are shut down. Experience has proved that to maintain several sets of tools on a single machine to the fine adjustment necessary to meet all the gages on fuse work handicaps the quantity

production from such machine more than is profitable. The logical result of this experience has been the shifting of those finishing operations on the automatics that were the most difficult to hold to size to roughing operations, allowing 0.015 to 0.030 in. of stock to be later finished off.

Following out this plan in the proposed equipment for finishing the fuse body, the machining operations would be as follows:

Operation 1—Drill, bore and finish ream interior of base, rough face end of base, rough face bevel, and finish turn outside to size, omitting recess.

Operation 2—Drill and rough bore percussion primer hole in stem, rough face platform and end of stem, rough turn stem including pilot, but omit recess and allow stock to finish shoulder, rough turn rim of platform.

Operation 3—(a) Rear cross-slide unit—Finish turn and groove rim of platform with form tool. (b) Front cross-slide unit—Finish face base end, finish face beveled base and recess, finish face platform, finish thread shoulder on stem and recess, finish face stem end. (c) Turret operations—(1) Finish turn threaded end and barrel of stem; (2) finish ream percussion primer hole; (3) score platform. Use roller stop for (1) and (3), cage collar stop for (2).

Inasmuch as operations 1 and 2 must conform to the plan to be carried out in 3, it will be necessary to outline them briefly.

Fig. 1 shows in general form the "85" fuse body: A is the forging as furnished to the manufacturer, B is the body when finish machined. Operation 1 assumes the forging as held in suitable chucks by the stem end, the stock on the outside and beveled shoulder of the base being removed at this first setting. In gaging for this operation all the internal bores and diameters, and the external body diameter, will use the standard limit gages, duplicates of those used on the final inspection. For the internal depths, two special forms of gage will be necessary, the use of which is limited to this operation.

These two special gages are shown roughly in Fig. 2. It will be observed that the end of the wall of the powder chamber is used as the point of reference for the internal depths, which is a departure from the usual practice of using the base end. There is very good reason for this in the close limit allowed from the wall of the powder chamber to the base end compared with the ample tolerance given for the depths of powder chamber, concussion chamber bore and the primer hole. Using the wall allows of taking advantage of all the tolerance given for these deeper bores, without running the risk of going outside the limit on the dimension from the wall to the base end of the body.

Ignoring the preliminary operations for roughing out the stock, which must be developed experimentally to suit both the characteristics of the material and the machine tool being used, the final machining operations would be as shown in Fig. 3. Although stock for refinishing is left on both the base end, surface a, and the base bevel, surface b, the standard, gage for the distance from the end to the bevel may be used, because the same finishing allowance on each would be sufficient and would not change the dimension.

For operation 2 none of the standard inspection gages can be used because experience has shown that particularly on this second operation it does not pay to try to work to the finish dimensions on any surface direct from the rough forging. The reason is that, whether due to changing from one chuck setting to another from operation 2 to 3, or to the natural tendency of tools on such work to spring away from the heavy side and dig in on the light side when reducing diameters on rough parts that are more or less distorted, the fact is that when the parts from operation 2 are chucked up for 3 the stems will run eccentric in almost every instance. The simplest way to correct this is not to correct it at all, but to make operation 2 a roughing operation solely.

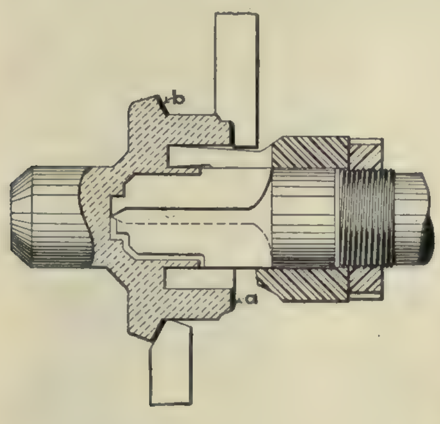


FIG. 3. FINAL OPERATIONS

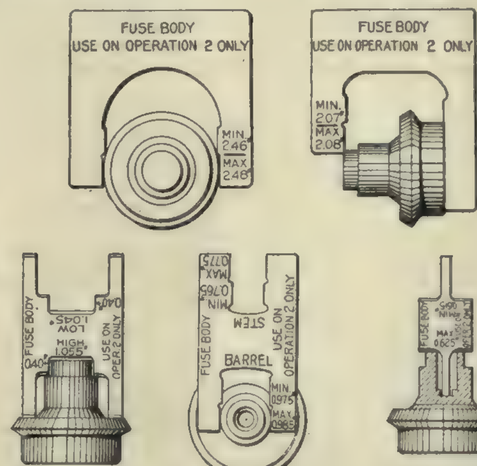


FIG. 4. SPECIAL GAGES

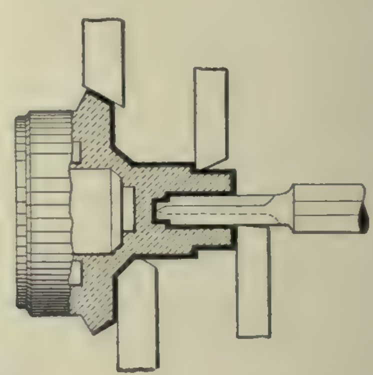


FIG. 5. TOOL ARRANGEMENT

The special gages needed for 2 are indicated in Fig. 4. Owing to the probable eccentricity, a greater allowance must be made on the roughed diameter than would ordinarily be allowed. Practice has shown 0.030 in. allowance from the mean dimension to be necessary. In choosing the limit of variation for the roughing gage it is not advisable to take all the limit allowed on some specifications, as it will lead to no end of trouble farther on. The writer has seen cases where plus 0.008 in. and minus 0.015 in., or a total of 0.023 in. tolerance, was allowed from the base end to the tip of the stem, while the height of the stem down to the platform and the thickness from the platform to the base end were both held to plus or minus 0.003 in. It would be possible, therefore, if advantage were taken of all this tolerance on the gage, to have the platforms roughed so thin through the base that they would not finish out. A much safer limit, and one that is practical to work to, is plus or minus 0.005 in. allowed on the roughing dimension.

In Fig. 5 is shown the arrangement of the tools for the final second operation. It will be understood that where a unit tool is here indicated, the same result might be secured by an arrangement of separate tools either on the same head or on successive steps in the operations. The essential point is to feed the material to operation 3 roughed in the form shown and with the amount of stock to be removed to finish not more than a maximum of 0.020 in. on the end surfaces and 0.030 in. on the diameters.

Operation 3 can be set up on either a hand turret lathe or any standard make of single-spindle automatic of about 1 in. spindle capacity. It is primarily a final finishing operation, but it is in the nature of a correcting operation also, the object being to correct all inaccuracies of the two previous operations and hold all essential dimensions to a much closer limit of accuracy than was practical up to that point.

The body is held by an expansion spring collet, partly shown in Fig. 6, fitting the wall of the powder chamber, and proportioned to locate from the top of the wall *a* with clearance at all other points. Between the base end of the body and the nose of the machine there must be at least ¼ in. in the clear to allow space for the end-facing tool. In Fig. 6 is indicated the form and relationship of the front and rear cross-slide tools. The form tool at the rear can be of any conventional design, but should cut on the center line, and should be arranged to make it as convenient as possible to whet the top face of the tool while in position. Many of the copper-aluminum alloys used for fuse bodies "weld" to the cutting tools very freely, and in order to maintain a smooth finish this metal must be frequently whetted off with a coarse carborundum stone.

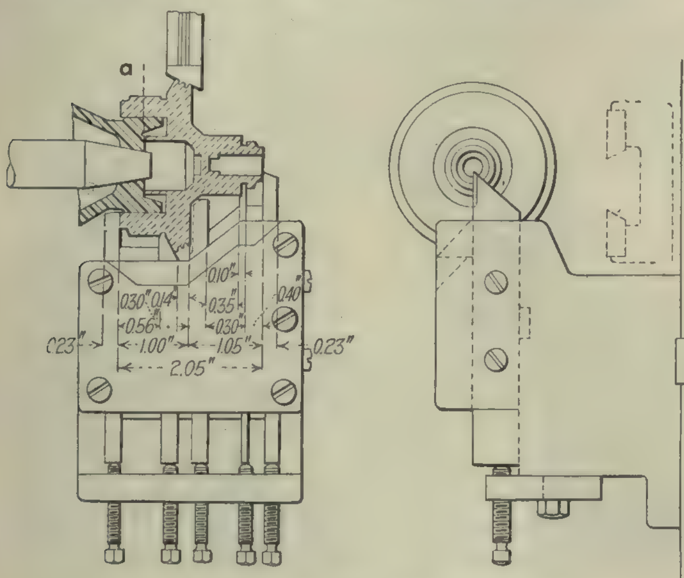


FIG. 6. THE EXPANSION SPRING COLLET

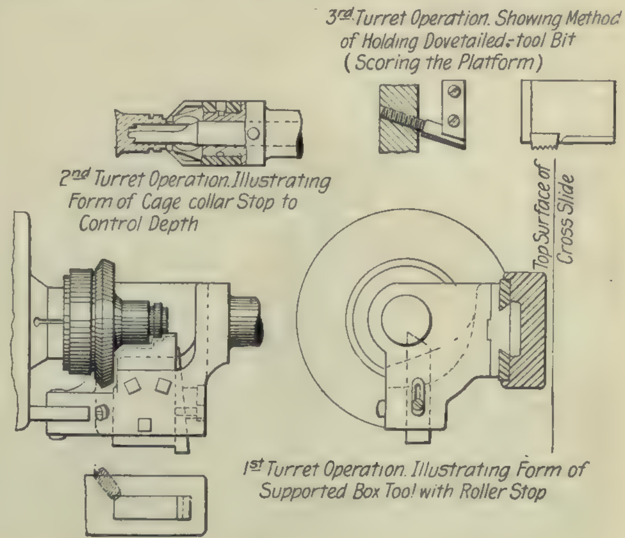


FIG. 7. THE THREE TURRET OPERATIONS

The Tool Holder

The tool holder shown at the front of the slide combines ease of maintenance and adjustment for diameter with a fixed location of end and shoulder measurements that practically takes these important dimensions out of the control of the adjuster and reduces them to a mathematical certainty. The cutting elements are built up with alternate high-speed steel blades and hardened and ground tool-steel spacers, the thickness of the blades and spacers being standardized to conform to the mean dimension given in the specifications. The cutting blades when dull are to be ground only on the end, and are given 30-deg. clearance to reduce the side drag.

It will be obvious that once the front tool block is adjusted to face the base end to correct length from the inside chamber wall, all the other length dimensions should check inside the gages, because the tool element is in itself a split gage for all these dimensions.

The three turret operations necessary to complete the work on the body are indicated in Fig. 7. The design and arrangement of the stops must be modified to suit the machine used, but in any case it will be necessary to use a guided tool holder for the turning operation, as the stem finish and diameter are very particular, and the limit of 0.004 in. allowed cannot be held on such machines as are commonly being used except with a form of guide and support such as shown. It should be remembered also that this finishing cut on the stem serves to correct eccentricity as explained above, and this provides an additional reason for not relying solely on the turret to rigidly support the finish turner. The roller stops shown are intended for use on hand-operated machines. It would not be practical to use them on automatic work, but if any first-class make of automatic were used it would not be necessary, as the difference in the character of operators, which they are designed to equalize, is not a factor in automatic work.

Need of Skill Lessened

In general the method as described will be seen to be in some degree a substitution of machine mathematics for human skill. This specific example may not go the full limit of the possibilities of the method even for the part under consideration, but it is at least along the line of reducing the variation in the labor element of production to its lowest terms, and with the percentage of both skilled and natural-born mechanics growing rapidly less in our factories, any advance toward the attainment of accuracy without skill is certainly a step in the right direction and one that will be found very useful in plants.

Methods Used in Manufacturing Small Electric Motors

By Robert Mawson

SYNOPSIS—Special tools and methods employed in manufacturing parts for small electric motors, including the continuous drilling operation on commutator shells. The fixture is provided with a number of jigs mounted on a rotating base, which is indexed around to the various positions. An interesting method of cutting small worm gears by the use of a tap is worth noting.

The Robbins & Myers Co., of Springfield, Ohio, manufactures a variety of electric motors for operating machines where a contained motive power is either necessary or advisable. In the production of these motors interesting operations are performed, as the parts must be made both interchangeable and in an economical manner.

In Fig. 1 is shown a continuous drilling operation for machining commutator shells. The arrangement is provided with a revolving table on which are fastened three drill jigs, each holding two commutator shells. The pieces are located between pins, as the drilling operation follows the facing and turning work. The cover is then dropped down, being held with a latch *A*. The jig in the front of the illustration is shown with the cover raised. The revolving drills are then fed through, the pieces being guided by bushings in the jig covers. Four shells are machined at one time. The correct location is determined by the pawl *B*, which fits in a notch. Another of these notches, for a different position, may be seen at *C*. Handles *D* are provided to enable the operator to revolve the rotating member of the jig fixture.

A view of two of the "Natco" multiple drilling machines that are used for this operation is given in Fig. 2. These machines are operating on a smaller size of commutator shell, drilling six No. 13 holes in each piece at the rate of 338 pieces per hour.

An interesting fixture made use of when milling the slot in the knuckles is illustrated in Fig. 3. These parts are turned from round bar stock, the shoulder turned, the hole counterbored and the end rounded. It will be seen by referring to the pieces on the machine table that the milled slot reaches nearly to the base of the piece. As the end is also counterbored, the milling operation is somewhat of a problem. The manner in which this was solved is shown in the illustration. The fixture is made with a sliding center block, the top and bottom edges being at an angle. The pieces, four in each fixture, are placed in bored holes; by tightening on the screws *A* the block *B* is drawn back. This action forces the center block against the two lower knuckles. The block *B* being forced against the two upper pieces at the same time, all four are held securely. Two fixtures are used,

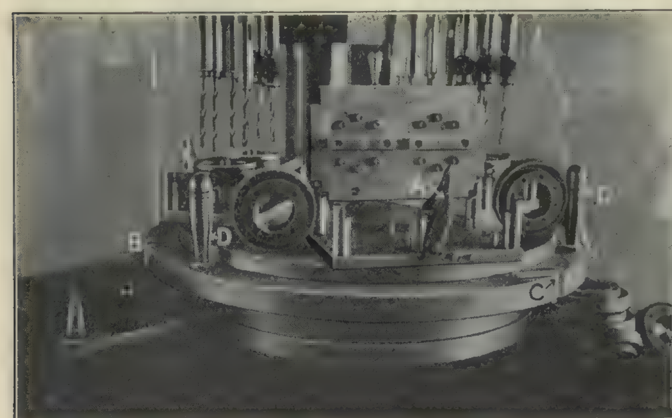


FIG. 1. DRILLING COMMUTATOR SHELLS

FIG. 2. TWO OF THE DRILLING MACHINES

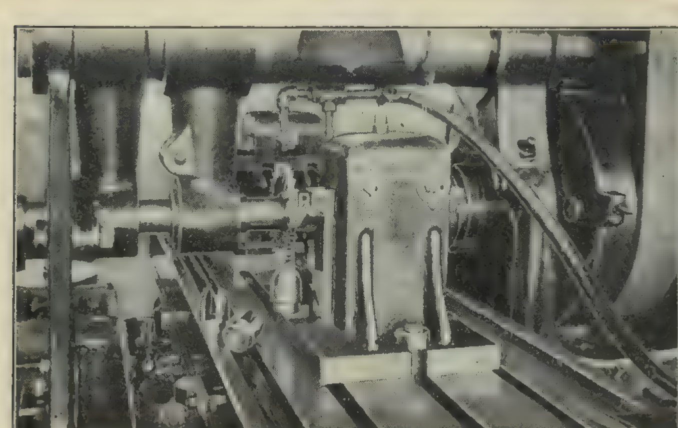


FIG. 3. MILLING KNUCKLES

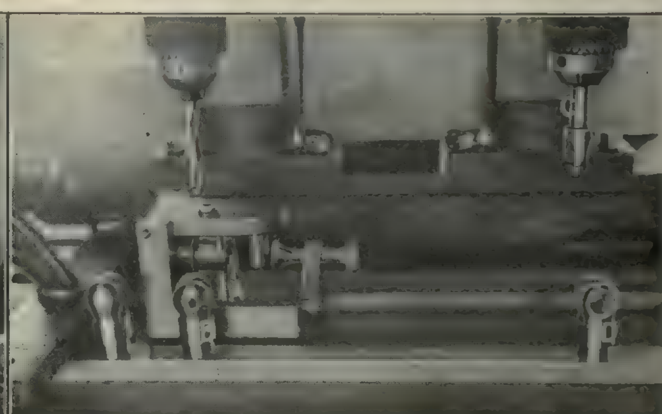


FIG. 4. FIRST AND SECOND DRILLING OPERATIONS

so that one may be loaded while four knuckles are being milled in the other fixture. The slot is $\frac{5}{8}$ in. wide and $1\frac{3}{16}$ in. deep; 60 are milled per hour.

In Fig. 4 are shown the first and second drilling operations after the milling of the knuckles. The piece is located on a tongue that fits in the milled slot and between into the milled slot in the knuckle, thus locating it. A $\frac{1}{8}$-in. hole $\frac{1}{4}$ in. deep is then drilled, as shown by the knuckle *D*. The piece is then placed in the jig *E*, the shank fitting between the two pins shown.

A recess is then milled in one of the counterbored holes to suit a key that is fitted in the knuckle. One of

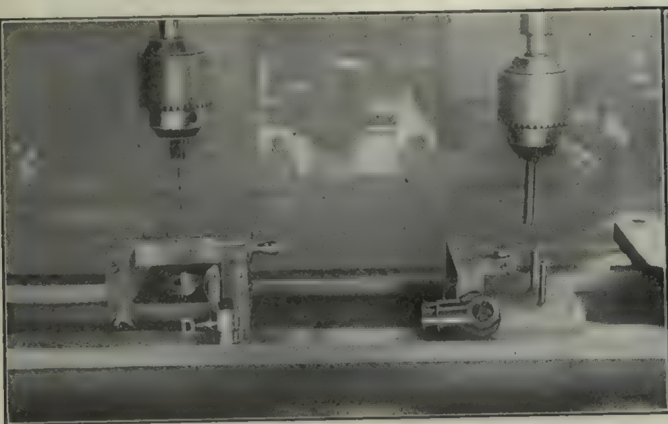


FIG. 5. THIRD AND FOURTH OPERATIONS

FIG. 6. MILLING SWIVELS

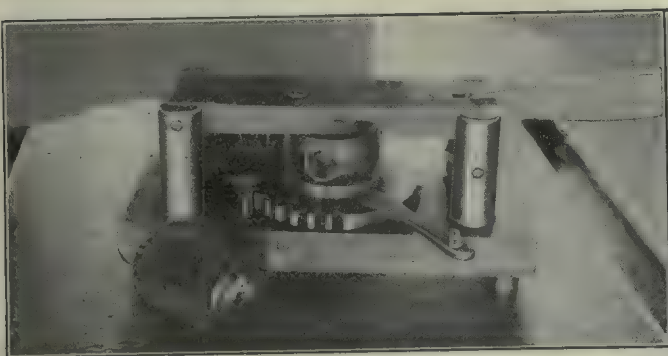


FIG. 7. DRILLING OSCILLATORS

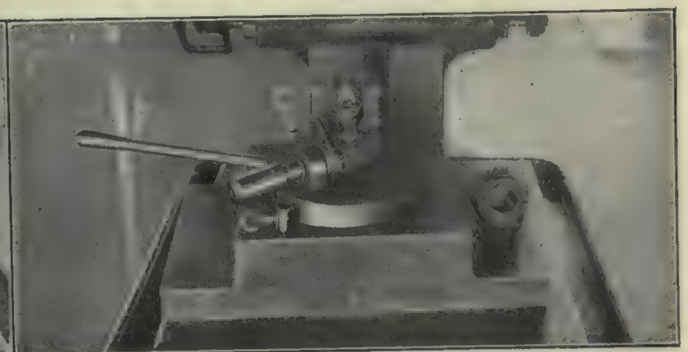


FIG. 8. MILLING OSCILLATORS

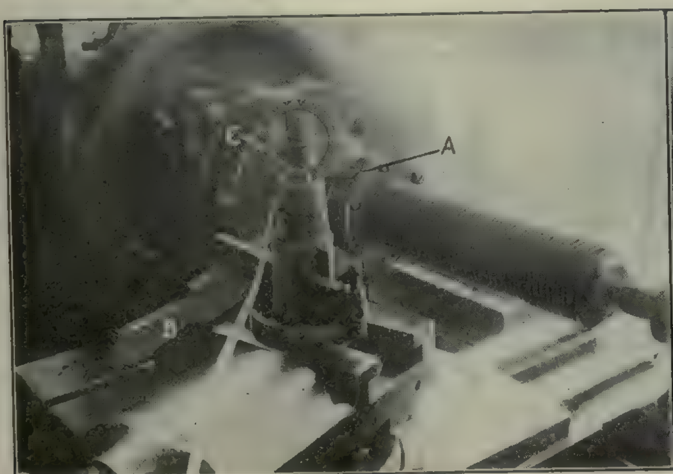


FIG. 9. WINDING EDGE RINGS

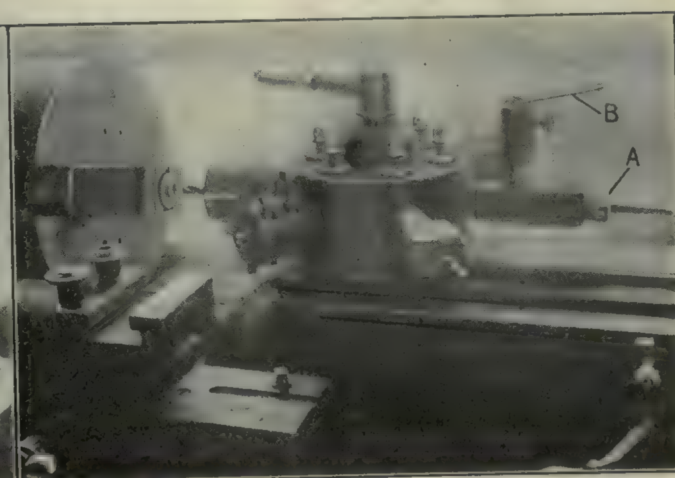


FIG. 10. MACHINING FAN HUBS

two pins, which may be seen in the base of the jig *A*. The cover is then dropped down and a $\frac{5}{16}$-in. hole drilled through both sides, as shown in the part *B*. The jig is then slid along under the spindle *C* and the jig cover raised. A hole is then counterbored through one side and about halfway through the other; the piece is then similar to that shown at *D*. The knuckle is then placed in the jig (Fig. 5) at *A*, being located in the bushing *B*, which is made to suit the turned shoulder of the piece. The cover *C* is then dropped down; this fits the machined knuckles after this operation is shown in front of the jig. The production from the four operations noted is 25 pieces per hour.

The fixture employed when milling the knuckle swivels is shown in Fig. 6. The pieces are made from round bar stock and machined to the shape shown at *A*. They are then dropped into holes, as shown in the fixture, and the screws tightened. The action of these screws is to force the three blocks together and thus hold the pieces firmly. The fixture is designed to hold 20 swivels; the

milled portion is $1\frac{1}{4}$ in. in diameter by $\frac{5}{8}$ in. thick and with the fixture shown is machined at the rate of 60 per hour.

In Fig. 7 is shown a jig that is used when drilling the oscillator. The piece is located on a pin that fits in a previously machined hole and by a sliding pin that fits in the machined hole *A*. The cover is afterward dropped down and held with a latch, as shown. Nine $\frac{1}{16}$-in. holes $\frac{3}{16}$ in. deep are then drilled, the various locations being obtained by the latch fitting in the notches shown. The handle *B* is used to pull the sliding member of the jig around to the different indexing positions. The production is 50 per hour. The oscillator is then reversed and located in the fixture (Fig. 8) as shown. A slot $\frac{3}{16}$ in. wide and 120 deg. round is then milled, the tool being guided through the bushing *A*. The handle *B* is used to pull the sliding member of the fixture around between the two stop pins *C*. One of the finish-milled oscillators is shown at the right of the fixture. The production for this operation from the fixture and machine shown is somewhere in the vicinity of 80 per hour.

The fixture shown in Fig. 9 is for winding copper end rings. The copper strip is fed through a slot at *A* onto the revolving arbor. The fixture is prevented from revolving by means of the bar *B*, which is attached to the fixture and comes in contact with the stop as shown. The lathe is then started and the copper strip is wound, being fed without kinks onto the arbor by virtue of passing through the slot in the fixture.

The wound copper spiral is then slit on one side, afterward being punched to form the end rings, one of which is shown at *C*. With this device approximately 1100 rings may be wound per hour.

In Fig. 10 is shown the method used when manufacturing fan hubs. The casting is held in a two-jawed chuck. The sequence of operations observed on the pieces is as follows: Rough form; bore; machine undercut; ream; finish form. The undercutting tool *A* is operated by the handle *B*, being fulcrumed on a screw, as may be observed. The production from this operation and machine is 27 per hour.

The operation of milling slots in the copper end rings is shown in Fig. 11. The rings, which have been

FIG. 11. MILLING COPPER END RINGS

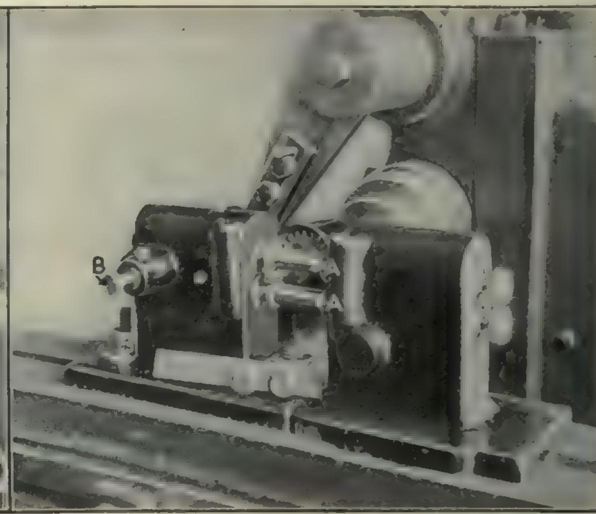


FIG. 12. MILLING SMALL WORM GEARS

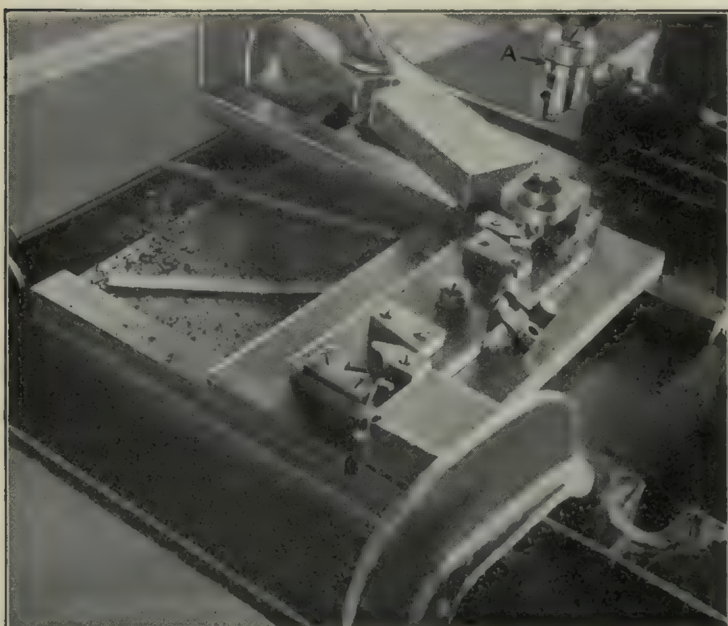


FIG. 13. MACHINING BRUSH HOLDERS

FIG. 14. A HANDY DRILLING JIG

machined all over, are located on an arbor and held in position by a large washer and nut. As the slots to be machined are at an angle, the fixture is placed at a similar angle to suit.

The various positions are determined by the handle A, which fits in notches of the handwheel, as shown. The rings are 9½ in. in diameter and 1½ in. wide, and the notches machined are 0.281 in. wide by ⅛ in. deep. The fixture holds two and the production is 15 per hour.

FIG. 15. ASSEMBLING COMMUTATORS

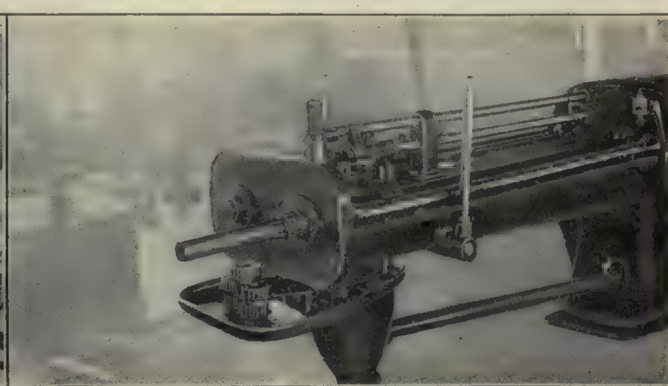


FIG. 16. BROACHING COMMUTATORS

Milling Small Worm Gears

The fixture used when milling worm gears for oscillating fans is shown in Fig. 12. The fixture holds two blanks that are located on arbors and driven by a key fitting in a keyway previously machined. The milling operation is performed by a tap passing between the two gear blanks, as shown. The shafts A are connected to the shaft B by means of a worm and worm wheels, so that the travel of the shaft B is the same as the pitch of the tap performing the milling operation.

By this means a perfect tooth is obtained on the gears. An advantage in cutting the two gears at one time other than increased production is the fact that the tap is operated between two surfaces, thus eliminating distortion of the tap and obtaining a better machined product. The gears, which are 0.621 in. outside diameter, are machined with 24 teeth, right-hand lead, and have a 0.150-in. double thread. The production is 55 gears per hour.

FIG. 17. MILLING GEAR BOXES

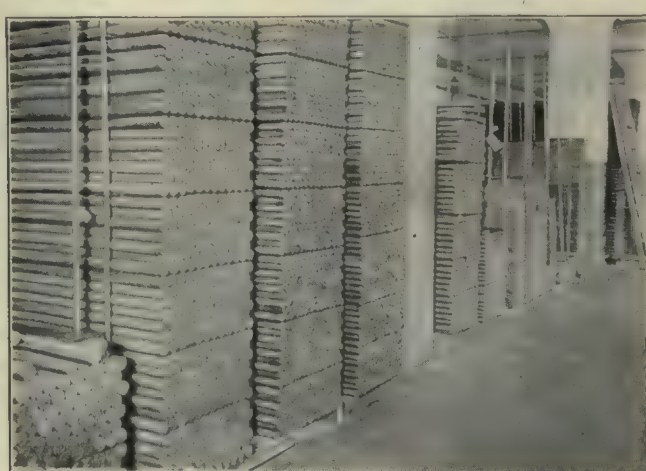


FIG. 18. A HANDY RACK FOR ROUGH STOCK

In Fig. 13 is shown a handy fixture for drilling, facing and hollow-milling brush holders.

It will be noticed that the tool is provided with three steel blocks. One of these has a notch into which the piece to be machined is slid. The brush holder is placed under the center block and comes against the outer block, which is made with a beveled face. This bevel forces the piece back and the action of the cutter, which is clockwise, holds it in position. The tool A is guided through a bushing to obtain the correct machined surface. The production with this fixture is 240 per hour.

A handy drilling jig is shown in Fig. 14. This is provided, on each side, with an arm A, in which is machined a slot. The plate B of the jig may be tilted to suit various angles, being fulcrumed on the pin C and held in that position by means of the bolts in the slots A. With this tool holes may be machined at any desired angle within the capacity of the jig, thus affording a useful drilling jig.

In Fig. 15 is shown the method used when assembling commutators. After the commutator has been assembled, it is placed on the gas oven A. When it is hot it is put in the fixture B and air pressure admitted by the valve C. This pressure forces up a bushing and compresses the commutator to make it tight and remove any possible air gaps. The commutator shell is then fastened on with screws, holes being provided in the plate D to enable the operator to get at the screws with a screw-driver.

The holes in the commutator are broached at this factory, and it has been found that not only are better results obtained, but also that the work may be done quicker. A view of a two-spindle Lapointe set up for broaching the armatures is shown in Fig. 16.

The fixture employed for milling the gear boxes used on oscillating gears is shown in Fig. 17. These castings have been previously bored and are located by arbors

that fit in these holes. The screws *A*, placed at an angle, are then tightened, the points coming in contact with the arbors and forcing and holding them down. The casting is thus forced down onto locating pads at *B* by virtue of the downward pressure created by the screws *A*. Two cutters are used 2½ in. wide with a ⅛-in. thick cutter mounted between them. Approximately $\frac{1}{16}$ in. of metal is removed and 48 gear boxes milled per hour, the fixture holding four at one time. A view of the racks on which the rough stock is stored is shown in Fig. 18. It will be observed that these racks are made of steel bar uprights, the stock being placed between them. When it is desired to subdivide any of the racks, horizontal plates are placed across as shown, thus keeping various grades of steel separate.

Speed-Reducing Attachment for Air Drills

By Harry F. Pannepacker

We had to tap over twenty-four hundred 1⅜-in. holes in special treated steel plates made into large structures, the shape of which allowed the use of air machines only.

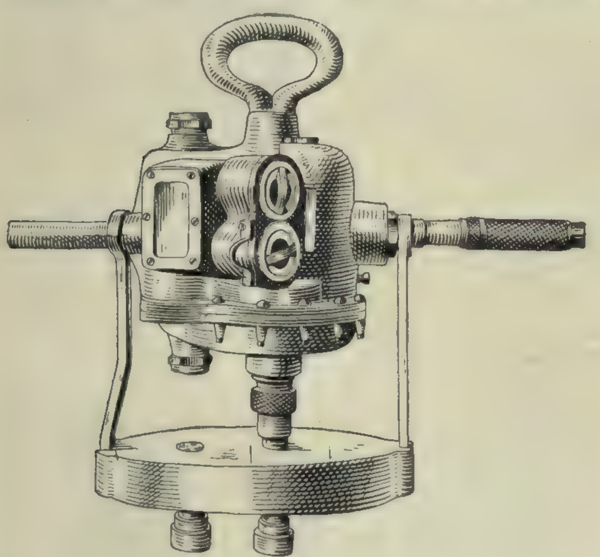


FIG. 1. REDUCTION GEAR FOR AIR DRILL

The drilling had been done satisfactorily, but the problem of tapping was still to be solved.

The thickness of the plates was 5 in. Some holes were drilled $1\frac{7}{16}$ in. in diameter half the thickness, the remaining half being drilled 1⅜-in. tap size, while still other holes were simply drilled blind and tapped out 2½ in. deep. Tapping by air machine had heretofore been out of the question, as their speed, 225 r.p.m., equivalent to 81 ft. cutting speed on the diameter of a 1⅜-in. tap, was too high. The air pressure was 78 lb., and several trials proved most unsatisfactory. The speed-reducing attachment shown was then made and connected to the air drill. With it the spindle speed was reduced to 67.5 r.p.m., equaling 24.5 ft. cutting speed, and the results were satisfactory.

Previously, all tapping had been done by hand, a gang consisting of a leader and two helpers, whose capacity was 2½ holes per hour. With the speed reducer, from 15 to 20 holes per hour can be tapped, a distinct advantage being gained in the auxiliary spindle, which extracts the tap at increased speed.

The machine is also used to insert the threaded rivets in the holes. As some of these have square heads of the same size as the taps, this is an easy task. A number of the tap rivets have slotted heads, but a pair of special sockets with tongues drive them very nicely.

The machine, briefly described, consists of a milled flat steel body, 2¾ in. thick by 10¾ in. long, rounded at the

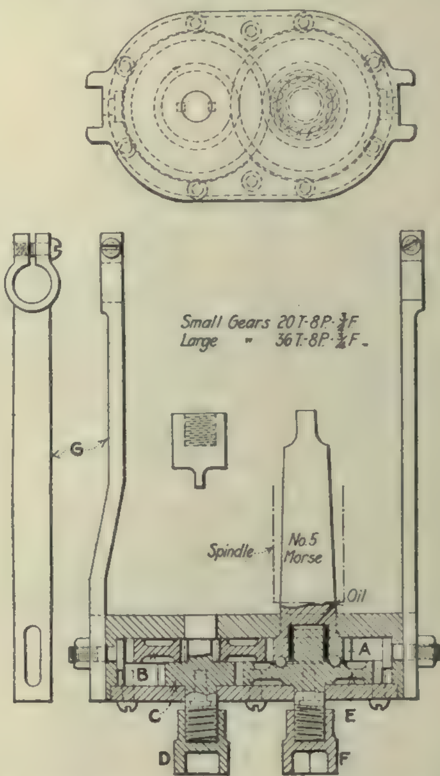


FIG. 2. SECTIONAL VIEW OF REDUCTION GEAR

ends and containing the four steel reducing gears. A No. 5 Morse shank, turned with the first pinion *A*, Fig. 2, of the train, meshes with the gear *B*. This second gear is keyed to a stud shaft that also carries a pinion *C* and socket *D*, from which is obtained the reversed direction. The gear *E* completes the train and drives the socket *F*. Ball bearings take the thrust.

A brass plate screwed into position incloses the gears from the bottom, while extending studs of the two shafts act as receivers for attachment sockets for taps, etc., the main stud running in the right-hand direction and the auxiliary giving opposite direction at increased speed.

A flat rod *G*, bolted to each end of the speed reducer and carried up to the handle on each side of the air drill, gives the necessary stiffness.

The cost of making was soon covered by the gain in time saved and labor costs.

Students of Ohio State University Make Eastern Inspection Trip

The Eastern inspection trip of the fourth-year students of the departments of electrical and mechanical engineering of the Ohio State University took place between Mar. 29 and Apr. 5, 1917. Visits were paid to various plants in the Eastern territory. Two days each were spent in Cleveland, Pittsburgh and Niagara Falls, while one day each was spent in Buffalo and Erie.

United States Munitions*

The Springfield Model 1913 Service Rifle

Butt Plate II, Butt-Plate Cap, Upper Band I

SYNOPSIS—This installment completes the butt plate and cap and gives the first half of the operations that are specified for the upper band.

OPERATION 9. HAND-MILLING SLOT IN PLATE

Transformation—Fig. 1695. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin A, clamped on sides, Fig. 1696. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutter, 2 in. in diameter, 0.251 in. wide. Number of Cuts—One. Cut Data—150 r.p.m.; hand feed. Coolant—Compound, ⅛-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1697; gage is put in place with pin to see fit. Production—325 pieces per hr.

OPERATION 17. FILING HINGE LUGS AND SPRING-SCREW BOSS AND FITTING

Number of Operators—One. Description of Operation—Filing lugs and spring-screw boss, also reaming pin hole. Apparatus and Equipment Used—File and four-fluted reamer, 0.10189 in. Production—45 pieces per hr.

OPERATION 18. ASSEMBLING BUTT PLATE WITH BUTT-PLATE CAP

Number of Operators—One. Description of Operation—Assembling butt plate and cap. Apparatus and Equipment Used—Hammer. Production—70 pieces per hr.

OPERATION 18½. STRAIGHTENING AND BURRING

Number of Operators—One. Description of Operation—Straightening, if needed, and burring. Apparatus and Equipment Used—File and lead block, brass hammer. Production—70 pieces per hr.

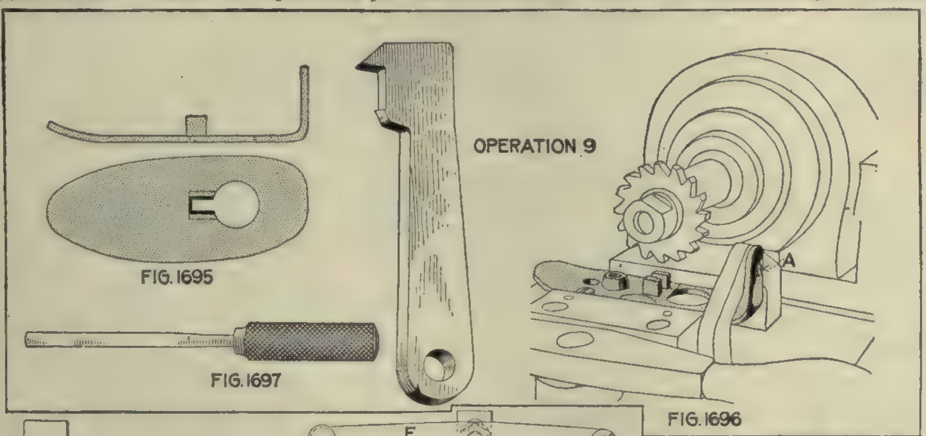


FIG. 1695 FIG. 1697 FIG. 1696

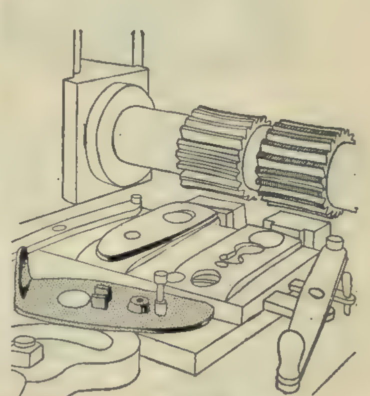


FIG. 1699

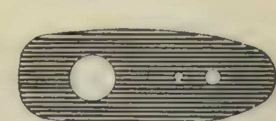


FIG. 1698

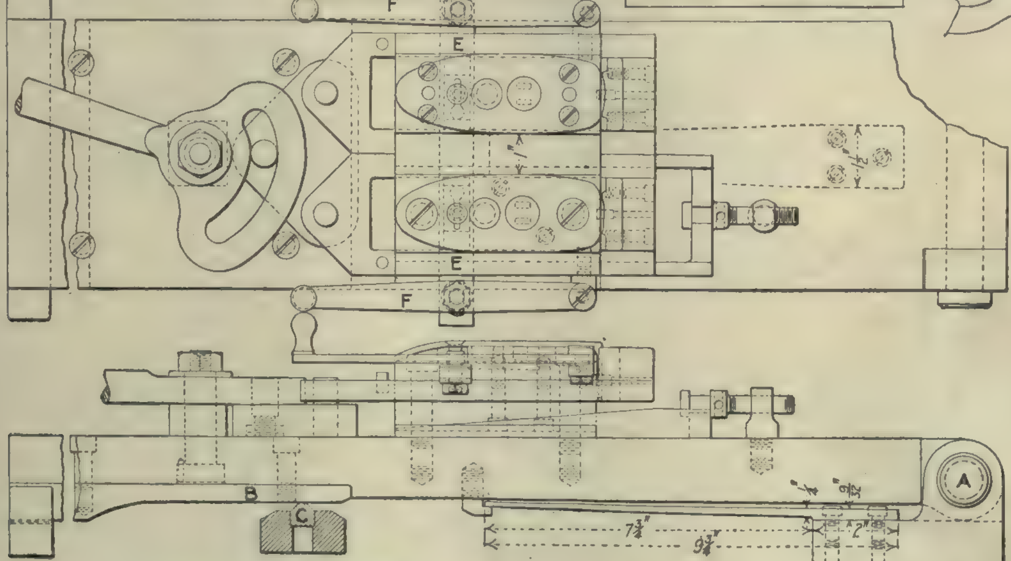
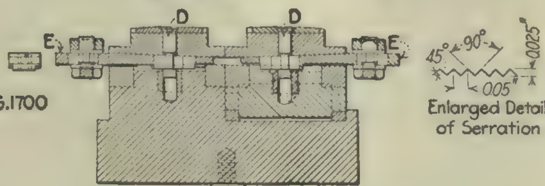



FIG. 1700

OPERATION 12

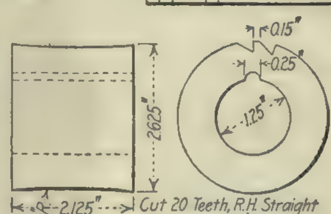


FIG. 1701

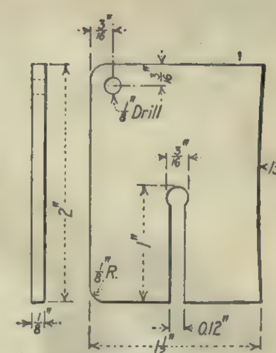


FIG. 1702

OPERATION 12. CHECKING BOTTOM OF PLATE LENGTHWISE

Transformation—Fig. 1698. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Located on pin, clamped on tang, Fig. 1699; bridge-milling fixture in Fig. 1700; this pivots at A and has a hardened-steel shoe at B, which rides on the block C as table moves forward; work is held by pin in tang-

screw hole and by studs DD, which are pulled down by slides EE, moved by levers FF. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutter, Fig. 1701. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—8000 pieces. Gages—Thickness, Fig. 1702. Production—25 pieces per hr.

OPERATION 12½. CROSS-CHECKING BOTTOM OF PLATE

Transformation—Fig. 1703. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Five. Work-Holding Devices—Held on pin clamped by vise jaws; jaws on formed elevating fixture, Fig. 1704. Tool-Holding Devices—Standard arbor. Cutting Tools—Pair of formed, sectional cutters, Fig. 1705. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, two ¼-in. streams. Average Life of Tool Between Grindings—8000 pieces. Gages—None. Production—25 pieces per hr.

OPERATION 13. TAPPING SPRING-SCREW HOLE

Transformation—Fig. 1706. Number of Operators—One. Description of Operation—Tapping spring-screw holes. Apparatus and Equipment Used—Tapping fixture with hand-wheel on spindle, work held in vise, Fig. 1707; details in Fig. 1708; tap with three right-hand spiral flutes, diameter 0.185 in., 26 threads per in. Gages—Plug thread. Prod.—125 per hr.

OPERATION 19. POLISHING

Number of Operators—One. Description of Operation—Polishing tang and edges. Apparatus and Equipment Used—Polishing jack and wheel. Production—35 pieces per hr.

1	Milling tang to thickness (1½ and 2½ grouped for 750)
1½	Burring tang and match bevel
2	Drilling and reaming pin hole
2½	Countersinking pin hole
4	Milling top crosswise
5	Filing and fitting tang of bevel
7	Grinding corner of tang for spring
8	Assembling to butt plate
9	Checking separate caps

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1710. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots and packed with powdered charcoal, heated to 850 deg. C. (1562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burner, powdered charcoal.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and put in the pickling solution (1 part sulphuric acid to 9 parts water) and left in this for from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

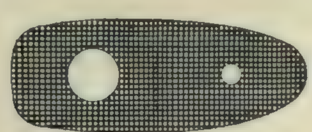


FIG. 1703

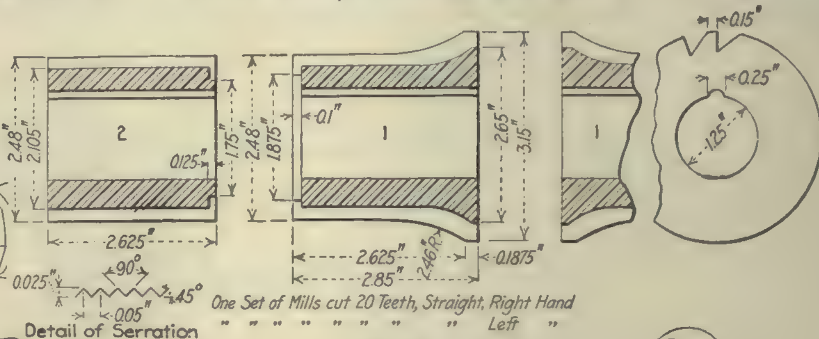


FIG. 1705

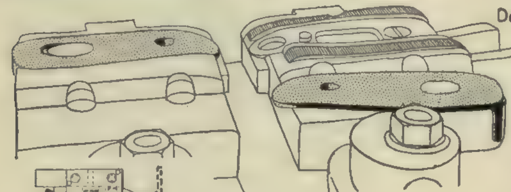


FIG. 1704

FIG. 1706

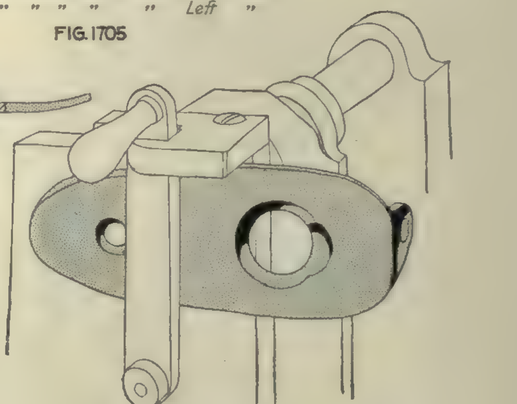


FIG. 1707

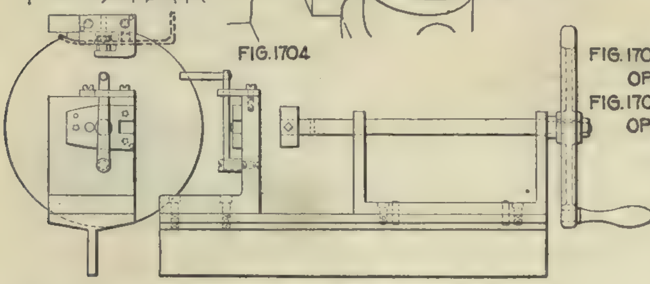


FIG. 1708

FIG. 1703, 1704, 1705 OPERATION 12½
FIG. 1706, 1707, 1708 OPERATION 13

OPERATION 20. ASSEMBLING BUTT-PLATE CAP SPRING TO BUTT PLATE

Number of Operators—One. Description of Operation—Assembling cap spring. Apparatus and Equipment Used—Hands. Production—125 pieces per hr.

OPERATION 20-A. COUNTERSINKING

Number of Operators—One. Description of Operation—Countersinking screw holes. Apparatus and Equipment Used—Speed lathe and countersink. Production—700 pieces per hr.

OPERATION 21. CASEHARDENING

Number of Operators—One. Description of Operation—Pack in ½ bone, ½ leather; heat to 750 deg. C. (1382 deg. F.) for 2½ hr.; quench in oil.

Butt-Plate Cap

The butt-plate caps, Fig. 1709, are finish forged on the bevels by a second cold dropping and require no machining on this surface. The operations given do not include the checking of the caps on the outside, as this is done with the butt plate after assembling. It is sometimes necessary to make the caps separately, and in that case they are checked in a special fixture which holds them separately.

OPERATIONS ON THE BUTT-PLATE CAP

Operation	
A	Forging from bar
B	Annealing
B-1	Pickling
C	Trimming
D	Cold dropping

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 1; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches—15,000 pieces. Dies—Same. Gages—None. Production—600 pieces per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—900 pieces per hr.

OPERATION 1. MILLING TANG TO THICKNESS

Transformation—Fig. 1711. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held upright, clamped by finger clamp, Fig. 1712. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1713. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—5000 pieces. Gages—Thickness of tang. Production—50 per hr. per machine.

OPERATION 1½. BURRING TANG TO MATCH BEVEL

Number of Operators—One. Description of Operation—Matching bevel with tang and burring. Apparatus and Equipment Used—File. Production—350 pieces per hr.

OPERATION 2. DRILLING AND REAMING PIN HOLE

Transformation—Fig. 1714. Machine Used—Pratt & Whitney 16-in. two-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1715; a cap is shown at A and in position, as at B; leaf C, with bushing, is swung up into position for drilling through side. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill and reamer, 0.10239 in. in diameter; four straight flutes, 1.3 in. long. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1716.

OPERATION 2½. COUNTERSINKING PIN HOLE

Number of Operators—One. Description of Operation—Countersinking pin hole on both sides. Apparatus and Equipment Used—Bench lathe and countersink. Production—350 pieces per hr.

OPERATION 4. MILLING TOP CROSSWISE

Transformation—Fig. 1717. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on pin, clamped by vise jaws, Fig. 1718. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1719. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Thickness and height of lug. Production—50 per hr. per machine.

OPERATION 5. FILING AND FITTING TANG FOR SPRING

Number of Operators—One. Description of Operation—Filing and fitting tang for spring. Apparatus and Equipment Used—File. Production—45 pieces per hr.

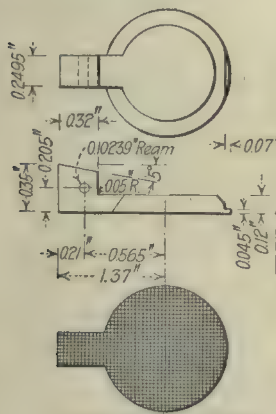


FIG. 1709

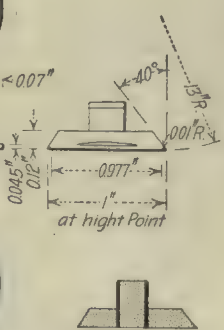


FIG. 1711


FIG. 1710

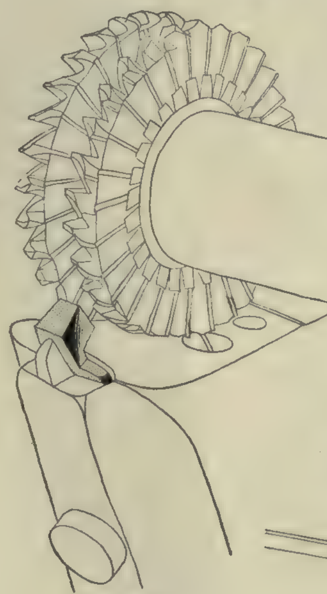


FIG. 1712

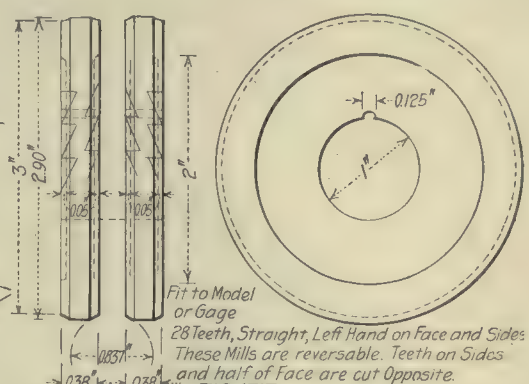


FIG. 1713


FIG. 1714

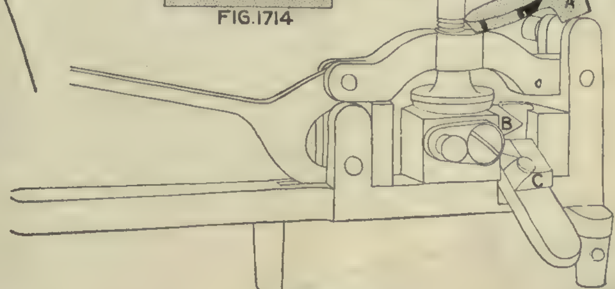


FIG. 1715

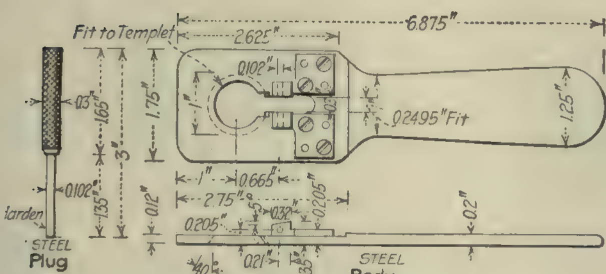


FIG. 1716


FIG. 1717

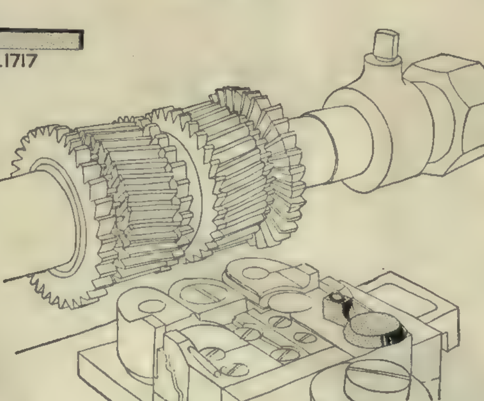


FIG. 1718

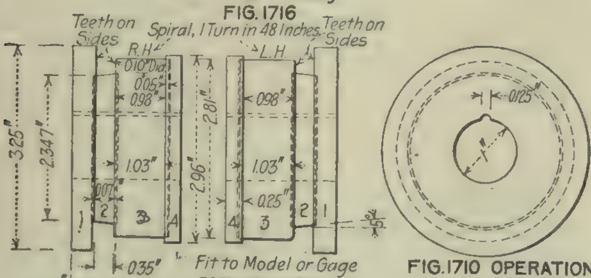


FIG. 1719

FIG. 1710 OPERATION A
FIG. 1711, 1712 & 1713 OPERATION 1
FIG. 1714, 1715 & 1716 OPERATION 2
FIG. 1717, 1718 & 1719 OPERATION 4

OPERATION 7. GRINDING CORNER OF TANG FOR SPRING

Number of Operators—One. Description of Operation—Rounding corners of tang. Apparatus and Equipment Used—Bench grinder or file. Production—350 pieces per hr.

OPERATION 8. ASSEMBLING TO BUTT PLATE

Number of Operators—One. Note—See butt plate.

OPERATION 9. CHECKING SEPARATE CAPS

Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held by pin through hole in lug in indexing fixture. Tool-Holding Devices—Standard arbor. Cutting Tools—Serrated milling cutters. Number of Cuts—Two. Cut Data—120 r.p.m.; ⅜-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—40 pieces per hr.

Upper Band

The upper band, Fig. 1720, is a drop forging of Class E steel, 1.4 in. round, and is forged on a formed mandrel to give the correct size and shape. This band holds the front end of the stock and of the hand guard together, with the barrel between. It also carries the lug that holds the lower end of the bayonet.

This piece requires considerable forging, owing to the irregular or nonsymmetric shape of the interior where it fits around the gun stock and the hand guard with the barrel between. The irregular interior is secured by first drilling a round hole and then swaging, or "mandreling," as it is called at the Water shops, using a series of mandrels to secure the desired shape. It is necessary for this band to have considerable strength, not only on account of its holding the rifle together at the front, but because it acts as the support of the bayonet. The bayonet lug at the front of the band on the lower side is subjected to considerable strain and is casehardened to resist wear.

OPERATIONS ON THE UPPER BAND

Operation	
A	Blocking from billet
A-1	Pickling
B	First trimming
1	Drilling to remove stock
3	Mandreling to inside shape
3-A	Pickling
4	Dropping on mandrel edgewise
5	Milling flash from both ends and sides
5½	Burring operation 5
6½	Mandreling to working size
6½-A	Pickling
21	Tapping screw holes
22	Milling across top to remove stock
21½	Reaming barrel seat and mandreling to correct inside shape
23	Slotting
23½	Stamping letter H
24	Filing to finish
24¼	Rotary-milling outside
24½	Rotary-milling outside of barrel
25	Polishing
28	Cornering
29	Bluing, hardening lug, browning
30	Assembling with swivel and screw

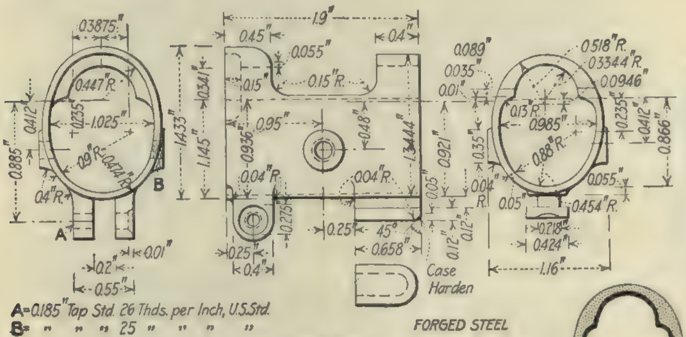


FIG. 1720

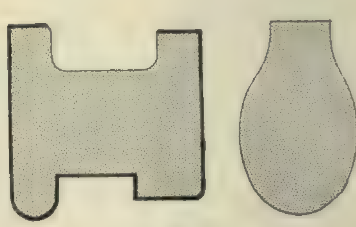


FIG. 1721

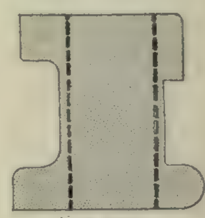


FIG. 1722


FIG. 1724

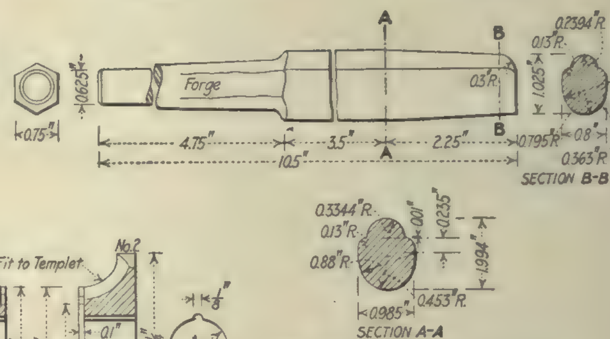


FIG. 1725

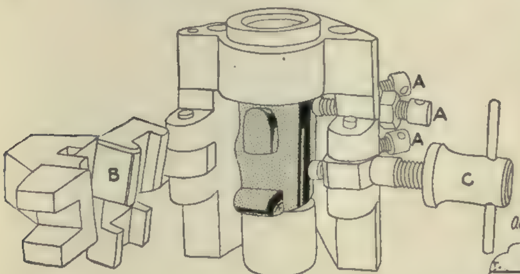


FIG. 1723

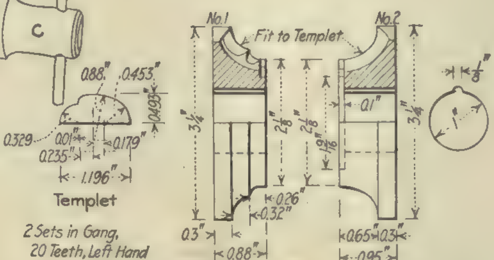


FIG. 1726

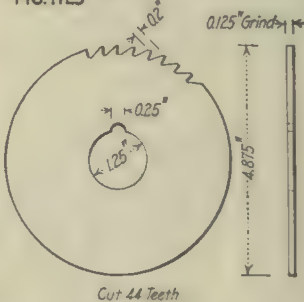


FIG. 1730-B

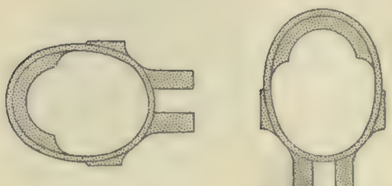


FIG. 1727

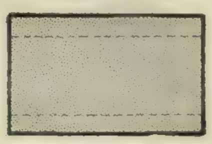


FIG. 1728

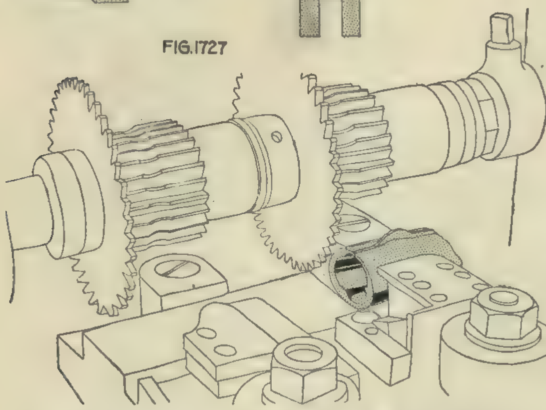


FIG. 1729

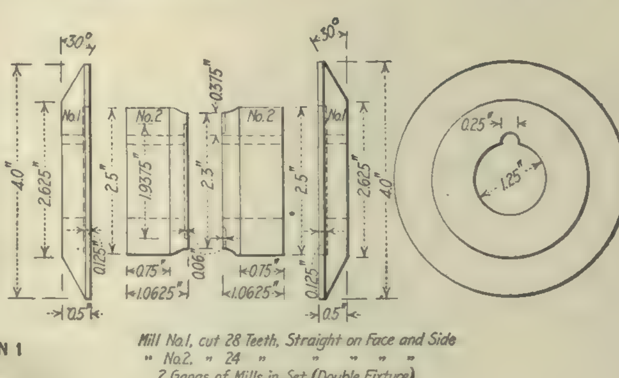


FIG. 1730-A

FIG. 1721, OPERATION A
FIG. 1722, 1723 OPERATION 1
FIG. 1724, 1725, 1726 OPERATION 3
FIG. 1727 OPERATION 4
FIG. 1728, 1729, 1730 OPERATION 5

7	Dropping on mandrel flatwise to finish
9	Trimming
9½	Annealing
9½-A	Pickling
10	Straddle-milling both ends
13	Edging to finished length
14	Milling bottom crosswise and front end of bayonet lug
15	Milling swivel lug
16	Milling bayonet lug
17	Profiling bayonet lug
18	Hand-milling swing cut to remove stock between lugs
18½	Burring for operations 14, 15, 16, 17 and 18
19	Drilling screw holes and face-milling bosses
20	Profiling undercut for hand tenon of hand guard
20½	Burring operations 19 and 20

OPERATION A. BLOCKING FROM BILLET

Transformation—Fig. 1721. Number of Operators—One. Description of Operation—Shaping from billet. Apparatus and Equipment Used—Billings & Spencer 1000-lb. drop hammer. Production—650 pieces per hr. Note—Blanked solid.

OPERATION A-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and put in the pickling solution (1 part sulphuric acid to 9 parts water) and left in this from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks and hand hoist.

OPERATION B. FIRST TRIMMING

Machine Used—Bliss back-geared press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Setscrew in

shoe; placed on mandrel for trimming. Stripping Mechanism—Pushed down through die. Average Life of Punches—15,000 pieces. Production—500 pieces per hr.

OPERATION 1. DRILLING TO REMOVE STOCK

Transformation—Fig. 1722. Machine Used—Barnes upright drilling machine. Number of Machines per Operator—Seven. Work-Holding Devices—Drill jig, Fig. 1723; screws A position the forging; the floating shoe B and the clamp C hold it. Tool-Holding Devices—Taper shank. Cutting Tools—Twist drill, 1 1/16 in. Cut Data—250 r.p.m.; 5/8-in. feed. Coolant—Compound, 1/4-in. stream. Average Life of Tool Between Grindings—100 pieces. Gages—None. Production—30 pieces per hr.

OPERATION 3. MANDRELING TO SHAPE

Transformation—Fig. 1724. Number of Operators—One. Description of Operation—The upper band, having the hole drilled, is heated and placed under a drop hammer; the mandrel, Fig. 1725, is then forced through the band, giving it the approximate shape of the barrel and stock. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer and mandrel, Fig. 1725. Production—200 per hr. Note—Fig. 1726

OPERATION 5½. BURRING OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs from operation 5. Apparatus and Equipment Used—File. Production—150 pieces per hr.

OPERATION 6½. MANDRELING TO WORKING SIZE

Transformation—Fig. 1731. Number of Operators—One Description of Operation—Driving mandrel in board to insure correct working size. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer; mandrel similar to Fig. 1725. Gages—Fig. 1732; A, length; B, diameter; C, clamping lug; D, bayonet lug. Production—350 pieces per hr.

OPERATION 6½-A. PICKLING

Number of Operators—One. Description of Operation—Same as previous picklings.

OPERATION 7. DROPPING ON MANDREL FLATWISE TO FINISH

Transformation—Fig. 1733. Number of Operators—One. Description of Operation—Dropping band flatwise to finish, using mandrel shown. Apparatus and Equipment Used—

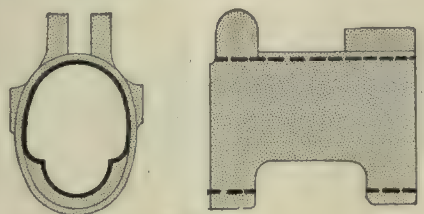
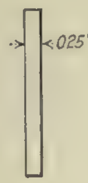


FIG. 1731



OPERATION 6½

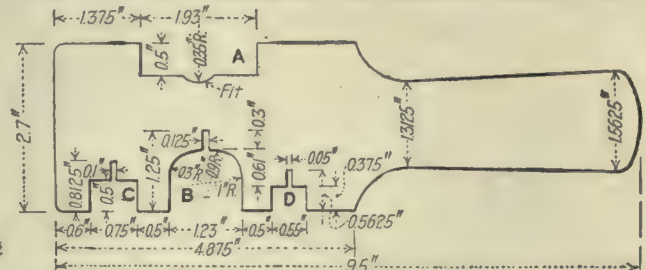


FIG. 1732

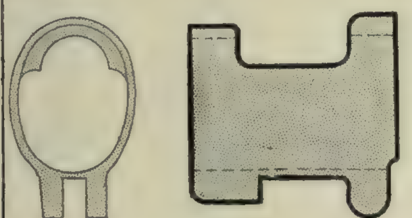
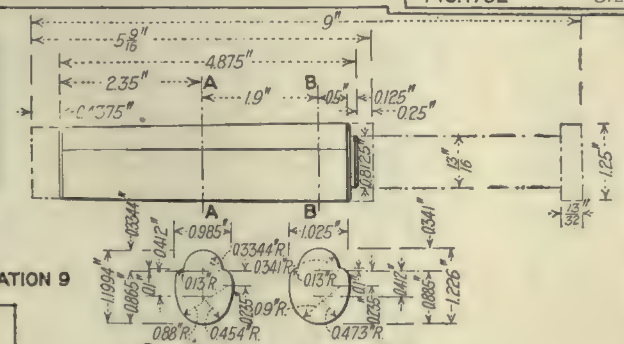


FIG. 1733



OPERATION 9

FIG. 1734

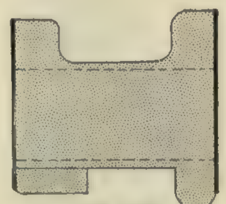


FIG. 1735
OPERATION 10

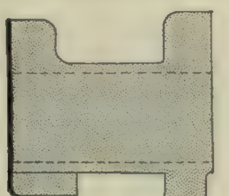
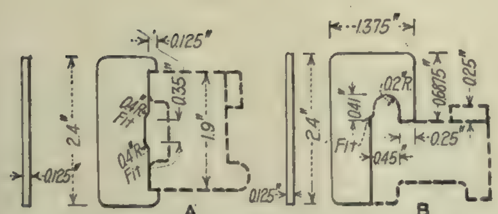


FIG. 1736



STEEL (Harden)
FIG. 1739

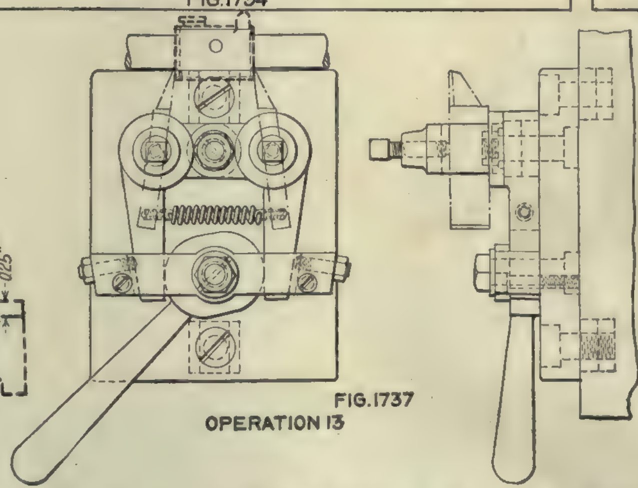


FIG. 1737
OPERATION 13

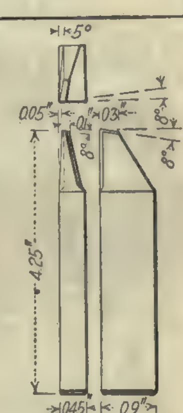


FIG. 1738

shows the milling cutter used in making these mandrels; this cutter is used in different operations to bring the band to the correct size and shape.

OPERATION 3-A. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling.

OPERATION 4. DROPPING ON MANDREL EDGEWISE

Transformation—Fig. 1723. Number of Operators—One. Description of Operation—Dropping edgewise on mandrel by turning first on the side and then with lugs down. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—80 pieces per hr.

OPERATION 5. MILLING END AND SIDE FLASH

Transformation—Fig. 1728. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—By vise jaws, Fig. 1729. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of cutters, Fig. 1730. Number of Cuts—One. Cut Data—70 r.p.m.; 5/8-in. feed. Coolant—Compound, 1/4-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—40 pieces per hr. Note—Reversed in jaws to trim both sides and both ends.

Billings & Spencer 400-lb. drop hammer; mandrel, Fig. 1734. Gages—None. Production—65 pieces per hr.

OPERATION 9. TRIMMING

Machine Used—Bliss back-geared press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—500 pieces per hr. Note—Trimmed on mandrel.

OPERATION 9½. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal, heated to 850 deg. C. (1562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Brown & Sharpe annealing furnace, oil burners, powdered charcoal.

OPERATION 9½-A. PICKLING

Number of Operators—One. Description of Operation—Same as previous picklings.

OPERATION 10. STRADDLE-MILLING BOTH ENDS

Transformation—Fig. 1735. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—In special vise jaws to hold

two at one setting. Tool-Holding Devices—Standard arbor. Cutting Tools—Side-cutting milling cutters. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush Average Life of Tool Between Grindings—5000 pieces. Gages—Form. Production—30 pieces per hr.

OPERATION 13. EDGING TO FINISHED LENGTH

Transformation—Fig. 1736. Machine Used—Special machine built at Hill shops. Number of Operators per Machine—

OPERATION 14. MILLING BOTTOM CROSSWISE AND FRONT END OF BAYONET LUG

Transformation—Fig. 1740. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on stud clamped by vise jaws, Fig. 1741. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Fig. 1742. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Com-

FIG. 1740

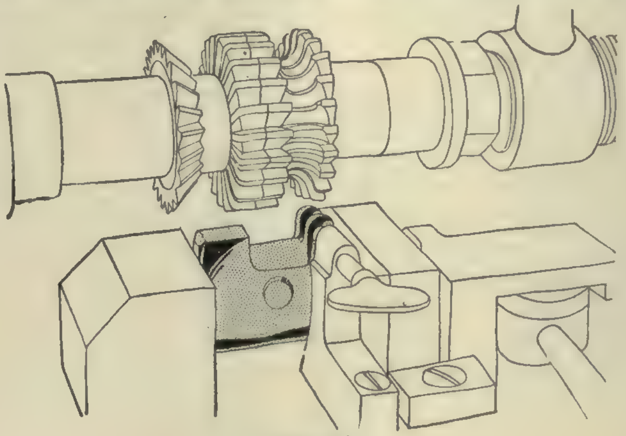


FIG. 1741

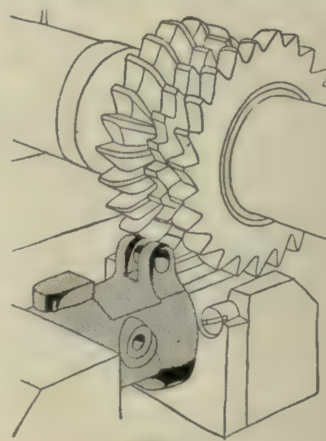


FIG. 1744

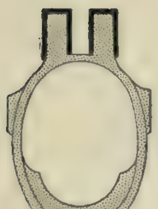


FIG. 1743

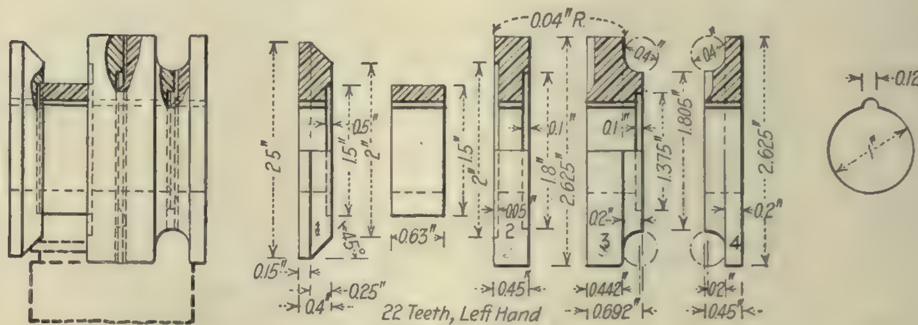


FIG. 1742

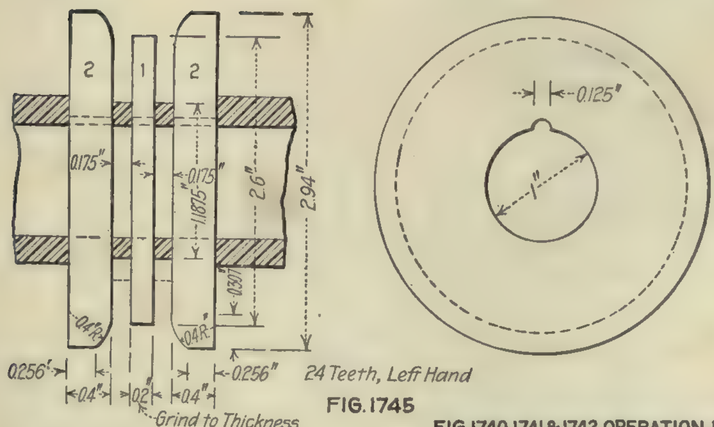


FIG. 1745

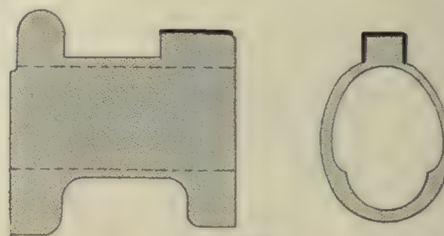


FIG. 1746

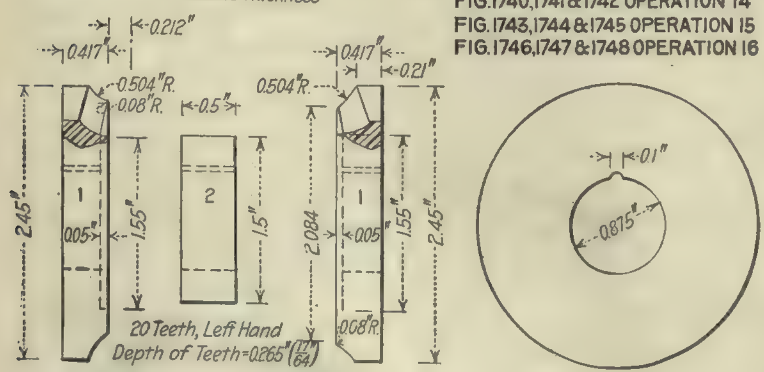


FIG. 1747

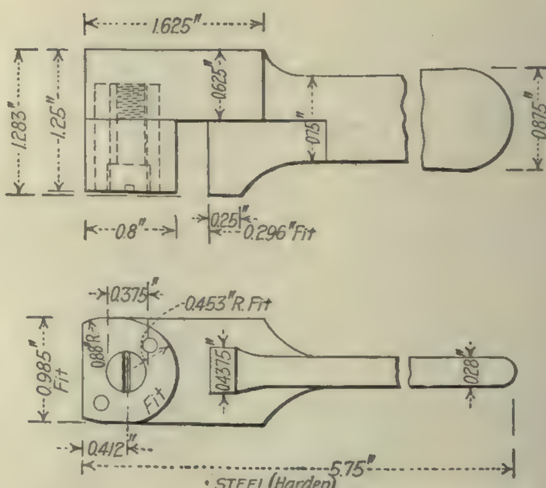


FIG. 1748

FIG. 1740, 1741 & 1742 OPERATION 14
FIG. 1743, 1744 & 1745 OPERATION 15
FIG. 1746, 1747 & 1748 OPERATION 16

One. Work-Holding Devices—Held on arbor. Tool-Holding Devices—Tool holder on crossfeed slide, Fig. 1737. Cutting Tools—Two hand-forged side tools, right and left, Fig. 1738. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1739; A, length; B, distance of lug from end. Production—125 pieces per hr.

pound, ¼-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Contour of lug. Production—50 pieces per hr.

OPERATION 15. MILLING SWIVEL LUG

Transformation—Fig. 1743. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on stud clamped by vise

jaws, Fig. 1744. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1745. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Width of swivel lug. Production—50 pieces per hr.

OPERATION 16. MILLING BAYONET LUG

Transformation—Fig. 1746. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on stud clamped by vise jaws, similar to Fig. 1744. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1747. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1748; A, height from inside of band; B, width. Production—50 pieces per hr.

OPERATION 17. PROFILING BAYONET LUG

Transformation—Fig. 1749. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on stud, clamped by vise jaws, Fig. 1750. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutters, Fig. 1751; A, first cut on outside; B, undercutting. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Length, width and undercut. Production—35 pieces per hr.

OPERATION 18. HAND-MILLING SWING CUT TO REMOVE STOCK BETWEEN LUGS

Transformation—Fig. 1752. Machine Used—Brainard large hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held in rotating fixture, Fig. 1753. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1754. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—125 pieces per hr.

OPERATION 18½. BURRING FOR OPERATIONS 14, 15, 16 17 AND 18

Number of Operators—One. Description of Operation—Removing burrs from previous operations. Apparatus and Equipment Used—File. Production—100 pieces per hr.

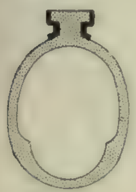


FIG. 1749

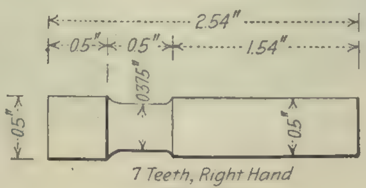


FIG. 1751 A

OPERATION 17

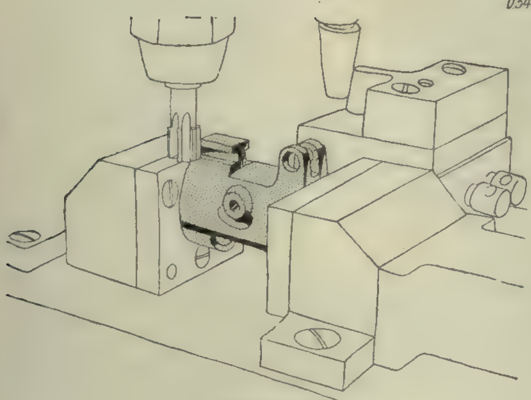


FIG. 1750

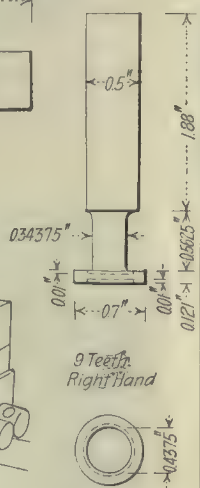


FIG. 1751 B

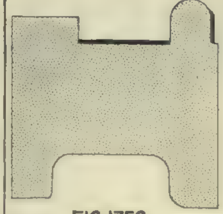


FIG. 1752

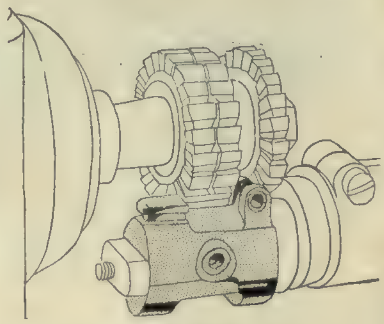


FIG. 1753

OPERATION 18

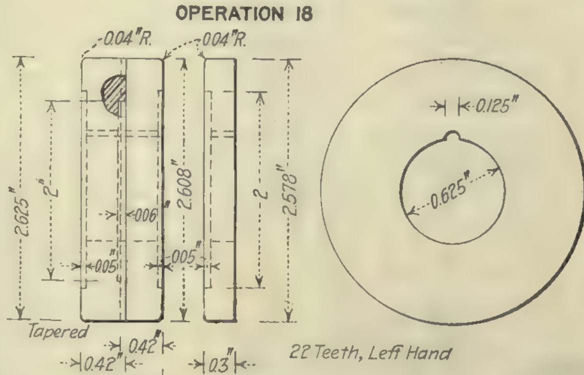


FIG. 1754

Manufacturing 1000 Mufflers a Day

Editorial Correspondence

The general tendency in the machine shop today is to specialize. This may be observed not only in the division of work, but also in the shops themselves. The Oldberg Manufacturing Co., Detroit, Mich., has followed this trend by specializing in the manufacture of mufflers. Of this automobile part 37 types are manufactured by this firm and supplied to 62 automobile companies—20 commercial-car and 42 pleasure-car builders. The average output is 1000 mufflers per day.

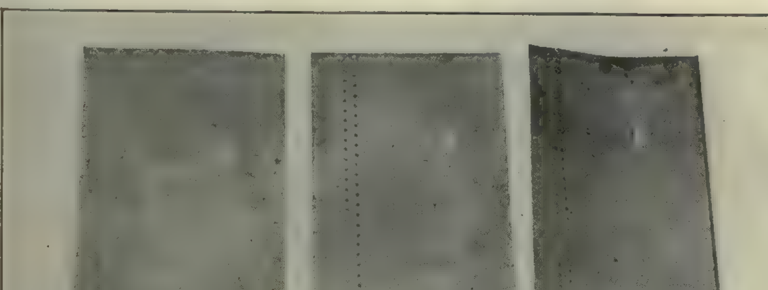


FIG. 1. FIRST THREE OPERATIONS

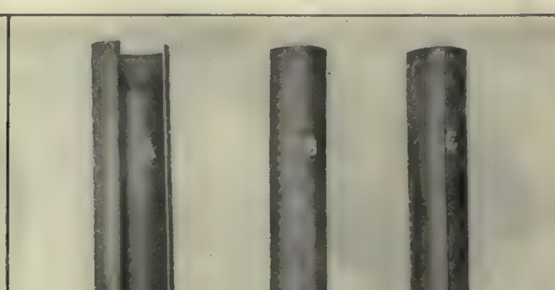


FIG. 2. FURTHER OPERATIONS

In making the mufflers the sheet, which is 0.025 in. (No. 24 gage) thick, is first cut to shape, as at *A*, Fig. 1. The next operation is punching the holes, as shown in the sheet *B*. The edges are then rolled over, as on the sheet *C*.

The sheet is rolled to form the pipe, as illustrated in Fig. 2, at *A*. The two folded edges are brought together, and the seam is rolled down, bringing the pipe to the shape seen at *B*. The seam is then welded at seven spots, using a Detroit electric welding machine for the operation. A muffler with the seam welded is illustrated at *C*.

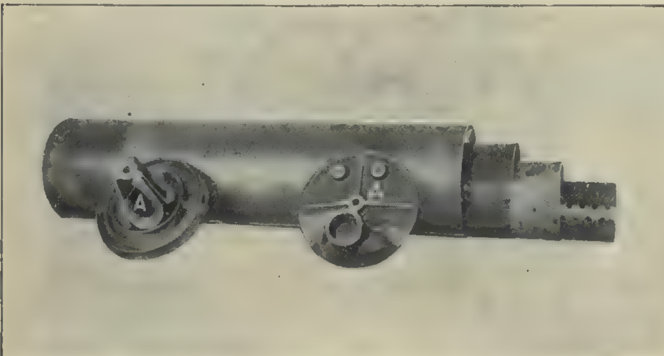


FIG. 3. THE VARIOUS PARTS FOR THE MUFFLER, SHOWING ECCENTRICALLY RIDGED HEADS

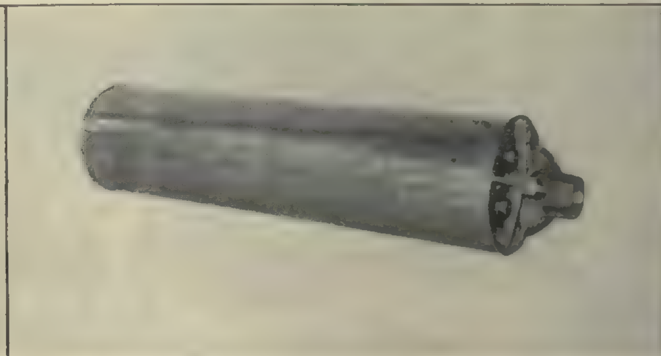


FIG. 4. THE MUFFLER COMPLETE AND READY TO BE ATTACHED TO THE EXHAUST PIPE

In making the mufflers, three, four or five of these sections are used, to suit different types. The action of the gas in all the mufflers, however, is the same. It passes out of the upper side of one section and, dividing, passes around the outside of the section to the bottom. The gas then enters through the holes in the next section, and the operation is repeated. This moving of the gas through the various sections is carried on until it finally issues from the outlet of the muffler.

The sections of the muffler are held together by cast-iron heads at each end and by a bolt passing through them. It will be observed, in Fig. 3, that the raised ridges on the heads *A* are placed eccentrically. The pipe sections fit over these ridges. Therefore, the space between two sections of pipe changes from narrow to wider. This construction allows the gas to expand as it passes from one section to the next. In Fig. 4 one of the assembled mufflers is shown ready to be attached to the outlet manifold.

The Microscope for Inspecting Screws

By Fred R. Williams

For some time I have experienced considerable difficulty in the accurate checking of hobs, taps, thread chasers, forming cutters and a number of other tools with cutting edges so located that it is almost impossible to measure them with any of the ordinary instruments of precision.

"Accurate Tool Work," by Goodrich and Stanley, has a chapter on the use of the compound microscope in the toolroom. While reading this, I saw the possibility of using that instrument to advantage in the solving of my problems, so I constructed the device shown in the photograph.

I used a Bausch & Lomb microscope having a magnifying power of 25 diameters, and an eye-piece with crosshairs intersecting at an angle of 90 deg. A Brown & Sharpe micrometer head is clamped in the angle plate, and turning the barrel causes the spindle to slide the block on which the microscope is mounted.

The microscope is focused on the top of the thread, and the eye-piece is turned until one of the hairs exactly coincides with the edge of the thread. Previous to this the line of travel of the microscope has been set parallel to the axis of the hob. By turning the barrel of the micrometer the microscope is moved until the hair exactly coincides with the edge of the next thread. The reading of the micrometer gives the relative accuracy of the thread. Likewise, the bottom of the thread can be checked by focusing the microscope on the bottom and repeating the operation. Pitch and lead may be measuser at the same setting. The inspection requires very little time; and the use of the apparatus is not limited to one size of thread, as are most inspection gages.

THE MICROSCOPE AND THE FIXTURES USED IN ADAPTING IT FOR TESTING THREADS

This very handy device costs complete less than $25 and has more than paid for itself in the saving of time effected by its use.

Letters from Practical Men

Home-Made Horizontal Forging Machine

A contract for 4.5-in. British high-explosive shells forced the consideration of the problem of closing in the noses. Of the usual methods, the forging machine or bull-dozer was deemed the most satisfactory, as it would be of use when munition contracts were completed.

The machine as finally built and installed is illustrated in Figs. 1 and 2. The frame consists of two 20-in. 65-lb. I-beams spaced 18 in. apart by short pieces of 18-in. I-beam riveted to the webs. The buttresses at each end are 20-in. 65-lb. I-beams riveted flange to

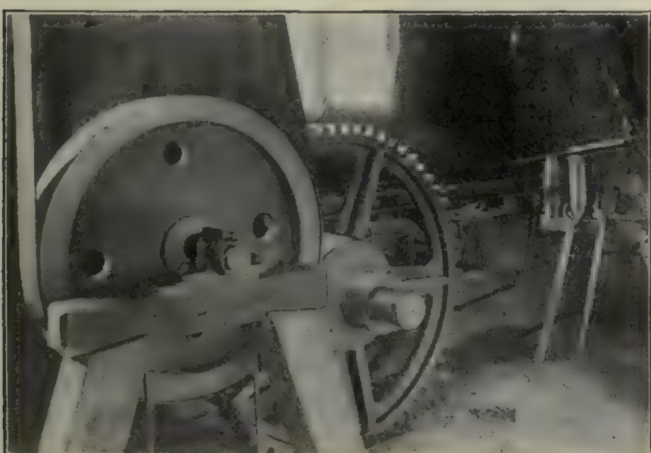


FIG. 1. HOME-MADE FORGING MACHINE

flange to the frame. This riveting carries the whole load and after being in use for some time shows no sign of distress. To the web of the buttresses are riveted two pieces of 4 x 4 x ⅝-in. angle, supported by angles riveted longitudinally to the web. These angles are to provide a bearing for the shaft boxes and the anvil block.

To relieve somewhat the shearing stress on the rivets and to prevent the main I-beams from bending, due to the eccentric load, four 3 x 3 x ½-in. angles are provided connecting the top flanges of the buttresses. These angles are secured with fitted bolts in reamed holes.

The crankshaft bearings are of cast iron, unlined, as it was considered that babbitt would not carry the load. The crankshaft, 6 in. in diameter, is of hammered steel finished all over. To keep the distance between the crankshaft bearings as short as possible and thus relieve the shaft of most of the bending stress, the crankpin is made in the form of an eccentric. The diameter of the pin is 13½ in., which is as small as it could be made; and the width is 6 inches.

Just beyond one of the bearings the shaft is swelled to 12 in. in diameter for a distance of 8 in., to form part of the clutch. The clutch is of the style usually employed on presses, etc., where one stroke only at a time is required.

The shaft was machined in a 24-in. Le Blond lathe, and one part of the work presented an interesting feature. Through the swelled portion a 2½-in. diameter hole had to be bored parallel to the axis of the shaft and located 4½ in. from the center, thus bringing the side of the hole in line with the outside of the shaft. After the turning was finished, the shaft was dropped upon the carriage and secured there after being carefully aligned. The hole was marked off on both sides of the swelled portion and drilled with a flat cutter held in the end of a bar fitting the live spindle of the lathe. So accurately had the setting up been done that, when the drill cut through, it pushed out a thin cone-shaped piece that showed, round the circumference, half of each center punchmark that had defined the hole when the work was started.

The large gear wheel is of 60-in. pitch diameter, 3-in. pitch and 6-in. face. An existing pattern was used, the hub being altered to house the clutch. After it was machined, the hub was strengthened by shrinking on a ring of 2½-in. square steel. The pinion shaft is of 3$\frac{7}{16}$-in. cold-rolled steel and is carried in three boxes, two of which are bolted to the top flange of the buttresses and the other secured to a bridge tree, driftbolted to the foundation timbers. Existing patterns were used for the pinion and the flywheel. The latter is 44 in. in diameter by 8-in. face and weighs 2000 pounds.

The connecting-rod is of cast iron, 14 in. center to center. The large end is made with light flanges that

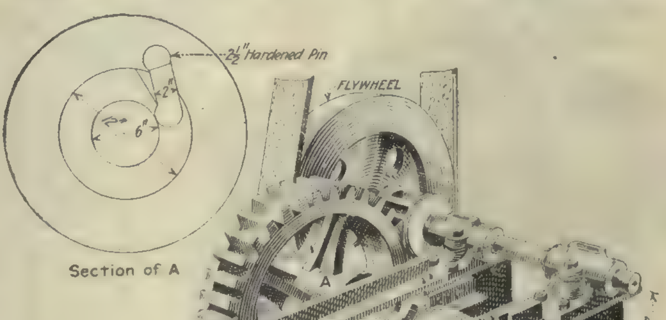


FIG. 2. DETAILS OF CONSTRUCTION

serve to keep it in position on the eccentric and also to retain the lubricant. The small end has a bearing on a semi-cylindrical surface machined in the end of the crosshead. To draw the latter back on the instroke, there is a 1½-in. pin through the small end of the connecting-rod.

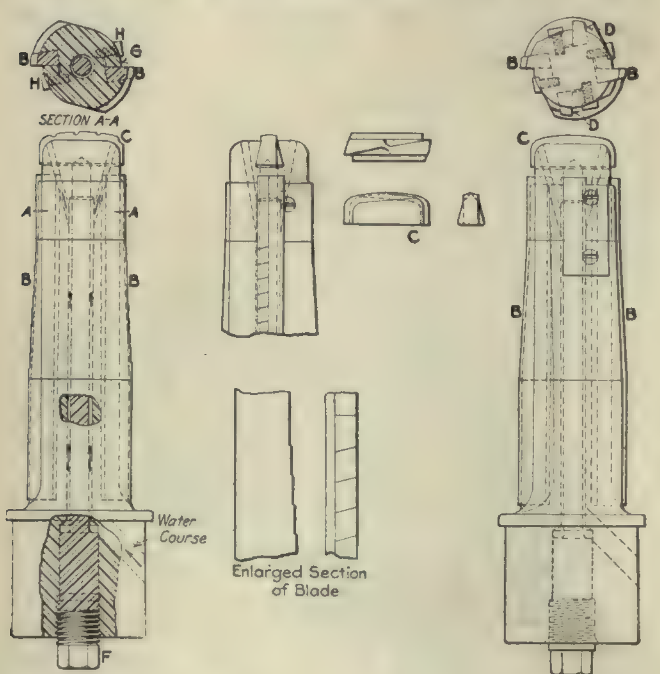
The crosshead travels on guides riveted to the top flanges of the main I-beams. The direction of rotation of the machine is arranged so that the lower guide carries the load. As the stroke of the machine is 7 in. and the slippers on the crosshead are 17 in. long, special provision has to be made for lubrication. This is accomplished by drilling two 1½-in. holes nearly through each slipper. Small holes are then put right through from the bottom of the 1½-in. ones, which make an efficient oil box. As these holes are located 7 in. apart, a proper distribution of oil is insured. The outer end of the crosshead is bored out 7 in. in diameter to receive the forming die. Two annular recesses are formed in the die chamber and are so connected that there is a continuous passage for the cooling water. The water connections are made flexible by a short piece of rubber hose. A small air hole at the back of the die is also provided.

A cast-iron block, 12 x 13½ in. in section, is secured to the buttresses to form an anvil, to which is bolted a holder to hold the shells while they are bull-dozed. The holder is semicircular and just long enough to hold a shell without allowing it to tilt. By using packing between the base of the shell and the holder the amount of closing can be regulated. A. F. Minzies.

New Westminster, B. C.

Roughing and Finishing Reamer for Shells

The illustration shows a roughing and finishing reamer that has proved successful on 3-in. Russian shrapnel. The reamer body has a high-speed steel cutter *C*, which is located and held firmly by means of a locating pin *F*. This pin forces the cutter into a dovetailed slot in the end of the reamer body proper. The purpose of the cutter *C* is to bore the powder chamber.



ROUGH AND FINISH REAMERS FOR RUSSIAN SHELLS

The two cutter blades *BB* are held firmly by means of taper keys *G*, which are forced down in front of the blades and held there by the fillister-head screws *H*. These blades serve for boring the two straight portions and the one tapered part of the shell. The cutting compound is forced through the turret and the reamer shank, along the side of the locating pin, and through the holes directly in front of the cutting edges of the cutter *C*. This washes out the chips and allows the reamer to cut freely without tearing.

Reamer 2 is identical to reamer 1, with the exception of the notches in the cutter *C* and the series of steps in the cutter blades *BB*.

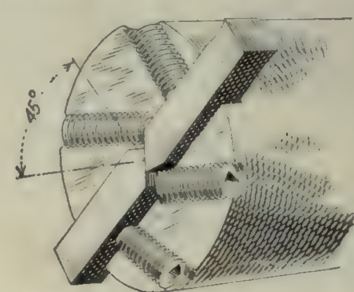
Reamer 3 is the same as reamer 2, with the addition of two short straight blades *D*, which ream in connection with the small straight portion of the blades *BB*.

The open end of the shell is first cut off to length; then the base end of the shell is centered true with the inside rough forging, after which it is rough and finished turned; then it is held in a collet chuck for the reaming operation. From here the shell goes through other machine and grinding operations. Fred R. Irwin.

Franklin, Penn.

Individual Adjustment for Boring-Bar Blades

The accompanying illustration shows a section through a boring bar that has a novel individual adjustment for the blades. As can be seen, each blade may be moved independently and locked in place. The advantage afforded by this construction is that small rectangular pieces of high-speed steel may be used for the blades. I recommend the use of hollow headless setscrews, as much greater pressure can be applied to the blades, holding them more rigidly. This construction is limited to the larger class of bars, as it weakens the smaller ones.



METHOD OF HOLDING AND ADJUSTING THE BLADES

This type of bar has been used extensively under my observation during the last year and has proved itself invaluable for close work. Cecil H. Strupe.

Indianapolis, Ind.

Heating Dies for the Purpose of Hardening

With some makes of steel, toolmakers and diemakers experience difficulty in the expansion of dies after hardening. In putting the die in the furnace it should be placed face down on a firebrick slab. When this is done, I have found that the hole contracts instead of expanding and allows about 0.002 in. for stoning. Where slightly too much has been filed from the hole in the die there is a chance of correcting it in this way so that the piece may be used. E. Kern.

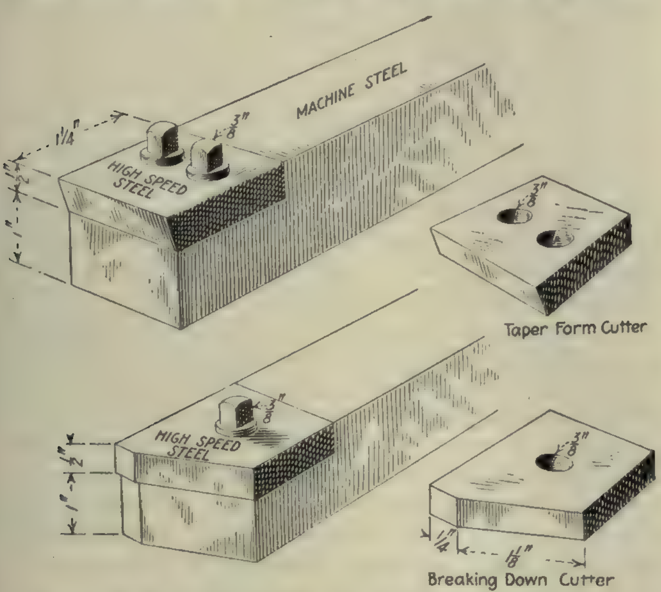
Long Island City, N. Y.

Discussion of Previous Question

High-Speed Steel Tips on Tools

The different methods of using small bits of high-speed steel with other metals interest me. Mr. Ellis, on page 161, writes of having trouble with the high-speed bits breaking off.

I have used form tools, much heavier than those shown by Mr. Ellis, welded to machine steel with about an inch of this steel beneath the high-speed bit and the high-speed piece set in so that it is flush with the top of the rest of the tool. Nevertheless, I experienced the same trouble—the high-speed piece breaking off at the weld. With turning tools I had the same difficulty, but we had a method that worked very nicely for the forming cutters, so that they gave us no more trouble than if they had been solid.



METHOD OF ATTACHING HIGH-SPEED STEEL TIPS

The illustrations show how the cutters were made. They have been in use now for months, with no breakage. Spare high-speed pieces are kept on hand, and various-formed pieces could be used with the same holder by having the holes the proper distance apart.

Bridgeport, Conn. CLINTON J. CONVERSE.

Cutting a Perfect Gear with a Broken Cutter

On page 254, Emil Daiber gives an illustration of trying to cut a perfect gear with a broken cutter. There must be something seriously wrong with either the Fellows gear shaper or the operator, when it is necessary to take two cuts on a 24-26 pitch gear to get within 0.004 to 0.006 in. of concentricity. I should advise inspection of the adjustments of the machine to see if the gears are turned true or if the arbor is out of true. If these errors do not prevail, gears ought to come within 0.001 in.

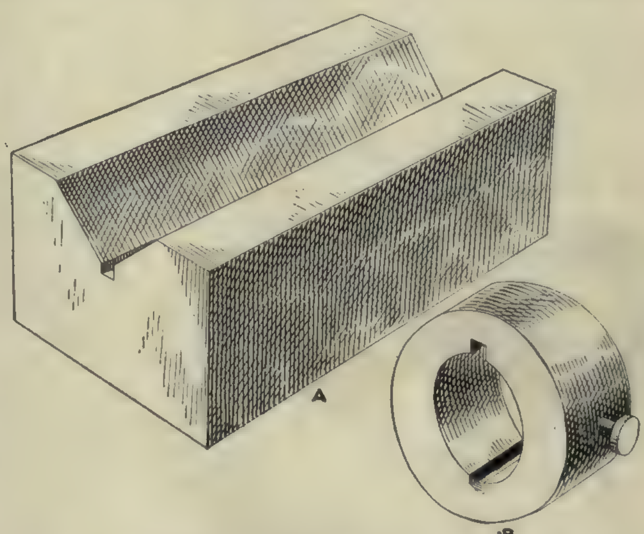
Mr. Daiber credits a Mr. Clark with cutting gears with one cut. This may be all right for a makeshift on gears with a very low pitch-line velocity, but on gears with a high pitch-line velocity it is not practical and not worth taking a chance. Gears with a burned tooth can be remedied by grinding the hard spot and cutting over at a reduced speed, provided the gear is burned in roughing; or the same method can be applied on a finishing cut if the gear does not run at a fixed center distance, the finishing cut being a little deeper than standard. With small gears or gears with a high pitch-line velocity it is cheaper to scrap them. H. BRIERLEY.

Torrington, Conn.

Cutting Keyways at 180 Degrees

I read with interest the article on page 110 relating to the cutting of keyways in shafts opposite each other, or at 180 deg., without using an index head.

I should like to submit the following method, which is also proving satisfactory for the same purpose. It would seem to me that this second method makes for greater accuracy, is just as simple, and has the added advantage that one can cut keyways at 180 deg., 90 deg., or at any angle desired and in any part of the shaft.



ATTACHMENTS USED WHEN CUTTING KEYWAYS

For cutting keyways at 180 deg., the shaft is set on two V-blocks on the miller. One of the V-blocks has a keyway, $\frac{3}{8}$ in. wide, cut through the bottom of the V, as shown in the illustration at *A*.

Next we have a collar *B*, which just fits the shaft; this collar has two $\frac{3}{8}$-in. keyways cut at 180 deg. and a knurled setscrew to hold the collar in place on the shaft. The first keyway is cut in the usual manner; then, before the holding straps are loosened, the collar is slid on the shaft up against the V-block, which has the keyway in the bottom of the V. Line up the keyway in the V-block, and one of the keyways in the collar, by inserting a $\frac{3}{8}$-in. key through

the collar into the V-block. Then fasten the collar in place on the shaft by means of the knurled setscrew.

Now loosen the work straps, withdraw the $\frac{3}{8}$-in. key, revolve the work until the opposite keyway in the collar will line up with the keyway in the V-block, insert the key again and proceed with the second keyway.

It will be evident that if the keyways in the collar are cut correctly, the keyways in the shaft will be accurate; provided, however, the key used in lining up the two keyways is a good fit.

This collar scheme would work, of course, in the same manner with holes in the collar and in the V-block and a pin for alignment. Most of our keyways are cut in cold-rolled shafting, and several collars are used to fit the sizes of cold-rolled steel used. A. L. BARRETT.

Oakland, Calif.

Matching Plate Patterns

In reply to Mr. Duggan's inquiry, on page 300, as to how the other fellow matches plate patterns, I give here what I find the simplest and quickest way.

In making a plate pattern it is always best to machine or file the joint true, then dowel and screw the two halves of the pattern securely together before any of the turning or scraping of either wood or metal patterns is attempted. No matter how many times the patterns are taken apart in the course of the work, provided there has been an accurate job done on the drilling for dowels, they will always match.

After the pattern work proper is finished, the patterns are taken apart and spotted on the match plate, care being taken to have enough room between the flask and the pattern for the sand and the gate. The plate is then drilled, using dowel-pin holes in the pattern as a jig. A clearance hole is drilled through the plate for the screws. The other half of the pattern is put in; and when the two parts are screwed together, there will be a perfect match. If at any time it becomes necessary to repair the patterns or make any changes in them, they can be taken off, doweled together again, have the necessary work done and be replaced on the plate, giving a first-class job.

Not long ago I had an order from an electrical concern. The piece was made on a common gate and was run in the foundry with a 90 per cent. loss, due to shifts or light and heavy metal in the cope or drag, the casting having a $\frac{3}{16}$-in. section. A new master pattern was made in halves. A set of patterns cast in brass were then turned to templets in the lathe and mounted on a $\frac{3}{8}$-in. aluminum match plate in the way described. We are now getting perfect castings, using a vibrator on the plate.

Another way I find good for making a match plate of patterns, especially patterns with an irregular parting line, is to make a master pattern and gate it just the same as for a running pattern. The pattern is rammed up in the usual way, cutting and slicking the required thickness, the inside of the loose pieces forming the outside dimensions of the match plate. The mold is then closed, and the parting on the outside of the flask is patched with sand to prevent any possible chance of the metal running away. It is then poured. When shaken out, an excellent match plate results. A match plate made in this way calls for the skill of a good molder and a flask with true pins. H. ARKLAND.

Buffalo, N. Y.

The Anti-Metric Case

My attention was recently called to an interesting article on "The Anti-Metric Case," on page 139 of the *American Machinist*. It reminds me of several striking examples of our inborn tendency to divide by 2, which have recently come to my notice. Only a few days ago it was announced in the Washington papers that the Treasury Department was considering the issuance of a $2\frac{1}{2}$c. piece, a "half nickel," fitting in perfectly with Mr. Halsey's table of coins on page 139 and supplying the only item necessary to make his table a complete demonstration of our nondecimal coinage.

Another case: I recently purchased from an English manufacturer of scientific instruments a spherometer supposed to be metric, with 100 divisions on the circle. After getting several queer-appearing readings with it, I discovered that the screw had four turns per millimeter, demanding a calculation with every reading. It was not merely an adapted inch-thread, either, for the dimensions were exact. This instrument was quite evidently made by a man who had been brought up on halves and quarters. Even the scientist accustomed to the use of the metric units has his difficulties; it has not been very long since a scientist asked me for the loan of a metric scale "about 6 in. long," 6 in. being merely a form of expression for half a foot, the unit in which he was thinking.

The chief point I wish to make from these examples is that the decimal system of numbers has nothing to do with the metric case. The decimal system is admittedly bad; but we will have to go on using it for the sake of facility in calculation, whether we use feet or meters, because the adoption of an ideal octoval or sexadecimal system is as remote as the adoption of a rational alphabet. Practically every metric or anti-metric publication confuses the issue by introducing arguments about the decimal system; if these could be separated out, we would see much more clearly what the real issues are.

One of these real issues is well stated by Mr. Halsey. It is that of standardized sizes of manufactured articles. It is a good *a priori* argument, but loses some of its force when one recalls the totally haphazard dimensions of some standardized articles, such as the standardized railway track, which is 4 ft. 8 in. and $\frac{1}{2}$ in. wide; or the standardized sizes of fire-hose couplings, which at last accounts included six species with a number of variatons; or the standardized 6-in. shaft, which has a diameter of $5\frac{15}{16}$ in.; or the standardized $\frac{1}{2}$-in. pipe, which has an outside diameter of 0.840 in., inside 0.542 to 0.623 in.; or the numerous standardized wire and sheet-metal gages with which the manufacturers have supplied us. Would all these dimensions become any more irrational if expressed in cubits, parasangs or meters?

Washington, D. C. ROBERT B. SOSMAN.

Planing a Taper Gib

On page 1122, Vol. 45, of the *American Machinist*, Mr. Winters brings up a point in planing dovetail slides for taper gibs, which might easily be overlooked. But an error was made in the figures. The secant of 30 deg., radius 0.25, is 0.2886, not 0.282, as shown. It should also be remembered that 0.2886 is a tangent of the gib taper and should be used as such. WILLIAM S. ROWELL.

Wilkinsburg, Penn.

Editorials

War Bonds—A Duty for Every American

Some of us are impatient to see the days go by without visible and striking proof of our having actually entered the war. We forget that the larger a body the more inertia it has in getting in motion. A 20-ft. motor boat can get get under way in a fraction of the time that it takes to raise steam on a dreadnaught. The organization of the man-power, machine-power and money-power of a nation of 100,000,000 souls is a task that cannot be completed in a week or a month, but which when completed will have momentum proportionate to its size.

But while it will take months to mobilize and train an army proportionate to America's power, and while it will take weeks to mobilize the machinery of industry in proportion to America's resources, there is one step that we can take immediately (and it is the most important step of all)—the mobilization of America's finances on a scale befitting our national wealth.

This mobilization of money is the first and most important step that we can take. Congress has already done its part in authorizing a bond issue of $7,000,000,000. Now it is up to us of America to demonstrate our intentions to the world in the way that we make this first move toward the maintenance of American rights and American ideals.

There are no age limits or physical requirements debarring any of us from serving our country immediately in this way. The denominations offered will undoubtedly be such that every American citizen, no matter what his resources or position, can do his bit. Even if the call were for an unreturnable contribution of this amount, there should be no hesitation. How much less when it is simply a loan to our Government, repaid with interest and secured by the unassailable credit of the United States?

Let the machine shops of the United States, owners and employees alike, demonstrate their patriotism emphatically and unmistakably by an immediate response. It should be a matter of pride with every shop in America to have the largest possible percentage of its workers enrolled in the ranks of Government bond buyers. Get after this, you factory managers, as you did after the safety-first movement. Put a poster in each department in the shop, bearing the motto, "Buy a Government bond." Explain to your men and women fellow workers and fellow Americans the purpose of this issue and how bonds may be secured. Explain to them that these bonds are as safe and solid as the Government itself. Explain to them that these bonds are as good as gold at any time and anywhere. Put into this movement, not only the initiative of the machinery builder who does things, but the inspiration of the American citizen who loves his country, and the answer of the machinery-building industry to our country's need will be a fitting one to record in history! BUY A GOVERNMENT BOND!

"American Machinist's" Representative in Washington

For the last two and a half years, since the outbreak of the European War, the *American Machinist* has put considerable of its energy into the distribution of information on munition-manufacturing methods. This work began with a description of Canadian shell manufacture, a few months after the outbreak of hostilities, extended to munitions made in the factories of the United States for the Allies, and within the last year to a description of American ammunition made in our own arsenals. Taken altogether, we have published some 800 pages of *American Machinist* size on this subject during the two years.

This has been done with the idea of serving our country and our readers at the same time by collecting and distributing information on a subject about which there has been but little information available in printed form. As a result we have very naturally received many inquiries from those wishing additional knowledge on this subject. To render further service to the Government and our readers in these matters, Fred H. Colvin, of the editorial staff, has taken up headquarters in Washington.

To Mr. Colvin belongs the credit for collecting and presenting the enormous amount of data bearing upon the operations on the Springfield rifle. And he is familiar with the methods of munition making in private plants as well as in our arsenals. Mr. Colvin's address for the present will be Hotel Powhatan, Washington, D. C., and he will be glad to be of service to those of our readers who may wish to avail themselves of whatever he can do in assisting them with information.

Not Without Honor Except in Its Own Home

It is a commentary on our lack of perception of the value of certain American inventions that these need to travel a long way from home in order to be appreciated.

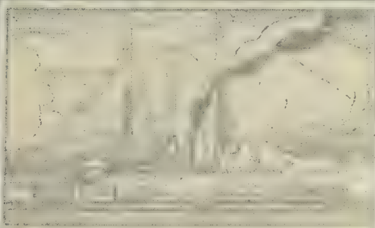
The airplane, strictly an American invention, has had its usefulness demonstrated thousands of miles away from the land of its birth. In our established attitude toward peace on earth, and our assumption that all other nations must hold the same opinion, we overlooked the best possible means of developing an impregnable defense for American principles and institutions.

If we had maintained our start in aëronautics; had realized the possibilities connected with the development of this art; had built aircraft in proportion to these possibilities and to our needs; had trained air men in proportion to these aircraft—we would have a sense of preparedness and a means of offensive and defensive action, equal if not superior to that of a well-trained army.

These "might have beens," however, are of use only as they confirm the intention of Americans to put aircraft in America in the place of honor that it deserves.

The President's Message

As requested by the President of the United States, we lay before our readers those portions of his message that bear upon our field of labor. Let the response of American industry be such as fittingly to exemplify American initiative and skill for all time.



Putting our Navy on War Footing

Creating and Equipping a Great Army

We must supply abundant Food for ourselves, our Armies and our Seamen

Abundant Materials out of Mines and Factories to Clothe and Equip our Forces

Coal to keep the Fires going in Ships at Sea

MY FELLOW-COUNTRYMEN:

The entrance of our own beloved country into the grim and terrible war for democracy and human rights which has shaken the world creates so many problems of national life and action which call for immediate consideration and settlement that I hope you will permit me to address to you a few words of earnest counsel and appeal with regard to them.

We are rapidly putting our navy upon an effective war footing and are about to create and equip a great army, but these are the simplest parts of the great task to which we have addressed ourselves. There is not a single selfish element, so far as I can see, in the cause we are fighting for. We are fighting for what we believe and wish to be the rights of mankind and for the future peace and security of the world. To do this great thing worthily and successfully we must devote ourselves to the service without regard to profit or material advantage and with an energy and intelligence that will rise to the level of the enterprise itself. We must realize to the full how great the task is and how many things, how many kinds and elements of capacity and service and self-sacrifice it involves.

These, then, are the things we must do, and do well, besides fighting—the things without which mere fighting would be fruitless:

We must supply abundant food for ourselves and for our armies and our seamen, not only, but also for a large part of the nations with whom we have now made common cause, in whose support and by whose sides we shall be fighting.

We must supply ships by the hundreds out of our shipyards to carry to the other side of the sea, submarines or no submarines, what will every day be needed there, and abundant materials out of our fields and our mines and our factories with which not only to clothe and equip our own forces on land and sea, but also to clothe and support our people, for whom the gallant fellows under arms can no longer work: to help clothe and equip the armies with which we are coöperating in Europe, and to keep the looms and manufactories there in raw material; coal to keep the fires going in ships at sea and in the furnaces of hundreds of factories across the sea; steel out of which to make arms and ammunition both here and there; rails for wornout railways back of the fighting fronts; locomotives and rolling stock to take the place of those every day going to pieces; mules, horses, cattle for labor and military service; everything with which the people of England and France and Italy and Russia have usually supplied themselves, but cannot now afford the men, the materials, or the machinery to make.

It is evident to every thinking man that our industries, on the farms, in the shipyards, in the mines, in the factories, must be made more prolific and more efficient than ever, and that they must be more economically managed and better adapted to the particular requirements of our task than they have been; and what I want to say is that the men and the women who devote their thought and their energy to these things will be serving the country and conducting the fight for peace and freedom just as truly and just as effectively as the men on the battlefield or in the trenches. The

to American Industry

industrial forces of the country, men and women alike, will be a great national, a great international service army—a notable and honored host engaged in the service of the nation and the world, the efficient friends and saviors of free men everywhere. Thousands, nay, hundreds of thousands, of men otherwise liable to military service will of right and of necessity be excused from that service and assigned to the fundamental, sustaining work of the fields and factories and mines, and they will be as much part of the great patriotic forces of the nation as the men under fire.

This let me say to the middlemen of every sort, whether they are handling our foodstuffs or our raw materials of manufacture or the products of our mills and factories: The eyes of the country will be especially upon you. This is your opportunity for signal service, efficient and disinterested. The country expects you, as it expects all others, to forego unusual profits, to organize and expedite shipments of supplies of every kind, but especially of food, with an eye to the service you are rendering and in the spirit of those who enlist in the ranks, for their people, not for themselves. I shall confidently expect you to deserve and win the confidence of people of every sort and station.

To the men who run the railways of the country, whether they be managers or operative employees, let me say that the railways are the arteries of the nation's life and that upon them rests the immense responsibility of seeing to it that those arteries suffer no obstruction of any kind, no inefficiency or slackened power. To the merchant let me suggest the motto, "Small profits and quick service," and to the shipbuilder the thought that the life of the war depends upon him. The food and the war supplies must be carried across the seas, no matter how many ships are sent to the bottom. The places of those that go down must be supplied, and supplied at once. To the miner let me say that he stands where the farmer does: the work of the world waits on him. If he slackens or fails, armies and statesmen are helpless. He also is enlisted in the great Service Army. The manufacturer does not need to be told, I hope, that the nation looks to him to speed and perfect every process; and I want only to remind his employees that their service is absolutely indispensable and is counted on by every man who loves the country and its liberties.

Let me suggest, also, that every one who creates or cultivates a garden helps, and helps greatly, to solve the problem of the feeding of the nations; and that every housewife who practices strict economy puts herself in the ranks of those who serve the nation. This is the time for America to correct her unpardonable fault of wastefulness and extravagance. Let every man and every woman assume the duty of careful, provident use and expenditure as a public duty, as a dictate of patriotism which no one can now expect ever to be excused or forgiven for ignoring.

The supreme test of the nation has come. We must all speak, act, and serve together!

WOODROW WILSON.

Steel out of which to make Arms and Ammunition

Locomotives to take the place of those every Day going to pieces

Our Industries must be made more efficient and more economically managed than ever

The Industrial Forces of this Country will be a great International Service Army

Every One who Cultivates a Garden Helps

Latest Advices from Our Washington Editor

By Fred H. Colvin

Washington, D. C., Apr. 21, 1917.

If patience is a virtue in times of peace, it is doubly so in these days of preparation for the struggle to come. The inevitable nerve tension makes every minute of delay seem doubly long and also makes it next to impossible to understand the reasons why seeming delays are necessary. Shops which are well equipped to make various kinds of munitions, or parts of munitions, and which are eager to feel that they are helping in the work of preparedness cannot understand why they are not called upon to begin work at once.

To all these the counsel of patience is doubly important at this time, for it will not be long before they are called upon to serve in one capacity or another; and they must not let impatience lead to any diminution of their desire to do their bit.

If anyone who is getting impatient at what seems to be unnecessary delay will carefully recall some instance in which he made some change in his output or in his plans, he will remember many delays of one kind or another, delays that developed in unexpected quarters and that did not yield at all readily to the usual methods of solution. Multiply this a thousand times or more and you have some idea of the enormous difficulties that confront the various councils and boards appointed to handle the gigantic problems now presented.

We must remember the tremendous task of securing data as to the capacity and availability of some 30,000 shops, which has been successfully accomplished. We must also remember that the utilization of these shops involves other departments, that they cannot be put to work until the order for materials has been filled and decision is made as to what is needed in each particular line. Remember, too, that there is a limit to human endurance and that heads of departments cannot work 24 hours a day, even though they might like to.

In other words, we must be patient. We must realize that activity which goes off half-cocked is often worse than wasted, that a sane and satisfactory foundation is absolutely necessary and that the heads of these boards are doing everything in their power so to plan the work that, when the start is actually made, there shall be no false moves, no exasperating and costly delays.

We all want to serve to the best of our ability, and we should remember that it is not possible for all to serve to the best advantage just when or just how we might elect. Many a skilled toolmaker would rather handle a machine gun in action, or an expert farmer might prefer the excitement of battle to the potato patch. But he who serves when and how his service is of the most value to the country is the real partriot, even if it does not suit his own convenience or desires.

How many shops will be called into direct, active coöperation, no one can say. If you are called, be as ready and as enthusiastic to do your level best as though the call had come during the first flush of war excitement. If your call does not come, if you continue to make your regular product and seem to be neglected as an active factor, remember that a certain amount of regular product is just as necessary as shells and rifles, that you are helping as much, only in another way.

The fact that you are not called to make munitions of war may easily mean that your work in regular lines is of better quality or more needed than the product of some competitor whose shop is taken for war product. Do not forget that any good, standard and nesessary product, whether directly connected with war or not, is as much a part of a successful war as the best machine gun. The men back of the lines, who are necessary to keep the soldiers fed and clothed and supplied with fighting material, are all a necessary part. And in many ways theirs is the harder part, because they toil without the knowledge of what is going on or the stimulation of the excitement.

Be patient until the call comes, and then let your pent-up desire for service speed the output to the limit.

How Can We Serve Best?

We have been called a nation of money grabbers, without sentiment or any of the finer feelings. And knowing that it was not true, knowing that such charges had their origin in jealousy, we have paid little attention to them. But no one who has watched the recent trend of public opinion, who has carefully noted the action of chambers of commerce, of copper and steel magnates, of meat packers and others who will be called upon to supply needed materials can fail to be impressed by the spirit that voluntarily produces such desirable results.

We can be proud that such men as Frank A. Scott, Howard E. Coffin, Julius Rosenwald and others of high standing are ready and willing to serve the country and to give us the benefit of their wide and varied experience. Instead of this being a plan for the making of huge profits, these men have secured remarkably low prices for copper, steel and other commodities.

Another gratifying feature of the present crisis is the absence of any ill-advised boastfulness, the evident desire on the part of the average men to be of real service to the country. Men of various mechanical attainments come to us to ask how they can best put their skill and experience at the disposal of the Government—and not with the idea of securing a fat salary or an easy berth, but to be of real service with a minimum of return.

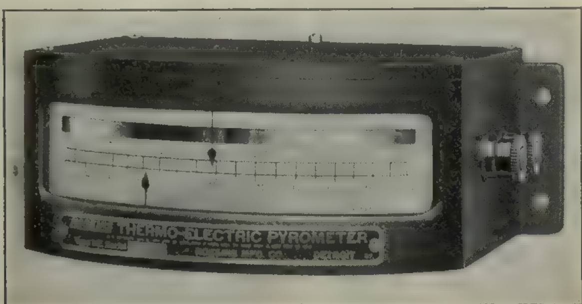
Can any of us do less? Must not every true citizen ask himself how he can best serve and look about for such an opportunity? Not the work we would rather do, but the work in which we can be of the greatest service. If we can be of more value making gages or shells, or in staying home to operate an automatic screw machine, that is where we belong, even if we prefer more active service. Brain counts as well as brawn, and we may be far more valuable at home, away from the excitement and its stimulation, than in the field where the actual fighting is done.

But wherever it be, let the thought of service for the best interest of all be the leading thought. To few are given the opportunities for public glory, but no one can rob us of the opportunity to be of real service in some way, no matter how obscure or whether the world ever knows of it or not.

Shop Equipment News

High-Resistance Pyrometer

The Hoskins Manufacturing Co., Detroit, Mich., is marketing a new high-resistance pyrometer together with a special thermal couple that requires no calibration. It is possible for the user to purchase the elements in coils and, when in need of a new thermal couple, cut off suitable lengths of wire, twisting and welding the ends together. The elements forming this thermal couple are special chromium and nickel alloys and are said to be of very long life on account of their immunity to the action of hot gases.



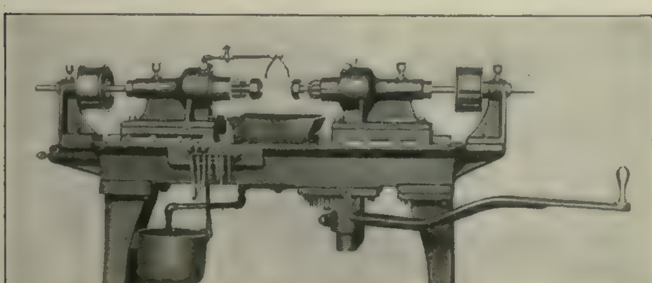
HIGH-RESISTANCE PYROMETER

The illustration shows the instrument known as the horizontal edgewise type, which is more accurate than the vertical type for the reason that balance errors of a needle are practically eliminated. The meters are made in six ranges, the upper temperatures being 800, 1100, 1400, 1500, 2000, and 2500 deg. Fahrenheit.

Multiple-Spindle Drilling Machine

For the purpose of drilling small holes in such parts as bicycle and motorcycle hubs the Langelier Manufacturing Co., Providence, R. I., is building the multiple-spindle drilling machine shown.

The two interchangeable multiple heads are carried in sliding housings, which are actuated simultaneously by the single feed lever at the right. The power is transmitted to the heads from the floating pulleys through double splined spindles. The jigs are self-contained in the heads, being located by a central keyed spring plunger. The first part of the movement of the heads clamps the work between the two jigs, while further motion feeds the drills through the work.

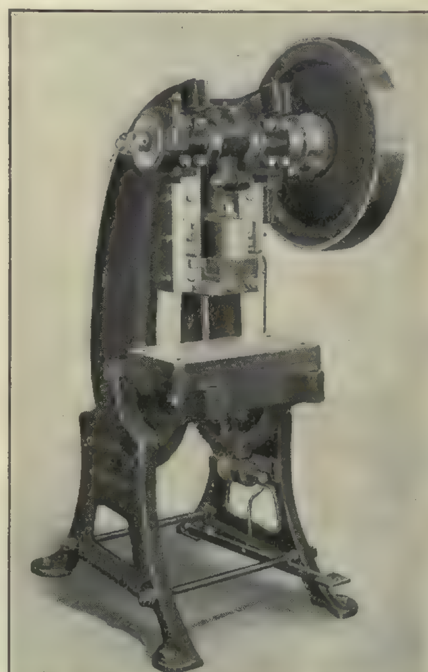


MULTIPLE-SPINDLE DRILLING MACHINE

If the holes are spaced on very close centers, alternate holes are drilled at the first operation, the piece then being indexed by means of a spring plunger that engages one of the holes already drilled. A second operation finishes the holes. A new piece of work may be inserted the moment the drills are withdrawn, as the construction is such that the piece drops out of the jigs by its own weight. Micrometer adjustment is provided for the drills, while a single stop suffices for both heads. The machine is equipped with an automatic system for furnishing lubricant for the drills.

Open-Back Inclinable Press

The Loshbough-Jordan Tool and Machine Co., Elkhart, Ind., is marketing the open-back inclinable press shown. It is equipped with a solid web flywheel containing a three-point clutch. A toggle control is used for the clutch, for the purpose of preventing the press from repeating. Upper and lower knock-outs are provided, and the screw and ball connection are in one piece. All bearings are self-oiling, and a worm and wheel device serves for inclining the press. Provision is made for removable tie-rods, if these are desired. A safety device is used for the lock bolt.



INCLINABLE PRESS

Weight, 2000 lb.; weight of flywheel, 365 lb.; size of flywheel, 27 x 4 in.; speed, 115 r.p.m.; opening in bed, round, 8 in.; oblong, 5 x 10 in.; opening through back, 10 in.; depth of throat, $6\frac{3}{4}$ in.; die space on top of bolster plate, $6\frac{1}{2}$ in.; distance bed to gibs, $10\frac{3}{4}$ in.; stroke, $2\frac{1}{2}$ in.; slide adjustment, 2 in.; thickness of bolster plate, $1\frac{1}{2}$ in.; square hole in slide for punch-holder shanks, $1\frac{9}{16}$ in.; floor space, 34 x 43 in.

Bench Stool

The stool shown in the illustration has been placed on the market under the name of the "Sampson Suspension Stool" and is intended especially for shop or factory use.

The device is bolted to the under side of the bench top and when not in service swings in under the bench, as

BENCH STOOL FOR FACTORY USE

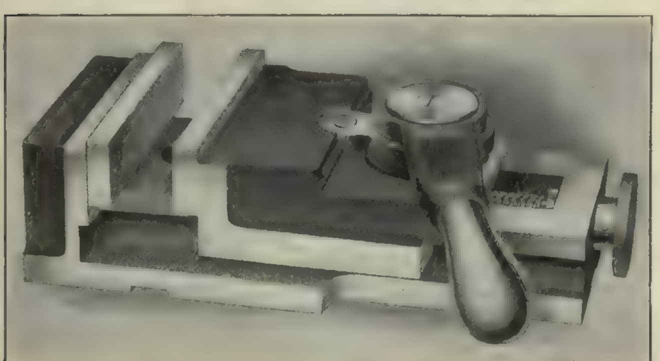
shown at the left, thus leaving the aisle space clear. The inner end of the arm rests against the base and acts as a friction lock for holding the stool rigidly in any position when the operator's weight is upon it. The stool may be readily swung to any position, however, when the operator's weight is not upon it.

All parts are of metal except the revolving seat, which is of wood, filled and varnished. If so desired, the seats can be furnished with elevating screws instead of the standard pivot. The American Engineering and Equipment Co., New Haven, Conn., is the manufacturer.

Quick-Acting Vise

A vise combining the old-style screw with a quick-action cam has been placed on the market by the F. C. Sanford Manufacturing Co., Bridgeport, Conn.

The adjusting screw runs in a floating nut, to which the cam is attached. In operation the vise jaws are



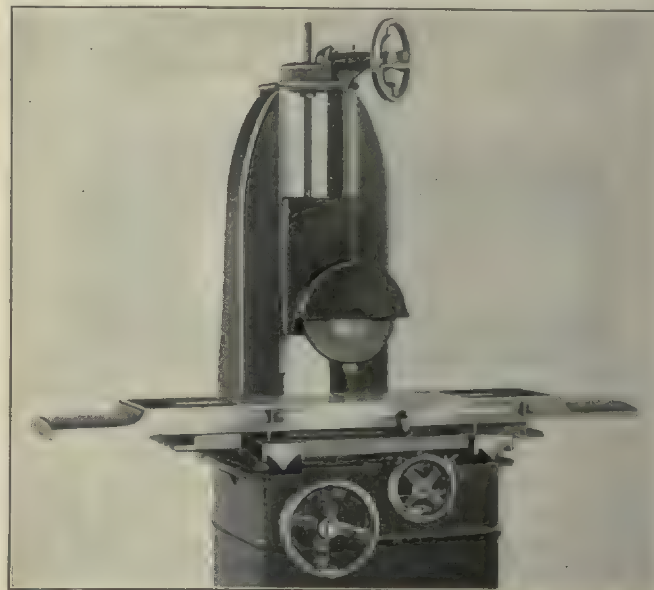
COMBINATION VISE

brought up to the work by the thumb-nut; then the operation of the cam locks the work tightly in place. The base and slide are of cast semi-steel, while all other parts are steel forgings. The jaws are hardened and ground square with the base. They are removable in order to permit the use of special forms, where these are made necessary by the shape of the work.

Surface Grinder

The machine illustrated, known as the No. 2 Reid surface grinder, is now being marketed by the Boston Scale and Machine Co., Boston, Mass. It is intended for work up to 18 in. long, 6 in. wide and 12 in. high.

The spindle is hardened, ground and lapped and runs in bronze boxes provided for adjustment for wear. It is raised or lowered by means of the handwheel at the top, which is graduated to read to half-thousandths. The table travel is automatic and is controlled by means of stops and



SURFACE GRINDER

Takes wheels to 7 in. in diameter and ½-in. face, with ¾-in. hole; working surface of table, 18 x 6 in. with three T-slots; longitudinal feed, 18 in.; crossfeed, 6 in.; vertical adjustment, 11½ in.; crossfeeds, 0.007 to 0.084 in.; floor space, 65 x 30 in.; weight, 1300 lb.

a reversing lever. This lever can be turned down so that the table can be operated beyond the reversing points without changing its positions of the stops. The transverse table feed is also automatic and may be set to feed in either direction. The positive crossfeed will feed from 0.007 to 0.084 in., either at one or both ends of the stroke. A quick starting and stopping device is used, operating from a push rod at the center of the handwheel. The machine has the cabinet type of base, a door providing for the storage of tools in the interior. A countershaft is included with the equipment.

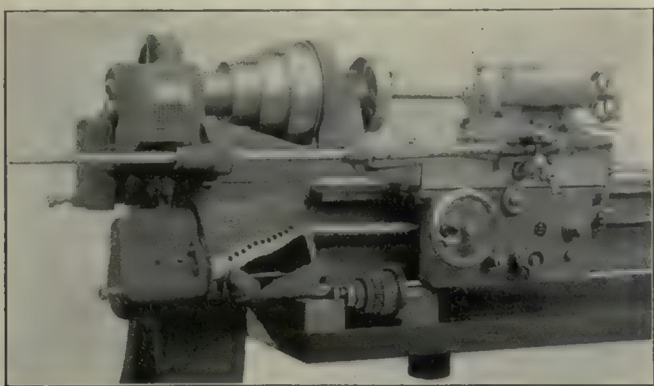
Compound for Hardening High-Speed Steel

The Bennett Metal Treating Co., Elmwood, Conn., is marketing a high-speed steel hardening compound known as "HeTzy," which is a black gritty substance a little coarser than granulated sugar. In use an ordinary case-hardening pot is filled with alternate layers of the hardening compound and the tools to be hardened, luted with fireclay and placed in a furnace heated to 1700 or 1750 deg. F. When the whole mass has been heated to this temperature, the tools are quenched and are ready for service. The compound can be used indefinitely, heating does not cause it to lose its ability to harden high-speed steel.

Relieving Attachment

The Cincinnati Iron and Steel Co., Cincinnati, Ohio, has put on the market the relieving attachment shown in the illustration. It is driven from the outside end of the spindle through a series of change gears, six gears being the number required to obtain the proper changes for cutting 1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 14, 16 or 20 flutes.

The driveshaft is journaled in a bracket on the carriage, and the sliding end can be made long enough to suit any length of bed. Two universal joints, a shaft and a sleeve, are used to transmit the motion from the drive to the camshaft, the slide and swivel movements being thus compensated for. Relieving may also be done in connection with a taper attachment. The camshaft runs in bronze bearings, but may be easily removed for placing cams.


RELIEVING ATTACHMENT FOR LATHES

Hardened steel is used for the cam roller and slide. The slide is connected with the top slide screw and has a spring rod with adjusting nuts that govern the amount of throw or relief required. These are also used to hold the slide and roller away from the cam when the compound rest is needed for regular work. The gears are guarded, and an index plate is provided.

Fluid for Marking Tools

The Artisan Chemical Supply Co., Detroit, Mich., is marketing a fluid compound for the purpose of marking tools. It is known as "Nasitra." The material leaves a black metallic deposit on the surface of the metal marked. The use of wax or asphaltum varnish is unnecessary, the fluid being applied with a pen or a sharpened stick.

Stripping-Plate Molding Machine

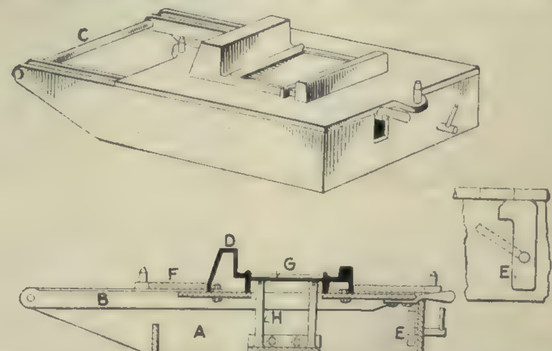
By J. V. Hunter

Practically all foundries doing repetition work have use for stripping-plate molding machines. The majority of such machines on the market are more or less intricate and costly. Yet any shop with a drilling machine can make up the type of stripping-plate machine illustrated herewith, although for the sake of uniformity and accurate work the use of a planer in finishing up the rough castings is of great advantage.

The machine is intended for shallow patterns with sloping sides that will recede rapidly from the sand face of the mold when lowered, since the lowering is not in a true vertical plane. This device consists of an open shell or cast-iron box *A*, which has two hinge arms at least a foot in length extending out on one side. The longer these arms the more nearly in a vertical line will be the withdrawal of the pattern.

The moving part is the long swinging lever, with two arms *B*, pivoted upon the same shaft *C*, held stationary by the arms of the main body; these arms are joined together by the planed plate that supports the pattern *D*. The result is that, when the latch *E* is released, the lever arm, plate and pattern all fall downward in an approximately vertical plane, stripping the pattern through the plate *F*, which closely follows the outlines of the pattern. Any metal-pattern worker or machinist engaged in finishing this class of machine-molding patterns will appreciate the clean sharp edges of the mold obtained by thus stripping through a plate.

As will be noticed in this particular case, the center of the pattern presents a broad area where the sand might have a tendency to fall away with the pattern while it was being lowered; to obviate this tendency, the center is made in the form of a loose plate *G*, which is supported by the stool *H* extending across between the two sides of the main frame to which it is bolted. So when the pattern is lowered, the plate *G* acts about the same as an individual stripping plate supporting the sand in this pocket until the mold is lifted off. A small forged handle bolted to *B* extends through a slot in the frame and serves for raising the pattern for the next mold.



HOME-MADE STRIPPING-PLATE MOLDING MACHINE

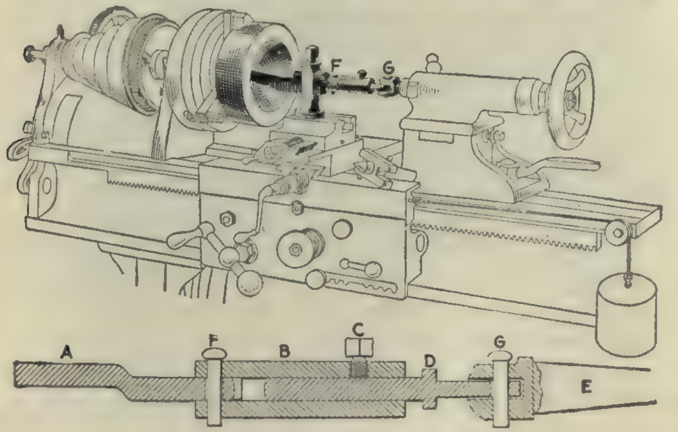
It is to be noticed that all parts of the pattern in a parallel line with the shaft *C* should have more draft than is provided in other stripping-plate machines, owing to the fact that they must necessarily swing somewhat as they go down; and therefore it is always advisable for this reason to put the portion of the pattern possessing the greatest draft at the end having the shortest radius—that is, toward the shaft *C*.

In making up the pattern for the stripping plate there is one point that, if carefully observed by the patternmaker, will save a great amount of tedious labor for the machinist who will have the finishing of the cast-iron plate: this is to bevel the edges, which will strip next to the pattern, at a very sharp angle on the bottom side, leaving a corner about an eighth of an inch thick at the top. The hole for the pattern is always necessarily made slightly smaller to provide for filing to a close fit, so when the greater portion of the casting has already been cut away by the bevel, the small remaining portion makes for easy and rapid fitting. Another reason for this bevel is that no opportunity shall be presented for sand to fall in and bind between the sides of the pattern and the plate.

Concave Turning

By Charles W. Parker

I was given a number of cup bearings to turn out at a given radius to suit the spindle of a sand roller. We had no means of doing the job in the small shop where I am employed, except perhaps by turning it out



CONCAVE TURNING OUTFIT

by hand to a gage. I decided to make the lathe attachment shown. It proved a success, and the job was done in a quarter of the usual time.

The center *E* is made to fit the tailstock, while *A* is held in the toolpost on the top of the tool. The piece *B* is bored to suit the part *D*, which is adjusted and held in position by the setscrew *C*. The required radius is obtained by setting *F* and *G* the correct distance apart. Centers in these pins facilitate measuring. The part *D* can be graduated to assist in setting.

The tool is started from the center of the job, the cut being fed by screwing the tail spindle forward as required. The crossfeed is set to work from the center outward, while the carriage is gradually drawn back by the weight, as shown above. This operation is both quick and accurate.

Automotive Engineers Prepared To Work with Government

The Society of Automotive Engineers has been active in classifying its membership as to capability for Government service industrially or with the troops. Over two thousand members have filled out blanks indicating their experience in designing and producing engines and other parts for airplanes, motor trucks, watercraft of various types, tractors and munitions. Men have been classified according to the following callings: Chief engineers, assistant engineers, draftsmen, electrical engineers, superintendents, metallurgists, inspectors, apparatus testers, laboratory engineers, truckmasters, purchasing agents, service men, tool designers, executives, chemists and fuel and lubricant engineers. Trained in the most highly organized industry the world has ever known, these members are well qualified to solve any automotive problems on which the Government may desire assistance. They are quite ready and willing to do anything that will assist the United States, serving in any capacity in which their country may see fit to use them at any time.

Personals

C. H. Roberts has been appointed comptroller of the Hess-Bright Manufacturing Co., Philadelphia, Penn. He was formerly factory accountant.

S. T. Gorman, formerly Eastern representative for the Canedy-Otto Manufacturing Co., Chicago Heights, Ill., has been appointed general sales manager.

W. C. Woodland, of the Packard Electric Co., Warren, Ohio, will become consulting engineer of the Steere Engineering Co., Detroit, Mich., on May 1.

W. B. Bennett, formerly with the Locomobile Co. of America, Bridgeport, Conn., has been appointed chief engineer and general manager of the Wayne Engineering Co., Honesdale, Pennsylvania.

G. W. Rice has resigned as works manager of the Aultman & Taylor Machine Co., Mansfield, Ohio, and is now assistant general factory manager of the Curtiss Aëroplane Motor Corporation, Buffalo.

C. Eccles has been elected president and manager, and **C. F. Bulotti** has been elected secretary, of the Eccles & Smith Co., dealers in machine tools at San Francisco and Los Angeles, Calif., and Portland, Oregon.

William A. Rockenfield, formerly engineer and sales manager of the American High Speed Chain Co., Indianapolis, Ind., is now production engineer of the Baldwin Chain and Manufacturing Co., Worcester, Massachusetts.

S. S. Macintosh, formerly with Strong, Carlisle & Hammond Co., Cleveland, Ohio, and **J. G. Nixon**, formerly with the Chambersburg Engineering Co., Chambersburg, Penn., have become associated with the Cleveland office of Manning, Maxwell & Moore, Inc.

M. C. Maxwell, formerly superintendent of the power and plant and of the tool-machine department of the Yale & Towne Manufacturing Co., Stamford, Conn., has been appointed assistant general superintendent. **A. O. Blackman** has been appointed superintendent of power and plant, and **J. B. Freysinger** has been made superintendent of the tool and machine department.

Business Items

The Sullivan Machinery Co., Ltd., Chicago, Ill. will move its Montreal branch to 37 Colborne St., Toronto, Can., on April 15.

The August Mietz Corporation, New York City, has bought the business of August Mietz, Emma C. Rueff, proprietress, and will carry on the business.

The Mid-West Brass Manufacturing Co., North Aurora, Ill., has recently been incorporated. The officers are: P. W. Blair, president, and J. F. Berthold, secretary and treasurer.

The Poole Engineering and Machine Co., Baltimore, Md., through a consolidation, has acquired exclusive manufacturing and selling rights of the turbo-gear formerly manufactured by the Turbo-Gear Co., Inc., Baltimore.

A. J. Corcoran, Inc., was erroneously reported to have moved its offices from Jersey City to John St., New York City. The notice should have read that the offices at 11 John St., New York City, would be moved to the factory at 761 Jersey Ave., Jersey City, on May 1.

The Pangborn Corporation, Hagerstown, Md., has purchased the sandblast business conducted by E. E. Perkins and G. A. Cooley, Monadnock Block, Chicago. Mr. Cooley joins the Pangborn Corporation, while Mr. Perkins will handle a line of condensing driers and dry kilns.

The Union Chain and Manufacturing Co., Seville, Ohio, has increased its capitalization from \$40,000 to \$60,000, the increase being in the form of a 7 per cent. cumulative preferred stock. The company's New York office has been removed to 30 Church St. O. J. Abell is in charge of the Chicago office at 565 Washington Boulevard.

Forthcoming Meetings

The Society of Automobile Engineers will hold its annual convention at Ottawa Beach on Lake Michigan during the last week in June.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The National Metal Trades Association will hold its next convention on Apr. 25 and 26 at the Hotel Astor, New York City. A meeting of the administrative council of the association will be held on the day preceding that on which the convention opens.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

The Society for Electrical Development, Inc., will hold its annual meeting in the United Engineering Societies' Building, New York City, on May 8.

The American Society of Mechanical Engineers will hold its annual spring meeting at Cincinnati, Ohio, May 21 to 25. There will be a joint session with the National Machine Tool Builders Association on May 21. The headquarters will be at Hotel Sinton.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796 Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1735 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

Increasing the Shop's Output by Shifting Shifts

By C. A. Hubbell*

SYNOPSIS—Dividing the day into three shifts and then changing these shifts so that every man gets a chance at day work as well as night work seems to have many advantages over the usual method of night work. This article tells how the plan has been worked out successfully in one plant.

Whenever the demand for product exceeds the normal output of a shop during the period that passes for a day's work, the management is confronted with one of the most trying problems that arise in manufacturing. Whether the day's work be eight, nine or ten hours (although the latter has almost disappeared in most sections of the country), there is a general reluctance to work more than the regular period. We all form habits of work as well as of other kinds and do not readily conform to a longer period in any direction requiring mental or physical labor.

Working overtime, or night work as we generally know it, has many objections, although it is often necessary to resort to it for limited periods. This requirement always involves extra payment or at least a controversy in regard to it and is often a source of discontent, if not acute friction. Then too, it is next to impossible to get a proportionate amount of work in a long day, so that the cost per piece always rises when night work or overtime is employed to any great extent. The best men object to working at night; and it is never easy to get a night force that equals the day shift in capacity, while an equal output is practically unheard of. Probably the difference between daylight and artificial light is responsible for more of this variance than we are apt to realize. But even with the best lighting, there seems to be less energy available in a man who works always at night.

The problem would be easier, perhaps, if the increase of business was sufficient to require a night shift all at once; but on the other hand, the gradual increase has its advantages and allows one to prepare for it by easy steps. The question of foremen or other executives for the night force is another serious problem, as here, too, the best men naturally prefer the day jobs in nearly all cases.

The usual plan of doubling up is to begin by putting on a small night force, often expecting the men to work from 12 to 13 hours, but paying them at a higher rate than the day men. This arrangement involves the employment of a night boss and introduces the possibility of friction with the regular, or day, man. And this is only one of the problems that beset a manager who knows that it is necessary for him to get more hours of product out of his machines rather than to increase his plant, even if he could purchase the extra equipment, which has been largely out of the question during the past two years.

Finding the demand for product far exceeding the capacity of our machines, it became necessary to run the plant more hours, and the usual night-shift plan was adopted. But no man likes to be continually on the night force, nor was it possible to get from the machines the production that we knew ought to be secured. So it seemed advisable to try another plan, and the three-shift method was gradually introduced. By going at radical changes of this kind gradually and sympathetically the complete coöperation of the men was secured, and comparatively little opposition developed.

We began with the automatic screw machines and soon had three shifts of men who could handle them in good shape. Each shift has a man who thoroughly understands setting up the machines, so that any adjustments can be made immediately, which not only saves delays, but also reduces spoiled work to a minimum. Next came the hand

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screw machines of various types and lastly the regular machine work, such as lathe and milling work, so far as it became necessary. The toolroom was also put on the three-shift plan to some extent, as tools wear out rapidly in continuous work and it is essential to have a constant supply.

The screw-machine department gives practically no trouble in changing from one shift to another, as the work is continuous and it rarely happens that a run of any piece finishes with the end of the working period. The hand screw machines are more difficult, as every man naturally feels that he is the best operator on that machine and that his ways are best. In the beginning there were complaints as to machines and tools, particularly the latter, not being left in good condition for the man on the next shift. Then, too, each man has a different notion as to the tool set-up in many cases, and considerable time is lost in changing over to suit the new man. So, while I believe in giving each man as much latitude as possible in handling his machine, it becomes necessary to restrict the individual tastes to some extent when three men use the same machine, one after the other. This was largely a matter of getting the men adjusted to work together, and a little instruction and explanation soon straightened out the difficulties so that these troubles have disappeared.

Secure Harmony by Personal Contact

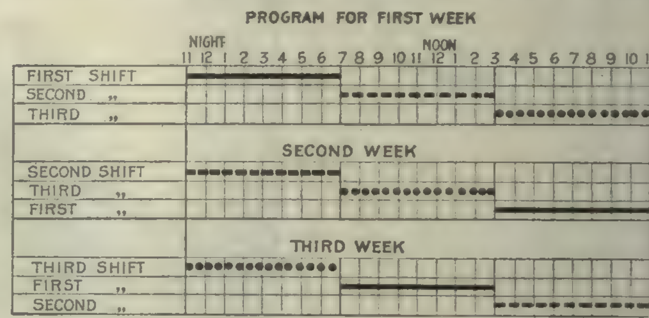
Regular machine work was more difficult; but as the three shifts were only necessary on such work as might be called manufacturing operations, they were also adjusted by personal inspection of the work, the careful adjustment of any difficulties that arose between men and, in fact, the harmonizing of the personalities of the working force. Hard and fast rules are obviated as far as possible and personal settlements made in every case in which it is admissible. Personality plays an important part in adjusting differences and in securing smooth and successful operation of any plan, especially if it is out of the ordinary. A spirit of fairness in making these adjustments keeps things running smoothly.

The toolroom was perhaps the most difficult place to get the three shifts into satisfactory operation, but it has been successfully accomplished as far as it is necessary to operate this department on the three-shift basis. Here again there is a flexibility that takes care of the unusual cases. Some work can be carried on by the next man as well as by the one who started it, and this is always done where possible, especially if it is a piece that is needed badly in the shop. Where the piece is so intricate that it seems desirable to have it finished by the one man, the work is left until he comes in on his next shift, even if it must remain on the machine, keeping the latter out of use during the two intervening shifts. This is of course to be avoided wherever possible. In other cases the work can be laid aside to wait for the original toolmaker, but without tying up the machine until he returns. These are all classes that must be decided individually by the foreman and call for good judgment.

One of the great problems is that of superintendence. Two men handle this very well, as the foremen of each department can manage the work for hours at a time, so that it is not necessary for the superintendent to put in too many hours at a stretch. The main thing is to have some supervision when the shifts are changing, so as to insure the new shift's getting started right. This result is secured with a little coöperation on the part of the two superintendents and the foremen and has given very little trouble. Where the foremen change with each shift, it is desirable to have the foremen shift at a different time from the men, so that they lap over and get the work running smoothly from one shift to the next.

Shifting the Shifts

One of the main reasons for our success is the method of arranging the three shifts. These start at 11 p.m. Sunday night and work through the week until 11 p.m. Saturday night, the shop standing idle during the next 24 hours. This arrangement makes the shifts from 11 p.m. to 7 a.m., from 7 a.m. to 3 p.m. and from 3 p.m. to 11 p.m. The shifts are changed every week, so that no one works continuously at night, but all take turns at the different shifts. The 24-hour shutdown makes this plan successful—in fact, gives a long rest between the shifts instead of working double shifts at the change.



SCHEDULE FOR SHIFTING THE SHIFTER

In making the shifts the man who quits work at 11 p.m. Saturday night does not go on again until 7 a.m. Monday; the man who quits at 3 p.m. Saturday goes to work at 11 p.m. Sunday night, and the man who quits at 7 a.m. Saturday morning goes on the job again at 3 p.m. on Monday. Each man gets a chance at all three shifts, so that there is no favoritism shown and all have an equal chance. There is no noticeable difference in output of the three shifts, except such as is found in every shop due to the difference in the production capacity of different men. This in itself is somewhat unusual in working a shop more than one shift and is highly desirable. The plan secures the best of coöperation from the men and has worked out very satisfactorily for all concerned. It is not perfect; no plan ever is; but it is the best we know so far and has successfully handled the growth of the shop from 125 to 350 employees.

Sammy's Shop—Selling Quality, Not Perfection

By W. Osborne

Mr. Brown walked up to Sammy with a broken part of a cornsheller in his hand. It was a casting that had broken at a place where several sections were joined. In the middle of the broken section was a spongy draw spot of quite liberal size.

Mr. Brown pointed to this spot as he said, "A customer has returned this defective piece with the demand that we replace it and that we also pay the cost for the repairs the machine will need before it is in good running shape."

Sammy took the piece, examined it carefully and handed it back. "What do you think we ought to do?" he asked.

"I think that we'll have to do as he says, and it'll be a pretty bad thing for us. A piece like that should never have gone out of the shop."

"I'm going to see the machine before I have anything to say," remarked Sammy, and he went out and hired a livery rig and drove into the country, although Mr. Brown opposed his going.

When he returned, accompanied by the farmer who owned the machine, Sammy was ready to express an opinion. "This man has no right to ask us for anything on account of the break, and you have no right to give it to him."

Mr. Brown looked surprised and the farmer looked angry.

"I suppose, young feller, that you'll try to claim that's a good casting," yelled the farmer. "Mebbe you'd like me to show it all over the neighborhood as the kind of stuff you turn out; and, by heck, don't you think they won't know it if you try any of your funny business on me," and he shook his fist in Sammy's face.

As the farmer was a big, husky fellow, nearly twice his size, Sammy did not accept the challenge of the fist. Instead he opened up a bag and took out several stones and some pieces of wood.

"Some of these pieces came out of the corn this man had piled up ready to be shelled, and some of them came out of the pile of cobs that had the corn shelled from them. From the marks on some of them it's safe to assume they've been through the cornsheller." Turning to the farmer, he asked, "What did you find in the cornsheller just after the break besides an ear of corn?"

"I didn't come here to talk. You didn't do much talking out at my place. You didn't dare to; and it isn't going to do you any good doing it here. You're going to make this right or I'm going to know the reason why," threatened the farmer.

Mr. Brown started to say something, but Sammy interrupted him. "I want this thing settled right, too, if I'm to keep on making cornshellers, and I am not through talking yet." He passed a piece of hard wood to Mr. Brown.

Stove Wood in the Cornsheller

"Almost any man ought to know enough to keep his stove wood and his corn separate. There's the piece that broke the machine." (Sammy had been at the farm some time before the farmer knew it. The farmer had a number of small children who, childlike, were interested in everything and also talkative.) "When we make a machine that's good enough to do the work we say it'll do, we've done our share. We're not selling perfection any more than you are when you're selling your farm produce. I'll bet that you couldn't deliver a perfect bushel of potatoes at any price. Do you sell the kind of stuff you take to exhibit at the county fair at the regular price?

"If you want perfection, you'll have to pay a different price than the one you pay for a cornsheller. Oh, I know what you're going to say about that spot in the casting, but I want you to wait, both of you, before you say it. The big trouble is that you don't know what you're talking about. Let me show you something."

He took them across the shop to the side door. Here there was a worn-out cornsheller that had been turned in as scrap by a man who had bought a new one. The machine looked as if it had seen long and hard service.

"Look at the shop number stamped on this machine," said Sammy. "We can tell from the office records just when this sheller was sold. The machine itself shows that it's done a lot of good, hard work. Here's the piece like the broken one. Notice how it's worn?"

Sammy took the piece off, and with a sledge broke through the part where the other one had broken. The same sort of a draw spot was disclosed.

"If anybody knows how to make that casting and have it dense in there he keeps it a secret. Ordinary foundrymen who are running foundries don't know how. You came here in a rage and demanded that we make it right with you. I think that after what I've shown you I have a right to ask that you make it right with the shop." As he saw the look on Mr. Brown's face he explained, "I'm not talking from a selling or office end.

Commercial Quality at a Commercial Price

"This man has cast unjust reflections on the shop and on every man in it. I'm willing to admit it was more through ignorance than through malice, but for all that I don't think the shop should allow such things to go unchallenged. There is a commercial quality. There is a commercial price that it is sold for. If the users of such machines are not suited with either, they don't have to buy. The office resents any criticism that's aimed at its commercial honesty, but it allows all sorts of criticism of its shop and the shopmen.

"Why, confound it all, Mr. Brown, when Seth Blank came in and said you were a robber, and were trying to make him pay a bill that he had paid, you told him very quickly to either show a receipt or pay that bill and shut up; but when old Cat Hollow Jones comes in with things all smashed up you call me in to prove that it wasn't our fault. We were held to be guilty until we proved we were not. If you remember, I went out and found that he had been moving the machine and the team ran away. Then there was that machine we sold to that farmer out on the hill road. It wore out too quickly. The air around here was filled with talk about soft iron and holes and shafts that might not have been round, and a lot more stuff that reflected on the shop, but there wasn't a word about the fact that the man who bought that machine drove a wagon that always groaned and squealed because he never oiled it. He never oiled that cornsheller either, if appearances count for anything.

"I'm running this shop, and I'm tired of having things blamed on us before they are proved; and I'm going to kick every time it happens."

The farmer was not a bad sort, and Sammy's outburst restored him to good humor. "I wish you'd study up about how to use the King drag on dirt roads and come out and make a speech for us in the schoolhouse," he said.

"Mebbe a fellow running a shop has his troubles too, even if he don't have to fight worms and bugs and things."

You are not getting all that was said, but it may interest you to know that the farmer took a new piece with him, and he paid for it too. Today he is a good friend of the shop.

Construction Features of the Canal Shops at Balboa

EDITORIAL CORRESPONDENCE

SYNOPSIS—Floor, roof and side-wall requirements in a shop building located in the Canal Zone are far different from those in the northern part of the United States. Illustrations show many of the features of construction.

These shops in most instances are equipped with movable metal louvers along the sides and ends, the louver blades being made of galvanized iron ⅛ in. thick and arranged in rows about 5 ft. long so that there are four rows in each 21-ft. shop bay. The blades have a width of 16 in., and when raised there is a clear space between them of 14⅜ in. The louver sections are carried upon the top surface of a concrete wall 6 in. thick and extend up under the overhanging roof to keep out the rain. The arrangement of the louvers and also of the rolling doors referred to in the first section of this article is illustrated clearly in Figs. 2 and 3, which represent the end of the boiler shop, shown in the first instance with the louvers open and the rolling steel doors closed, while the second view shows the doors and most of the louvers wide open, the doors rolling up under the projecting eaves of the structure. These views are presented as characteristic of the closure features of most of the main-shop buildings at Balboa, though there are other types in use in certain cases, as some of the buildings had to be totally inclosed while others required no closing at all.

FIG. 1. LOOKING TOWARD THE OPEN SHOP END

The appearance of the end of the machine shop with louvers and rolling steel doors wide open is well brought out by Fig. 1, which is reproduced from a photograph taken inside the building and looking directly toward the open end. It illustrates the great amount of open area thus secured and shows the ample clearance obtained for the passage of the overhead traveling crane, which operates on runways extending well out from the end of the building. A series of louver blades, it should be stated, is operated by a single lever. This actuates a shaft which is connected by a link to each row of louvers so that the blades of a series open and close together when the lever is manipulated. The machine shop, erecting shop and tool department are in the building at the end of the group of structures shown on the plan, Fig. 5, page 311. This building is 360 x 190 ft. and consists of two monitor-roofed structures with a sawtooth section between, as represented by the drawing, Fig. 4, and by the halftone engraving, Fig. 5. The latter view

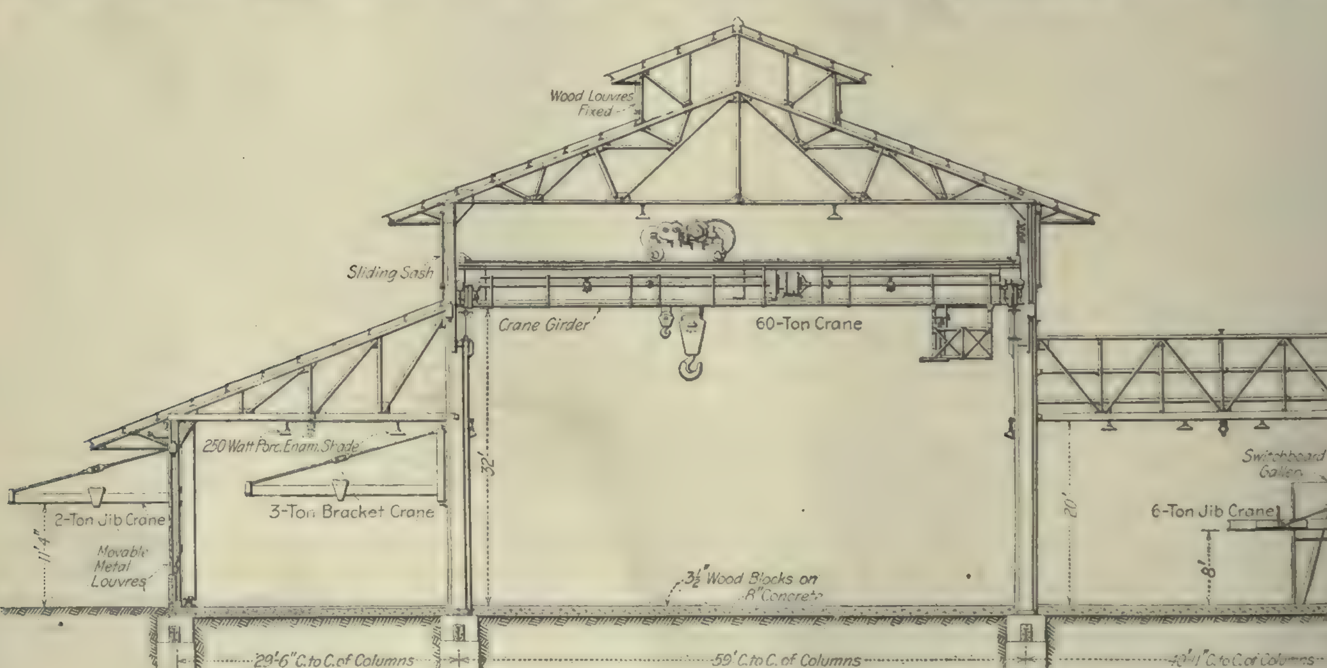
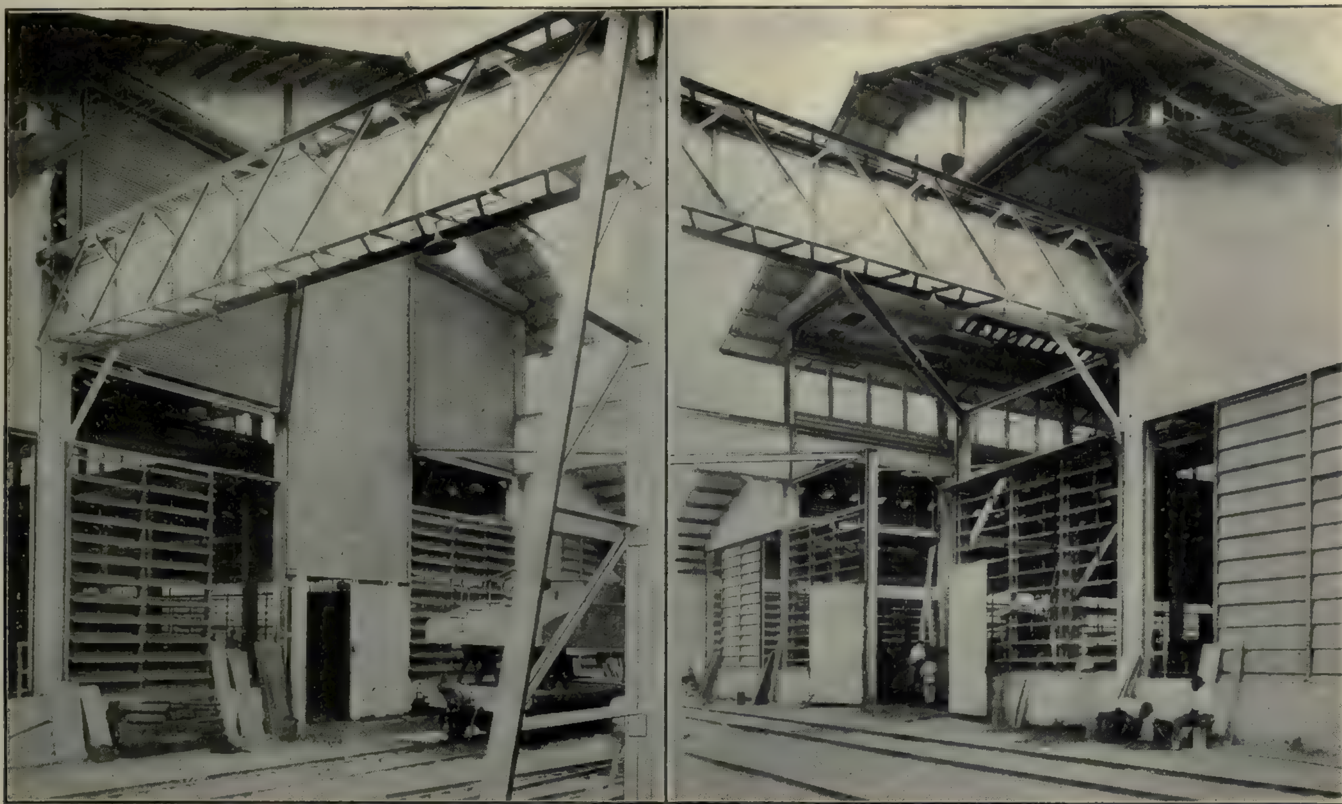


FIG. 4. SECTION OF THE MACHINE-SHOP BUILDINGS, SHOWING THE TYPE OF

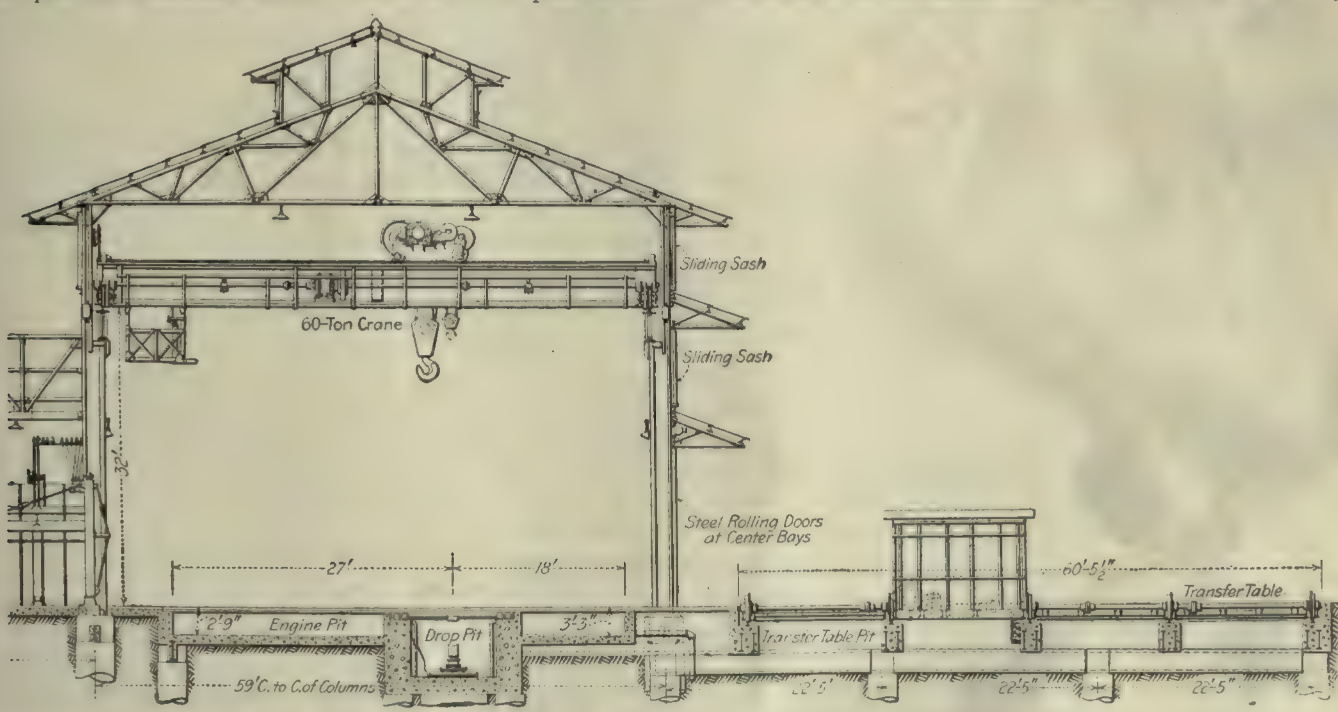


FIGS. 2 AND 3. THE BOILER SHOP, SHOWING THE STEEL ROLLING DOORS OPEN AND CLOSED

shows clearly a detail of the south end of the sawtooth aisle and the arrangement of roof lights, windows, etc.

Referring to the drawing, this gives the principal dimensions of the building proper, shows the arrangement of steel rolling doors, louvers and the like and the general features of monitors, sawtooth sections, crane runways and so on. Of further interest are the construction features relating to foundations, piers, structural members, method of supporting craneways for the 60-ton travelers, position of transfer table and location and form of pits for locomotive work. There are four pits at one side of the shop, one of them a drop pit, and about one-half of the erecting aisle is utilized for heavy repair work on engines and other heavy equipment, such as steam shovels, dredges and various other similar machines that are used in canal work.

At the opposite, or east, side of the building, as will be seen from Fig. 4, there is a lean-to 29 ft. wide which is fitted with suitable jib cranes and equipped with the smaller tools, planers, slotters, shapers, etc. The general layout of the tool equipment in the main shop will be considered in another article that will follow shortly.



CONSTRUCTION USED AND THE ARRANGEMENT OF THE VARIOUS CRANES, PITS, DOORS, ETC.

As will be noticed upon inspection of the drawing, the floor of the machine shop consists of $3\frac{1}{2}$-in. wood blocks placed upon 8 in. of concrete, one strip of blocks being left out about every 30 ft. and the opening filled with pitch, thus forming a joint to allow for expansion of the blocks due to the dampness of the climate. This type of floor is also used in the planing mill. This is a feature that is very important when a climate similar to that of the Canal Zone has to be contended with. In the foundry a clay floor is provided, while cinders are used in the forge and boiler shops. The storehouse, pattern storage, power plant, gashouse and toilets have concrete floors, and the steel-storage building, car shop, lumber shed and coke shed have earth floors. The machine shop, like most of the other buildings, has a tile roof, the tile being manufactured on the Isthmus, thus saving the large shipping expense which would be incurred if the material were imported. All the machines in the shop are electrically driven, the current coming to the plant at 2200 volts and the motors operating at 220 volts. The current is three-phase, 25-cycle. The lighting is by tungsten filament lamps on 110-220-volt circuits, and general illumination is provided throughout.

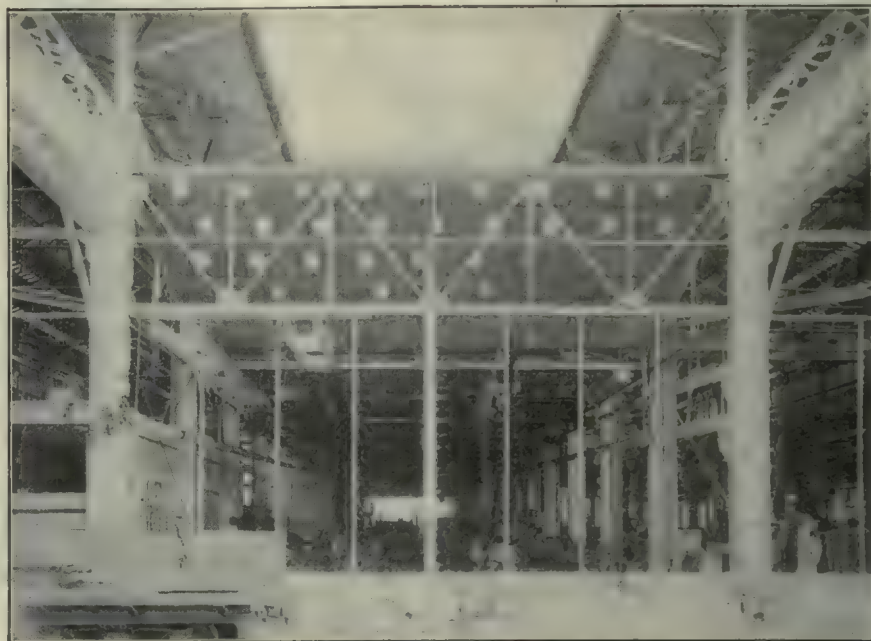


FIG. 5. DETAIL OF SOUTH END OF SAWTOOTH AISLE

Method of Training Mechanics in an Isolated Plant

By E. J. Leach

As superintendent of a factory employing 300 men and making very accurate interchangeable parts, I am constantly faced by the problem of getting high-class toolmakers. As we are somewhat isolated, we must not only keep in repair, but build, all the tools for an increasing production.

My method is to select carefully from a large number of unskilled applicants boys whom I think have the intelligence and mechanical instinct to make good mechanics. That is no easy job. These boys are put to work in the productive machine shop on drilling machines, turret lathes and such work as they can handle. Here they learn to use a scale and caliper and to read micrometers. If my judgment is good and the boys show signs of learning rapidly, they are given the more accurate work as fast as they can do it.

After a few months' time they generally become familiar with operating lathes, millers and drilling machines and are able to work to very close limits. They are then transferred to the toolroom and allowed to turn up guide pins, bushings, cutter blanks and other simple work for the toolmakers to finish. I make it a point to see that each of the boys works for several of the older toolmakers, so that he gets the different methods used by these men.

They are all required to work for several months in the grinding room on Brown & Sharpe, Bath and Wilmarth & Morman grinders, and they also spend several months in the hardening room. In the grinding room, under the supervision of a competent man, they learn to set up and grind work very accurately; and in the hardening room they learn the principles, at least, of hardening steel. As they become capable of doing more accurate work, they are given cutters and simple jigs and tools to build completely.

I have been asked if it pays to go to all this trouble to train men and run the risk of losing them after spending the time and trouble to make them worth something. I believe that boys properly handled can be made to turn out sufficient work to pay for the trouble, even if they do not stay with you as long as you would like. Inducement can be offered after three years' service in the form of a check or a set of micrometers or some other useful tool. Most men are contented to work in a shop for a long time, if they are treated fairly and paid what they are worth. A man who has learned his trade in your shop and is familiar with your methods and work should be worth as much to you as to a man for whom he has never worked. If the manufacturers would try to give at least a part of their worthy men an all-round training, the men would soon learn that it is not necessary to go from shop to shop to gain experience.

Encouragement Necessary

The young man in the shop needs encouragement and advice. I make it a practice to stop occasionally by a workman and inquire what he is doing and how he is doing it or make some comment on his work. This especially applies to the apprentice toolmaker. He is given to understand that through his foreman he can arrange a time when he can see me and talk over any point that is troubling him. I might say that this opportunity is taken advantage of frequently, and a heart to heart talk proves beneficial to both of us. The apprentice sees that I have his interests at heart and am trying to help him, and I get information that I could not obtain from any other source.

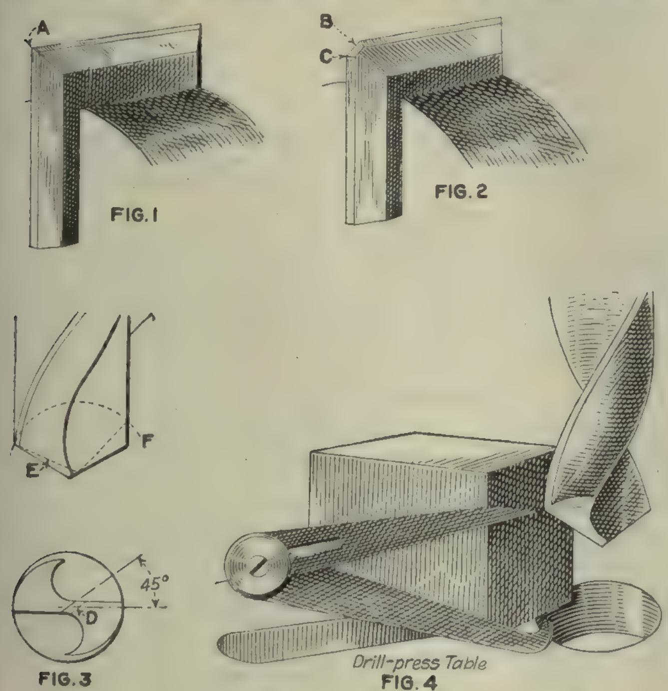
Toolroom Grinding

By J. B. Murphy

SYNOPSIS—In the following article and accompanying drawings an attempt is made to point out several toolroom errors that are frequently a source of trouble in the production departments.

Some of the more progressive milling-cutter and twist-drill manufacturers have issued fairly complete descriptive and instructive literature. That this descriptive matter can and should be much more comprehensive and so arranged as to be immediately available to the man in the shop I will endeavor to show.

For example, hand a shopman a copy of any twist-drill manufacturer's treatise on drill grinding. Let him read it clear through, then give him a 1-in. drill and require him to grind it correctly free hand. Ten to one an examination of the ground drill will cause you to reach the conclusion that somewhere and somehow something is wrong. Again, a milling cutter may be cutting rough and scratching the work. Read over all the cutter-grinding literature available and follow the instructions ever so carefully, and still it will be an even chance that the cutter will cut rough.



FIGS. 1 TO 4. CUTTER AND DRILL GRINDING

In this article I shall endeavor to take these and other matters of importance under a sort of semi-analytical consideration and explain methods I have successfully employed during the past five years on work of this sort.

Another matter deserving of consideration, I believe, is the little-known adaptability of certain grinders, especially the No. 2 Brown & Sharpe surface grinder and similar machines, to a very much wider range of work than many realize.

Particularly just at this time, when machine tools are so scarce and deliveries slow, are we interested in knowing just what work a given machine can do, not as a stunt or as an emergency, but as a profitable proposition. It is plainly impossible to cover any great part of the ever growing field of grinding in a single article, but I have chosen representative examples and will endeavor so to explain the job in hand that the class of work represented may be shown in a new and clearer light.

If we consider, first, Fig. 1, a Barber-Colman 6-in. inserted-tooth milling cutter, machining drop forgings, it will be seen at *A* that the grinder has left a sharp corner. Now, without concerning ourselves with the speed and feed at which the cutter is to operate, it will be sufficient to follow this sharp corner through a very few pieces of work.

Plainly, this corner changes from a cutting to a tearing corner, in proportion to its dullness. A frail unsupported corner, as this is, is dulled almost at once, and then the metal begins to freeze to the dulled corner and is pushed and torn from the stock.

Again, if this corner is removed with a 45-deg. cut or any other angle, as some of the best-known makers advise, the evil is by no means eliminated, only modified; and we merely postpone the minute when scrap work begins to come through. The reason for this is clear, for the objectionable corner is but moved a little farther up the side of the cutter (see *C*, Fig. 2) and, being somewhat more obtuse, is better supported; therefore, it will stand up better, but the sharp needle-point corner is still there. To grind this corner round would eliminate all angles, but it would also be impractical; yet this is what we have to approximate, but in a very modified form.

A Good Way To Sharpen Cutters

For some years I have experienced gratifying results in grinding milling cutters as shown in Fig. 2; that is, grinding the periphery parallel with the bore and with 1-deg. clearance on the side of the teeth, from point to heel, and chamfering the corner at 45 deg., as shown. Then, before the cutter is stocked in the tool crib, the corner *C*, Fig. 2, is well stoned to remove completely the sharp corner; in stoning, however, care must be used to preserve the clearance. Thus, the corner, the most important point of the cutter as well as the most troublesome, is replaced by a modified round cutting point.

Some, in objection, may point to the action and staying qualities of a diamond-point lathe tool in comparison with a round-nose lathe tool. In answer I have this to say: In turning, the diamond-point tool moves into the stock in an entirely different manner from that of a milling cutter. While a diamond point moves sidewise and cuts with the whole side equally, a milling cutter moves straight into the work, and the point, or corner, of the cutter must receive the full pressure of the cut. Here is where the trouble peculiar to milling cutters is generated, and the oilstone, liberally applied, will give the corner a good supporting backing.

In Fig. 3 is shown exaggerated how a drill may be ground with boths lips exactly equal in length, and still be far off center. The end view shows a good practical working clearance for general use—a clearance of about 8 deg.—and the center should show an inclination of about 45 deg.

Certainly, a hard and fixed clearance for all sizes of drills cannot be right, for the clearance must be governed by the feed to be used. Therefore, correctly speaking, a clearance that would be correct for a $\frac{3}{4}$-in. drill would not be right for a 2-in. drill, if the drill is to develop its highest efficiency and is expected to produce the greatest number of holes before becoming dull. Nor is this condition changed in any way by the fact that various grades of steel are used in the manufacture of drills, for the higher the speed at which a drill can be operated the greater the feed per minute that can be employed; hence, we complete the cycle and arrive at the beginning.

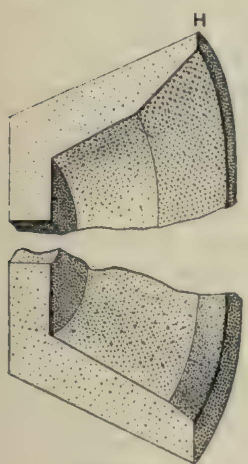


FIG. 5

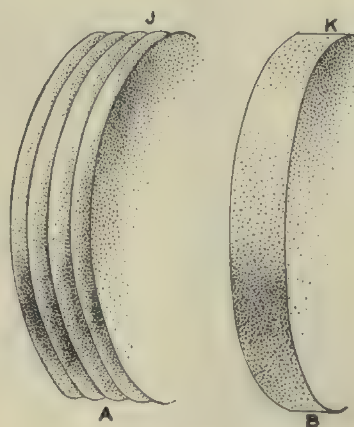


FIG. 7

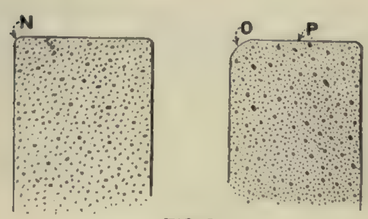


FIG. 6

FIGS. 5 TO 7. VARIOUS METHODS OF DRESSING WHEELS

Owing, however, to the imperfect design of the various drill grinders in general use, we have of necessity effected a compromise in this matter, but I will try to show the most practical way to obtain the different angles and clearances recommended.

In the end view, Fig. 3, it is shown that the index of clearance, or the central web, is ground to show a clearance of 45 deg. with the lips of the drill. This angle, being a very familiar one to us all, is easily approximated by eye and is a correct angle for drills in general, if we have to adopt one angle for many sizes of drills. Care must be exercised, however, to keep this center truly central, for partly because of the twist of the drill and partly because of the inaccuracy of the human eye, it is the rule that all drills ground by hand are out of center more or less, as shown at *D* and *E*. At the same time the lips may be of exactly the same length, as shown at *F*. A drill so out of center will throw the burden of cutting upon that lip forming the more obtuse angle with the longitudinal center line of the drill. A glance at the drawing will make this point quite clear.

Now, it is known that such a drill will stagger and crowd in going through the work, producing to a greater or less extent an elliptical, rough and possibly a "belled" hole, all of which are things to be carefully avoided by the producing man of the shop.

In Fig. 4 is shown a method of testing a newly ground drill. The drill is placed in the drilling machine in which it is to be used; the drill may run out slightly, especially if the hole is to be reamed, and the principal test should be for true center of lip angle. This may be ascertained by a surface gage or by holding a pair of hermaphrodite calipers on the table and against a block, as shown in the drawing; revolving the drill will complete the test.

The angle of each lip is, by common practice, 59 deg., or one degree less than a lathe center, for a good bearing. The clearance to the heel of the cutting edge may be about 8 deg., notwithstanding that a greater clearance is often specified. Care should be taken to see that the drill is placed against the grinding wheel at or a little above the center of the grinder spindle, to avoid a tendency to back rake the cutting edge.

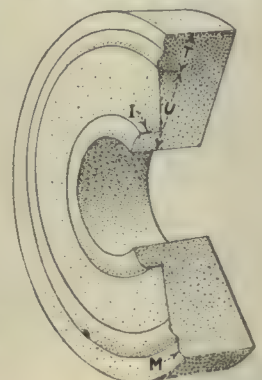


FIG. 8. USING THE IDLE SIDE OF THE WHEEL

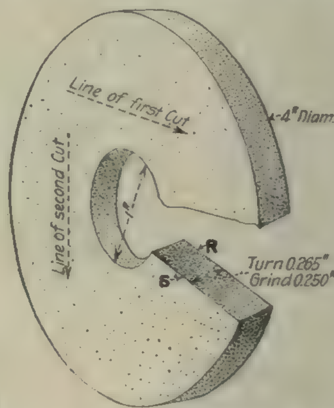


FIG. 9. AN INSPECTION GAGE REQUIRING SKILL AND WELL-DRESSED WHEELS

Grinding Wheels for Roughing and Finishing

In Fig. 5 is shown a cup wheel dressed in two ways—right and wrong. At *H* is shown the cutting point of the wheel dressed to a width of about $\frac{1}{16}$ in. Without unduly wearing away the wheel this gives an edge that enables the particles to break away, thus preventing glazing of the wheel and heating of the work; it tends to keep the wheel true, also, and presents a clean, sharp cutting edge.

In the lower half, at *I*, is shown the same wheel dressed to give a wide cutting face, under the false impression that a wheel will require less dressing and will therefore last longer. But the facts are that such a wheel, because of the larger mass of particles which will have less tendency to break away, will glaze very rapidly and heat the work. As the pressure against the wheel is increased, the section of the wheel that happens to be slightly softer than the rest of the wheel is practically broken; the particles are forced to break away in a certain place or places. This relieves the pressure on the wheel, and the wheel then, through its elastic properties, continues to run, but out of true and partly glazed—a very bad condition.

In my practice I have found it much better to keep all wheels true, clean and free cutting. When in doubt I use the recommendations of the manufacturers as to the grain and grade of wheel and personal judgment and experience as to methods of dressing. For general pur-

poses a Norton No. 47-H, if properly cared for, will give good results as an all-around toolroom wheel, particularly for surface grinding.

In Fig. 6 is shown a point I would emphasize. At N is the part of the wheel where falls the burden of the cut. It has been good practice to dress wheels this way, slightly rounding the corners at N and, when the wheel is trued up, using the diamond to produce the shallow grooves around the periphery of the wheel, as shown at A, Fig. 7. For general roughing-out work, this makes a very good wheel—one that I consider much better, more easily prepared and more saving of the wheel than any other method I have noticed so far. The grooves form excellent cooling air spaces, supplied with cool air by the wheel itself, while the particles will break away just enough to keep the wheel in good condition.

For finishing, after the work has been reduced to plus 0.002 or 0.003 in. or so, this wheel will not give the finish that should be produced on ground work of the best grade. At B, Fig. 7, is shown a wheel, true and fine, that is intended to follow the "standard" finishing wheel, shown in Fig. 6. It is merely the roughing wheel, rounded at O, so that the cut may be more evenly distributed over the face of the wheel, as at P. In finishing instruments, high-grade jig parts, dies, gages and work of a similar nature it is well to follow with a second fine finishing wheel, as shown at B, Fig. 7.

For those who must use the side of the wheel for grinding, Fig. 8 offers a suggestion. After the side of the wheel is trued up, the diamond is used to produce shallow grooves, as at M. Owing to the liability of weakening the wheel, these grooves should not exceed 1/64 in. in depth, nor should they be carried farther back than is shown at T, Fig. 8. The portion U should be dressed for clearance as shown.

In Fig. 9 may be seen an inspection gage wherein the finished parts consist of the sides R and S only. For all its apparent simplicity the finishing of this gage requires both skill and properly prepared grinding wheels. The magnetic chuck was used on the No. 2 Brown & Sharpe surface grinder. A sheet of paper was placed on the chuck, under the gage, to modify the tendency to buckle or warp and to avoid scratches in removing the work. The gage was roughed down with the wheel shown at A, Fig. 7, and sized with the round-cornered wheel shown in Fig. 6.

Each cut was taken at right angles to the preceding cut, the work being turned around one-quarter turn for each cut, as indicated. The reason for this turning was to correct all errors due to warping caused by the slight amount of heat generated, and light cuts were necessary.

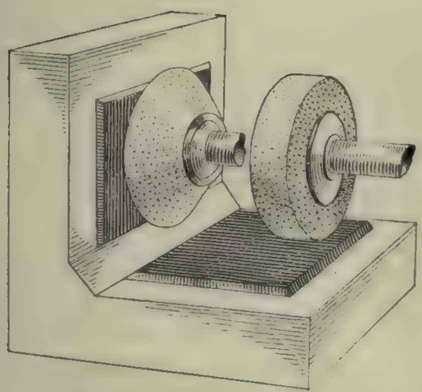


FIG. 10. GRINDING PADS

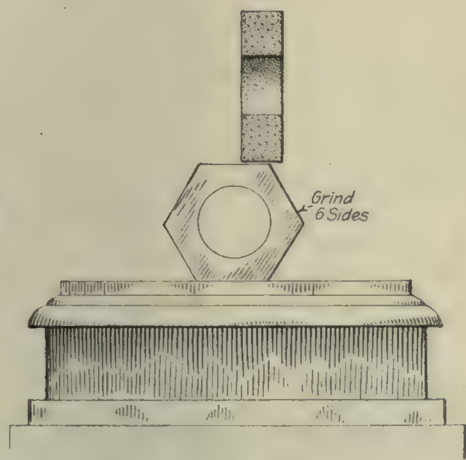


FIG. 11. GRINDING A BROACHING GAGE

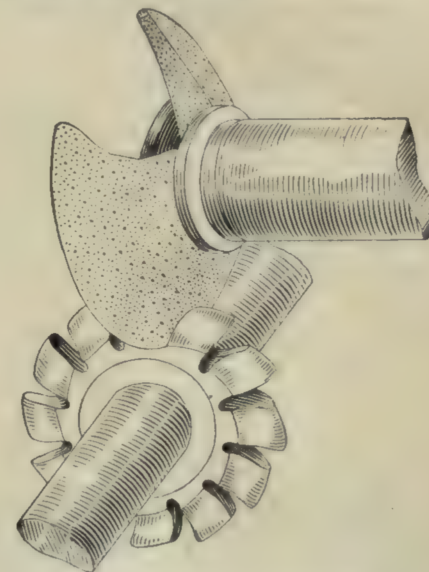


FIG. 12. GRINDING CUTTERS

In Fig. 10 is shown a jig part and how the two pads should be ground at the same setting. This job had to be clamped direct to the table.

In Fig. 11 is shown another possibility of the surface grinder—finishing a hexagon broaching gage after it has been roughed out on centers. This job is shown on the magnetic chuck. As would be expected in a job of this sort, a high degree of finish was required; that was one of the principal reasons for finishing it on the surface grinder.

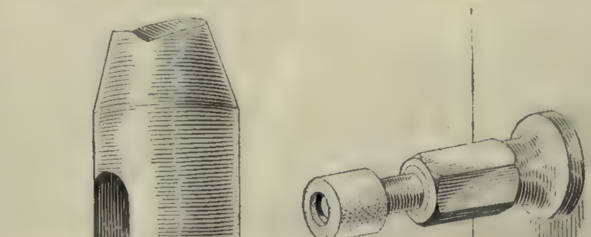


FIG. 13. EXAMPLE OF SLOT GRINDING

In Fig. 12 is shown a superior method of grinding gear cutters, using a dished wheel and the index centers.

In Fig. 13 is shown a job of slot grinding, using an extension ¾-in. wheel and operating the vertical movement of the head only. Both stroke dogs should be set against the trip lever. To bring the slot true, the job is clamped direct to the table, as shown.

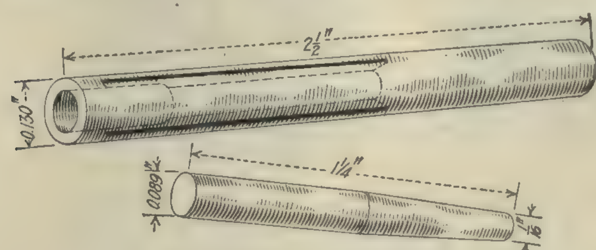
The foregoing is a part of my personal experience in the field of precision grinding, and some of the jobs illustrated were finished within a week of writing these notes.

Design of Laps for Small Holes

By J. W. Ackerman

There has been a demand of late for a small lap that will expand and give as good results as the lap with the taper pin and screw adjustment. I have tried several styles of cheaper laps without obtaining the results desired, so I devised the one shown, which will be found simple and quickly made.

This lap is 0.130 in. in diameter. To make it, a piece of round brass a little larger than 0.130 in. is held in a



EXPANDING SMALL LAP

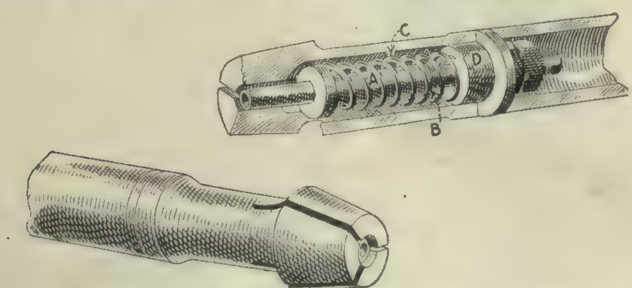
spring chuck in the lathe and turned to diameter, 2½ in. long. The end is drilled ½ in. deep with a No. 43 drill, 0.089 in.; and with a No. 49 drill, 0.073 in., the hole is drilled to a depth of 1½ in. With a $^1/_{64}$-in. circular saw, four slots are put in, starting ⅛ in. from the end and running to the end of the hole. The pin is made from a piece of No. 43 drill rod, tapered at one end to enter the small hole. Tapping it in gives a satisfactory adjustment.

Stop and Knockout for Spring Collet

By Matthew M. Richards

The illustration shows a stop and knockout that has been used successfully in brass manufacturing.

The stop *A* is applied to an ordinary spring collet as shown. The plug *D* is driven into the rear end of the



STOP AND KNOCKOUT FOR SPRING COLLET

collet. The spring *C* forces the stop and knockout *A* forward, its travel being limited by the checknuts.

In operation the machine is run continuously. The work is pressed against the end of the pin *A*, which recedes within the collet till the shoulder *B* strikes the plug *D*. The collet is then closed. When the collet is opened, the work is thrown out of the collet by the action of the spring *C*.

Movies in the Shop—A Letter from Jack to Bill

Dear Bill—I want you should set down and write me at oncet about what show thare is whare you work for a a no. one workman to get a job. Ive a good one here, puling down good money $12.50 evry week, but something has come up to make me shure its for my interrest to jack it up as soon as I can acsept a position somewhares else.

Its like this Bill. The blamed co. is gonta put in a movie into the shop to make we fellers work harder for our meger salleries and I dont meen to stand for it. Ill tell you how I got wise to thare neefarous scheem. Last night wen I got home I remembered that Id left all my tools on the bench raped in my overhalls, no not the mikes someone droped, thay are safe home and Ive got them prikpunched so I can set them for a haf inch and a three eights and Tom is gonta learn me whare to prikpunch them for qarter and etc., but all the rest part of my kitt, my boll peen that that old enjineer lost and both my too pairs of callipers. Well I went back to the shop hotfoot to lock up my kitt and seen a light in that big storeroom you know Bill over the front dore. I ast the dorekeeper what was on and just then my fourman Smith you know Bill, he came along and says Come in and you may learn something. The meen snide as if anyone could learn me anything about my traid. Well Bill it was a reglar movie, only but no thrilling drammers about rescuing the lovely Gwendolin nor no such, but you could never gess Bill, just a mutt runing a enjin leth, and gee didnt he make the chips fly.

In the fillum was a clock about 1′ foot large with a long seccond hand to show how fast the man worked. There shure aut to be a lawr Bill agenst timeing men that way. I gess the boses was afrade it mite make a bad impression for the next fillum shone a autermattic making nerld head screws and onest Bill you never seen a job done so slow. But thay didnt fool me, I new it stood to reason thay wouldnt put a movie in the shop to learn us to take it eazy but was planing to speed up all we fellers so we cant urn a desent days pay. The next fillum want no masheen tool a tall but one of them loomes that spins coton into cloth and the big bos you know old Brown Bill, he says the whole show was give to get the co. to by a movie to carry round to learn byers how our masheens works. Mebbe he thinks Ill beleive a sailsman can lug a movie in his grippe, but Im wise to his curvs Bill. Ime gonta jack up just as soon as I can acsept a position whare the boses dont set up all night to get up dewflikers to cheet an onest workingman out of his hard urned pay.

So write me Bill but if thay have movies in your shop you neednt bother, for Ill give up the traid and take to plumming or some other traid whare thay dont have movie cheeting masheens. Yours truely,

Jack.

PS—Bill Ime runing too power haksaws but dont you think you could get me into the toolmaking? But not if thay have movies.

Using Wood To Replace Metal in Die Construction

By William C. Babbitt

SYNOPSIS—Attention is here called to a little-known method of constructing dies for the drawing and forming of sheet metal. The cost and upkeep are low, and the work done is actually smoother than with similar all-metal dies.

It is quite probable that the Chevrolet Motor Co. was the first concern in the country to use dies made of wood in regular stamping operations. The surprising part of it is that the wooden dies turn out better work than their metal counterparts; and the quality of the work is by no means the only advantage offered.

Before going into the details of these dies let us make note of two facts: First, hard maple is used in constructing the dies; second, the stock from which stampings are made is 22-gage three-pass reannealed sheet iron. This particular gage metal is merely the standard used in Chevrolet body work, and it is not at all essential that this gage be used in connection with wooden dies.

The die shown in Fig. 1 is a composite die—that is, it is partly a wooden and partly a steel die. The "metal dies" are at either end *AA* and comprise two sets of steel cutting edges. These edges nick out the corners of the stock, as shown on the finished piece. All other parts of the die, including the bases for the cutting edges, are wooden except that, as is generally the case, a strap of iron is put around the die so that the operator will not injure it when pounding the sides in making adjustments.

The stock fed this machine is flat and has the two round holes and the wide slot in the center already cut out as they appear in Fig. 1. These serve to locate the piece in the die. The finished piece turned out by this machine is seen resting on the ledge of the ram. The die bends the stock at *BB*, at *E*, and also along the line *FF*, besides cutting out the corners. The stamping shown in the illustration is completed by the die in a single operation. This is a general rule which holds good throughout the entire article. In this case the finished piece of work is a section of the mud pan, and it is shown in its assembled position at *A* in Fig. 4.

The die pictured in Fig. 2 is a good example of an ordinary shallow drawing die with pressure plate. In dies of this nature the company has found it advisable to cover the wood with 18-gage sheet iron at points where the wear is most severe. Thus, in this die, the wood on the upper block is so faced, but the die cavity and plunger are of unprotected wood.

At either end of this die there is a pair of guides *B*, which are slotted so as to allow the bolts at their lower ends to slide in them. When the pressure plate hits the die it stops, the springs compress, and the punch keeps on descending to the end of the stroke. The piece of finished work at the left is only about half of the entire piece turned out by this machine. Because of the nature of the draw it was found best to make two of these parts in a single piece and then cut them apart afterward. The die produces smooth work which is remarkably free from wrinkles and other defects. This finished piece is also a pocket in the under pan *B*, Fig. 4.

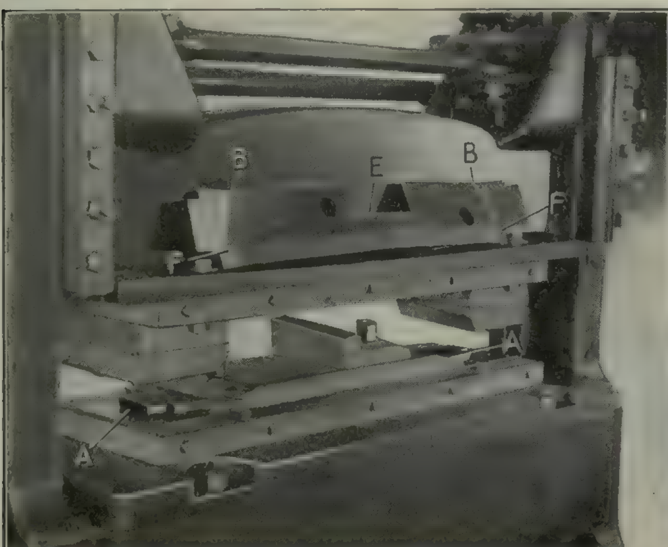


FIG. 1. COMPOSITE WOOD AND METAL DIE

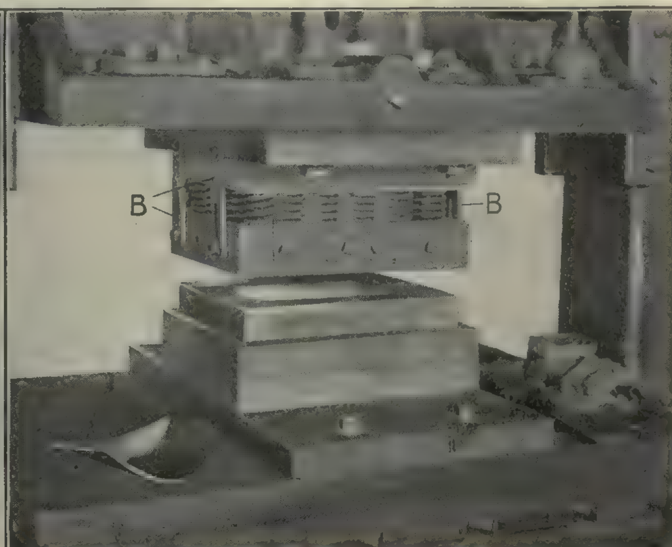


FIG. 2. WOODEN DRAWING DIE

One rather astonishing fact about the stampings from wooden dies is that they are consistently superior to those from metal dies. This may seem a rather broad statement, but it holds, nevertheless, in all cases tried so far. One naturally expects to have trouble with metal breaking or wrinkling at points where the drawing or upsetting is most severe, but for some reason this seems to have been eliminated in wooden dies. Just why, is a mere matter of conjecture at the present time. Possibly the fact that wood has more spring and "give" may have something to do with it, though it should be noted in connection with this statement that no allowance is made

for such spring; and that if two dies were built, one of wood and the other of metal, and both were designed to turn out the same stamping, they would be identical as far as size and shape are concerned.

Another good example of a wooden die is shown in Fig. 3. Here again the two sections of the tool are partly faced with 18-gage sheet steel where the surface is subjected to extreme wear; and a metal drawing edge has been let into the surface of the upper half. This saves wear on the edges of the cavity. The finished part appears in front of the die, and it is also shown in its position in the mud pan at *C* in Fig. 4. The blanks fed this die are flat and are cut out on rotary shears.

The method by which the Chevrolet company makes its crown fenders is interesting from several points of view. In the first place, instead of securing some new machine designed especially for such work, an old Williams White & Co.'s No. 3 Bulldozer, which was formerly used in wagon tire work, is utilized. This machine was found to be so efficient for the job that it has been retained even after the experimental stage was over; and it is on this machine that fenders are made at the present time. The wooden die used on this job is shown in position in the jaws of the bulldozer in Fig. 5, and the finished work turned out by this die in Fig. 6.

Fig. 5 is a view along the die from above. Section *A* of the die is fastened to the moving jaw of the bulldozer. The floating part *BB* serves a double purpose; it acts as a pressure plate and also helps in "breaking" the metal—that is, turning up a right-angled flange around the edges of the work. This section of the die is a bent U-shaped "ring," and because it is so long, narrow and thin, it is necessarily made of steel. The rest of the die, however, is wood, with the exception of the iron straps for protection and reinforcement. All other important parts, including the plunger and its cavity, are of wood. In operation, when the jaws of the bulldozer come together the metal drawplates, as in standard practice, hit first and hold the stock, turning up the flange before the plunger hits the metal to form the crown. The finished fender shown in Fig. 6 is turned out in a single operation.

The Chevrolet Motor Co. first started to use wooden dies on simple bending operations. From this it was

FIG. 3. ANOTHER LARGE WOODEN DIE

FIG. 4. PARTLY FINISHED PAN, SHOWING PARTS

FIG. 5. FENDER DIE AS SEEN FROM ABOVE

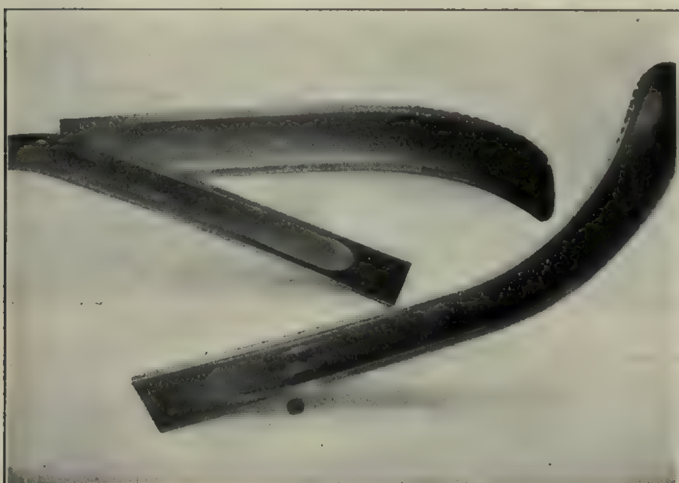


FIG. 6. SOME OF THE BULLDOZER WORK

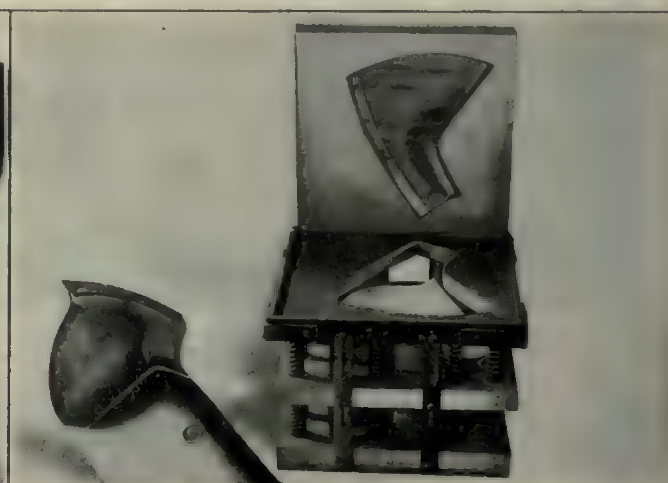


FIG. 7. A DRAWING AND FORMING DIE

but a short step to other simple dies. The company was led to take this step because it did not have the space or facilities to meet its increasing demands for steel dies. Gradually, as each subsequent wooden die proved successful, more and more complicated ones were constructed, until now the point has been reached where experiments are being made with one-operation wooden dies on work which it is doubtful if steel dies could do as well, even in several operations.

Such a case as this is illustrated in Fig. 7. Here an excellent idea of the construction of a rather complex die can be gained. The work which this die is designed to turn out is shown on the sample piece in the cut, it being that part beyond the chalk line. This part will form a section of the radiator splash guard, the idea being to seam a piece onto the straight part where the chalk line is in the figure; and also to seam a corresponding piece on at the other end. These mudguards will now be made in three sections instead of one as heretofore. They were formerly pounded into shape by hand against forms. It might be worth noting here that this die had just been completed and had as yet never been used at the time this picture was taken.

I have said that the quality of the work produced by wooden dies is by no means their only advantage, and now that we have seen how the dies perform under actual shop conditions let us consider these other good points.

Without much doubt the most important of these is expense. In connection with this, F. W. Pierce, of the Chevrolet company, states from experience that the cost averages less than one-tenth that of steel dies. He further says that a set of dies which would take five months to build of steel can be made of wood in four weeks. Aside from the mere cost of labor, the financial saving resulting from this gain in time would be very hard to estimate, especially if the dies were needed in a hurry. Furthermore, repairs on wooden dies are very quickly and easily made, with an accompanying low expense; consequently, the cost of upkeep is very small indeed.

The mention of repairs brings us to another consideration. Will the dies stand up under constant use? The answer is, "Yes, as far as is known." Again we quote Mr. Pierce, to the effect that one of the wooden dies will run out 10,000 or more stampings with repairs only amounting to about $5, and that he sees absolutely no reason why such a die would not turn out 20,000 or more. Of course, when all has been said, the fact still remains that a metal die will last longer than a wooden one; but if the latter stands up long enough to do the work required of it, that is all that can reasonably be asked.

Repairing Cast-Iron Gears

By James Owens

We had several gears broken on our shell lathes. As we could not wait to get castings, we tried putting in several studs and shaping them to the form of regular teeth; but they kept getting loose. The gears were then turned ½ in. below the root of the teeth, and a steel band was shrunk on, turned to size and the teeth cut. This saved us a lot of time and gave us gears as good as all-steel ones.

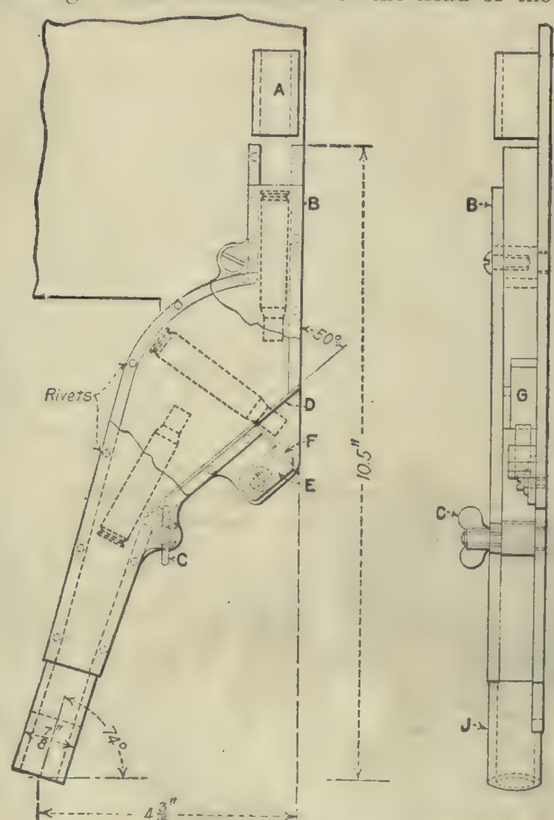
Small-Arms Cartridge-Case Selector

By John F. Sorkin

An arrangement that performs the operation of delivering cartridge cases to a machine with the head end first after receiving them as they drop from a hopper with either end falling first is shown in the illustration. The device may appear simple, yet it is an ingenious method of producing the result required.

The selector consists of a pipe A into which the feed tube from the hopper is inserted. This pipe leads into the box arrangement, which is constructed of pieces of brass bent into shape, as shown, and riveted together. The cover B is held by two screws. The wing nut C is easily loosened, permitting the cover to be swung back in order to view the inside. The piece of tempered sheet steel D receives the cases as they strike in falling. E is an adjustable bracket that holds the steel finger F, so that it extends slightly within the opening G. The tube J leads to the machine.

The width of the opening inside the box is made about ⅛ in. larger than the diameter of the head of the case,



CARTRIDGE-CASE SELECTOR

to allow sufficient play for the case when falling through the selector. If the head end drops first, it strikes on the piece of sheet steel D, slides along the inclined surface and drops out through the spout end. This action is plainly seen, since there is nothing to alter the position of the case in its fall and, furthermore, the head end being heavier, gravity aids it in keeping its original position during the fall.

If, however, the mouth end comes down first, the neck of the case slips through the opening in the piece D and, striking against the steel finger F, pivots at that point, causing the case to invert its position and fall out head downward, as indicated in the illustration. The device works satisfactorily and does not clog.

Repair and Upkeep of Spline Broaches*

By Walter G. Groocock

The repair and upkeep of broaches is such an important item that the broach designer must of necessity pay some attention to this side of the subject. It will be readily recognized that the life of a set of broaches depends very largely on the attention they receive after they are put to work. Consequently, the design should be such that careful attention will prolong the life of the broaches without any sacrifice of accuracy or utility.

Spline broaches should never have dead sharp corners on the cutting teeth, except for the last few teeth of the finishing broach. It will always be noticed by any close observer of broaching that the corners are the first to fail. This, of course, is in accord with a turner's experience with a parting tool. If the sharp corners of the broach teeth are just rubbed off with an oilstone so as to give about $^1/_{100}$-in. radius, they will stand up much better than if they are left quite square; and if the corners are subjected to periodical examination and those teeth showing any signs of wear are touched up, then the life of the broaches will be prolonged.

When working on very tough or hard materials this periodical examination is absolutely essential, because one bad tooth on a spline broach will soon bring disaster to other teeth near it unless some precaution is taken. The preventive means that may be adopted are various and will naturally depend on the disorder; but whatever the method adopted, it must be such that no double load can fall on the teeth following. When a tooth is bad—that is, is beyond the usual point where a local sharpening will give it a fresh lease of life—the best thing to do is to grind it until it presents a cutting edge. As it will not, when so treated, do any real cutting, the work it should have done must be shared among, say, the next four teeth in order.

Thus, suppose the load per tooth on a broach is 0.004 in. and a tooth has failed; then instead of the next tooth to it having to take 0.008 in., as it would have to do if the broach was left in its damaged condition, the next four teeth to the damaged one should be ground so that each of them will take a cut of 0.005 in. The question may be asked, If the damaged tooth will not cut, why grind it to a cutting edge?

Teeth that have to be ground below the cutting line should always be ground so as to cut, because there is always a distinct possibility of pieces of chip getting in front of them; and if the tooth has a cutting edge, no harm will result. On the other hand, should it be just roughly rounded off and a chip get on it, a bad rub will result in the broach getting crowded to the opposite side of the hole, with the possibility of serious damage.

Reason for Grinding Bad Teeth

There is yet another very good reason why the bad teeth should be carefully ground to a cutting edge and not merely rounded off. Accidents will happen; and after a time, particularly with spline broaches working on tough alloy steels, so many of the teeth get chipped and show signs of failing at the corners that it is necessary to do something that will keep the broaches in service. This may be accomplished in several ways; for instance, another broach may be made to replace the damaged one, or an extra broach may be put in the roughing set and by so doing reduce the load per tooth.

To take a concrete case for an example, suppose a set of broaches used for pulling out a 2x1¾-in. six-splined hole is in bad order. There are four broaches to the set (roughing), each having 32 effective teeth. Then the diameter increase per tooth would be $\frac{250}{128} = 0.002$ in. per tooth or, say, $\frac{1}{16}$ in. per broach. Now if it is decided to have only four broaches to a set, then a new No. 4 broach must be made; and Nos. 2, 3 and 4 must be ground respectively to the sizes required for Nos. 1, 2 and 3. Properly casehardened broaches should always have a good $\frac{1}{16}$ in. of case, and consequently by reducing the broaches as mentioned the casehardening will have been ground only about halfway through.

If, on the other hand, the broaches are thought to have been overloaded and it is decided to introduce another broach to ease the load per tooth, then only sufficient should be ground from No. 1 to make it clean up; and serving the others the same quite possibly would only need about half the teeth on the additional broach to cut, leaving the other half available for subsequent grindings to bring the corners into good condition.

The Question of Reserve Teeth

The question of having a reserve of teeth is one that is closely allied to the design of the broaches. All new broaches should have several teeth at the back end that do not cut when first used, and these teeth will be available when grinding takes place. To illustrate this point, take the case of a broach with 36 teeth, the total increase in diameter of which is to be $\frac{1}{16}$ in. Now the broaches may be made by spreading this work over the whole of the 36 teeth, or 0.002 in. per tooth can be taken and leave four teeth idle. This latter is to be preferred, because when the corners are bad the face of the teeth can be ground; and this will reduce their diameter so that after a few grinds it will be found that there are only three idle teeth.

Apart from this orthodox grinding of the face of the teeth the corners may, through mishandling, wear, etc., get into such a poor condition as to necessitate grinding the tops of the teeth, as mentioned before. If three idle teeth are in reserve, this means that the diameter of all the bad teeth can be reduced by 0.006 in.—quite an appreciable amount to grind off—and still have the broach the same size at its finishing end. For this reason alone, short spline broaches should never be designed to have less than four idle teeth each, and on finer pitches six teeth would be preferable.

Another point in connection with the making of broaches, which will materially assist in their maintenance, is this: After the broaches have been in use for some time and require sharpening, they will be found to be sprung out of truth. If the sharpening is to be just a local grinding of the face, this error from truth will not matter; but should it be desired to grind the tops of the teeth, then naturally the work must run true before the wheel can be applied to the broach.

If, when the broaches are made, one of the chip grooves about the middle of the broach is also ground concentric with the tops of the teeth, then when it is desired to grind the tops after use, the work can be kept running true on the grinder by running on a small steadyrest.

Shop-Lighting Legislation in 1916

By C. E. Clewell*

SYNOPSIS—A summary of the developments in shop-lighting legislation during 1916, and a review of the situation prior to the beginning of the past year. The legal requirements in Wisconsin and New York are referred to, and the importance of the code of lighting of the Illuminating Engineering Society, in helping to promote the recently enacted codes in Pennsylvania and New Jersey, is discussed. Some of the operating features of these new codes in actual practice are explained, including the difficulties of inspection. A new and simplified instrument for measuring illumination, called the "Illuminator," is described.

As introductory to the following summary of some of the recent developments in shop-lighting legislation, it is wise to consider briefly some of the phases of the situation prior to the beginning of 1916, most of which have more or less direct bearing on the notes to follow.

Orders in Force in Wisconsin

The orders of the Wisconsin Industrial Commission on shop lighting issued on Jan. 20, 1913, and the accompanying shop-lighting handbook for superintendents and electricians issued by the same commission on Mar. 1, 1914, appear to be in force and unchanged up to and including 1916. These orders have been covered completely in the *American Machinist* (Vol. 40, p. 1033) and hence it is necessary at this point merely to mention that the specification of intensity, for example in Order 2102 for hand and machine operations, is made as the equivalent in amount to not less than the light produced by a 1-cp. lamp hung 10 ft. from the floor for each 4 sq.ft. of floor space. In other words, these orders direct attention to the lamps, and do not primarily consider the intensity at the work, and hence on this account are somewhat unsatisfactory from the standpoint of a comprehensive ruling.

It is of special interest to note these Wisconsin orders at the outset, first, because they represent the pioneer effort in this country to fix the amount of illumination in shop spaces; and, second, because of the fact that the more recent legislation in 1916 has increased the recommended intensities considerably beyond these earlier orders of four years ago, and by comparison are more definite and complete. To those who have been following the Wisconsin enactments in the shop-lighting field, it will be of particular interest to note that there is some prospect of a modification in these original orders so as to bring them into line with what is now considered good practice in legislation of this class.

New York State Law of 1913

At practically the same time as the issuance of the Wisconsin orders on shop lighting, Senate Report No. 36 of the State of New York was issued under date of Jan. 15, 1913, in which regulations governing the lighting of factories and workrooms were defined. These regulations, although carefully worded and designed to remedy glare, insufficiency, and the like, do not specify intensities at the work. In an article by L. B. Marks (*Lighting Journal*, January, 1913) it was explained that the idea then was to confine the work on the New York laws to remedy such evils as glare and the like—that is, to prevent, as far as possible, the use of such lighting as is a menace to the safety and the eyesight of the public. No changes in the New York laws have been noted during 1916.

Illuminating Engineering Society and British Reports

Up to the close of 1915, the shop-lighting legislation in Wisconsin and New York was the principal development. Toward the close of 1915, however, the completion of the Code of Lighting for factories, mills and other work-places by the committees on Lighting Legislation and Factory Lighting of the Illuminating Engineering Society, made possible the subsequent legislation reported below in 1916. Interest in this same line of legislation was further promoted by the issuance of the now well known first report of the departmental committee on lighting in factories and workshops, under date of May, 1915, by the British Parliament.

The widespread interest attached to this British report is perhaps best shown by the comment of the *London Electrical Review* for April 17, 1915, which says in part:

> The Departmental Committee appointed by the Home Office to investigate this question [the lighting of factories] has been a long time at work, having been constituted more than two and a half years ago; but it must be admitted that the subject was one of extreme difficulty and complexity, and we are not disposed to reproach the committee on the score of undue delay. On the contrary, we think it has followed a wise course in publishing the results which have already been obtained, without wating for the completion of the inquiry, which may not be reached for years to come, in view of the conditions which now prevail.

Notable Paper by L. B. Marks

At the very outset of 1916 (Jan. 21) L. B. Marks, of New York, presented a comprehensive digest on the general subject of lighting legislation in the form of a paper before the Philadelphia Section of the Illuminating Engineering Society, in which he pointed out that within the past five years there have been numerous and vital changes in legislation relating to almost all factory requirements except lighting. In closing his paper, Mr. Marks stated that the Illuminating Engineering Society was organized ten years ago to advance the theory and practice of illuminating engineering and to disseminate knowledge relating thereto; that the society has no affiliation with any commercial organization and is admirably suited to act as a clearing house for authoritative information relating to the subject of natural and artificial lighting; and that the society welcomes coöperation with legislative bodies and others who are interested in the enactment of statutes, ordinances, rules and regulations for lighting.

As a most significant feature of this Philadelphia meeting, John Price Jackson, Commissioner of Labor and Industry of Pennsylvania, and Col. L. T. Bryant, Commissioner of Labor of New Jersey, were present and entered into the discussion of Mr. Marks' paper. In particular, Mr. Jackson, when expressing his interest in this particular subject, stated that his own department would be

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glad to accept the offer made by Mr. Marks, and take advantage of the coöperation of the society in drafting a code suitable for practical application in the industries of Pennsylvania. Colonel Bryant also expressed himself as being strongly in favor of correcting the abuses in the lighting of shops and workrooms in his state.

Another interesting development during the year was the discussion of this I. E. S. code in connection with a paper presented by the writer on "Modern Aspects of Factory Lighting and the New Code" before a joint meeting of the New York sections of the American Society of Mechanical Engineers and the Illuminating Engineering Society on Mar. 14, 1916, at which was presented a well worked out analysis of the I. E. S. code from the viewpoint of the mechanical engineer. A number of helpful suggestions and constructive criticisms were included in this discussion. Through channels like this, it was possible to modify and revise the code as first prepared, so as to eliminate difficulties which might not otherwise have been noted until it had been passed by one or the other of the state departments.

The Pennsylvania and New Jersey Codes

Following the Philadelphia meeting in January, 1916, a conference took place between representatives of these state departments and the main committee on lighting legislation of the Illuminating Engineering Society, in New York City, and somewhat later, a more definite consultation was held between representatives of the Pennsylvania state department and a sub-committee of the society, at which the regulations of the I. E. S. code were discussed in detail from the standpoint of their application under practical working conditions. As a result, a lighting code was issued by the Pennsylvania Department of Labor and Industry, becoming operative on and after June 1, 1916.

As an important sequence to the adoption of the I. E. S. recommendations by Pennsylvania in June, the state department of labor in New Jersey, under date of Aug. 1, 1916, issued a code of factory lighting, in which the I. E. S. code was used as the basis with slight revisions and modifications.

This code contains, in addition to the rules or requirements, an appendix of some 38 pages under the heading "General Information and Suggestions," which makes the treatment unusually complete and explicit.

Operation of the New Codes

The Pennsylvania code has now been in effect for sufficient time to form at least partial conclusions of a preliminary nature as to its practical features. The Bureau of Inspection of the Pennsylvania Department of Labor and Industry reports that no objections to the code requirements are on record to date (January, 1917) on the part of the industries to which it applies, and that the only question which has been raised refers to emergency lighting, a feature apparently not yet definitely settled by the department.

The reference to emergency lighting in Pennsylvania's code occurs under Rule V and reads as follows: "Emergency lighting shall be provided in all work space, aisles, stairways, passageways and exits; such lights shall be so arranged as to insure their reliable operation when through accident or other cause the regular lighting is extinguished."

A number of inquiries have been made concerning the exact interpretation of this rule, and at least one manufacturer has suggested that a literal enforcement of this requirement may work a hardship in some cases. On inquiry, however, no indication of definite opposition to this particular ruling has been given by the state department.

Locations of Emergency Lights

The new code in New Jersey omits the comma (,) after the word "space" in Rule V (see quotation from the Pennsylvania code, Rule V, given above), which thus reads: "Emergency lights shall be provided in all work space aisles, etc.," thus limiting the locations where such emergency lighting must be installed, to aisles, stairways, etc., whereas a literal interpretation of the Pennsylvania code would include work spaces as well as aisles and passageways. In the New Jersey code, moreover, Rule V is supplemented with a footnote, interpreting the wording of the rule as follows:

> Emergency lighting systems may be installed in various ways, and specifications of all such systems shall be submitted in duplicate to the Bureau of Electrical Equipment of this department for preliminary approval, before being installed. All such lighting shall be (if electric on separate circuits) entirely independent of the regular lighting equipment and shall take energy from a source acceptable to the Department of Labor and which is not liable to failure, through accident, or other cause, to the regular lighting system.

(For comment on New Jersey's code, see *American Machinist,* Vol. 46, p. 38.)

Casualty Insurance Rates

In the practical application of these new codes, the element of incentive on the part of the industries to comply with the requirements would probably be still further increased if a reduction in rates were offered by the casualty companies to the *well lighted* factory or shop. This rather unique plan has been suggested by a New York expert,

TABLE I. INTENSITY REQUIREMENTS IN FOOT-CANDLES

Class of Work	Clewell's "Factory Lighting," 1913	G. E. Co.'s "Handbook on Lighting," 1913	*Wisconsin "Orders," Minimum, 1914	I.E.S. Code of Lighting, Minimum, 1915	†British First Rep., Minimum, 1915	Pennsylvania's Code, 1916: Minimum	Pennsylvania's Code, 1916: Good Practice	New Jersey's Code, 1916: Minimum	New Jersey's Code, 1916: Good Practice
General lighting	....	0.08	....	....	0.25	....	....	....	....
Yards, roadways, etc.	....	....	....	....	0.05	0.05	0.05 to 0 25	0.05	0.05 to 0.25
Stairways, etc.	0.50	0.50	....	0.25	0.10	0.25	0.25 to 0.50	0.25	0.25 to 0.50
Foundries	....	3.00	1.50	1.25	0.40	1.25	1.25 to 2.50	1.25	1.25 to 2.50
Rough manufacturing	3.00	2.00	0.75	1.25	....	1.25	1.25 to 2.50	1.25	1.25 to 2.50
Fine manufacturing	5.00	5.00	1.50	3.50	....	3.50	3.50 to 6.00	3.50	3.50 to 6.00
Extra-fine work	....	....	....	....	....	5.00	10.0 to 15.0	5.00	10.0 to 15.0

* Intensities in this column are estimated from the specifications of candlepower per sq.ft. as given in the Wisconsin Orders.

† No recommendations are made in this first report for the illumination required for the work, the intensities specified in this column merely being given for general illumination, without regard to the needs of the work itself.

and is modeled after a corresponding ruling by the fire insurance companies, where the insurance rate on a building is lower when fire protective devices are provided, and where the electrical wiring in the building has been passed by the Fire Underwriters' Association. If the actual accident rate is definitely lowered in the well lighted shop in contrast to the poorly lighted shop, there might be a warrant in reducing casualty insurance rates, where the requirements of such lighting codes as discussed above are fully complied with. No ruling, however, in this connection, has yet been noted.

Table I gives a compilation of practically all shop-lighting legislation to date and furnishes a convenient basis for comparing the minimum and recommended intensities with average practice.

The minimum and average requirements of each of these new codes are specified by intensity (foot-candles) at the work. It is next to impossible to check these intensities by mere observation of the illumination, although a person well versed in factory lighting can sometimes form a close estimate of the intensity by noting the size of the lamps and type of reflectors, also the general surroundings of the space in question. In both codes, moreover, measurements are to be made by a portable photometer or illuminometer, this usually being a device for comparing the intensity at the work with the intensity produced inside the photometer box by a standard lamp.

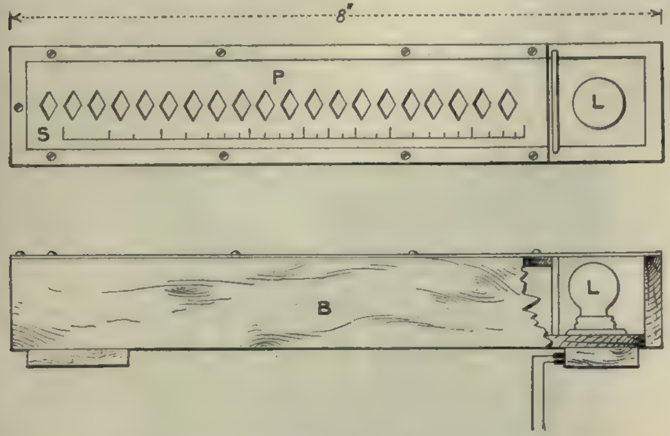


FIG. 1. DIAGRAM OF THE "ILLUMINATOR"

One of the most interesting developments in 1916 was the announcement by Dr. Clayton H. Sharp, of the Electrical Testing Laboratories, New York City, of a new and simplified illumination tester, which he has named the "Illuminator." The peculiar importance of this announcement will be realized at once when it is remembered that the principal portable photometers for illumination measurements have been expensive instruments and of such a nature that some little dexterity is required in their use.[1] In this new instrument the principle of operation is such that there are no moving parts, as in the other types, and practically no skill is required in its operation; and its accuracy, while not so high as the more expensive instruments, is sufficient for many practical purposes.

Construction of the Illuminator

Referring to Fig. 1, *B* is a rectangular box containing a small tungsten lamp *L* mounted behind an opal glass screen. The top of the box over the rest of its length is made up of a sheet of clear glass to which is pasted an arrangement of papers *P*, which constitutes what is similar to a so-called continuous photometer disk extending from one end of the glass to the other. The interior of the box is painted white, except for the distant end, which is black. The photometer element of the box is shown at *P*, and this consists of a sheet of fairly heavy paper with a slit cut out of it, this slit being shaped with saw-tooth edges as shown in the diagram. Over this entire element *P* there is pasted a sheet of thinner translucent paper having a mat upper surface. When the lamp is lighted, the end of the slit nearest the lamp is very bright, this brightness falling off as the distance from the lamp increases. When an illumination to be measured falls on the top of *P*, the outer portions of this surface are mostly lighted by the exterior illumination, but the slit is illuminated chiefly by the lamp inside the box. At the point where the brightness of the exterior portion appears the same as the brightness of the saw-tooth openings, the saw-teeth fade away and are hard to distinguish. This point can be recognized without difficulty by an observer, provided the papers used on *P* are properly chosen. The scale *S* serves to indicate the amount of the illumination. It is obvious that two observers can look at *P* at the same time, and hence can check the judgment of each other's eyes while making the measurements.

Figs. 2, 3 and 4 have been drawn to illustrate possible interpretations of the codes of Wisconsin, Pennsylvania and New Jersey for rough manufacturing work. In Fig. 2 the layout is based on a specification of the equivalent

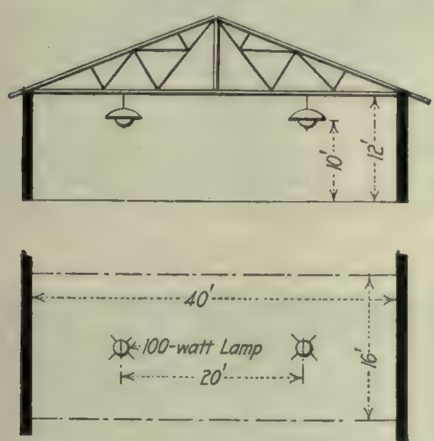


FIG. 2

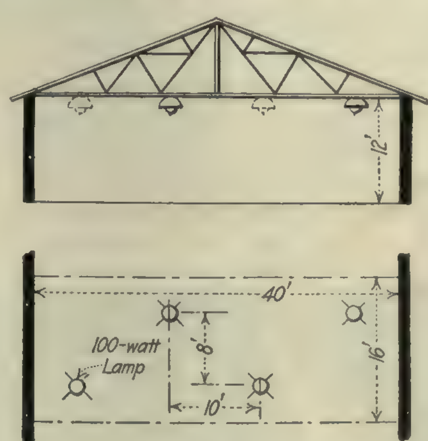


FIG. 3

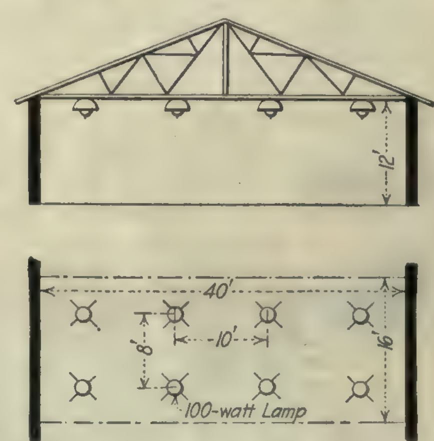


FIG. 4

FIGS. 2 TO 4. VARIOUS LIGHTING PLANS

Fig. 2—A lighting plan based on Order 2102 of the Wisconsin Lighting Code. Each lamp produces 80 mean horizontal candlepower, hence the installation represents the equivalent of 1 cp. for each 4 cu.ft. of floor space. Fig. 3—Lighting plan based on the minimum requirement for rough manufacturing work. The factor, 1.25 foot-candles on the work, is from the Pennsylvania and New Jersey codes. Wherever possible the lamps should be arranged symmetrically, as in Fig. 4, rather than staggered as indicated in this illustration. Fig. 4—Lighting plan based on the higher value of acceptable practice. This also fulfills the specifications in the codes of Pennsylvania and New Jersey for rough manufacturing work. With efficient reflectors this installation should result in 3.0 foot-candles on the work

[1]For information on other portable photometers see "Handbook of Machine Shop Electricity," pp. 282 and 288.

of one-quarter of a candlepower per square foot mounted 10 ft. above the floor (Wisconsin Order 2102). Tungsten lamps with a rating of 1.25 watts per candlepower are used in this diagram and for 640 sq.ft.—that is, one bay as shown—we must have 160 cp. as a minimum, or, at 1.25 watts per candlepower, we must install two 100-watt tungsten lamps (that is, $160 \times 1.25 = 200$ watts per bay).

In practice eight 100-watt tungsten lamps (same rating as above) per bay, when equipped with efficient reflectors, produce at the work about 3 foot-candles; hence four lamps per bay would produce about the equivalent of 1.5 foot-candles, the minimum being 1.25 in Pennsylvania and New Jersey. The layout in Fig. 3, corresponding to the next largest even number of lamps to that of the exact minimum, is chosen to represent one way of producing the minimum in these states for rough manufacturing. It is to be noted that the plan of the lamps shown in Fig. 3, where the outlets are staggered, is not nearly so good as where the lamps are symmetrically located in squares, as indicated in Fig. 4.

In Fig. 4 eight 100-watt tungsten lamps per bay are shown, and here, if efficient reflectors are employed, we may expect to secure about 3 foot-candles of illumination at the work, this corresponding closely to the higher value under the heading of acceptable practice in the Pennsylvania and New Jersey regulations for rough work.

In Fig. 2 the intensity would probably not exceed an average of 0.75 foot-candle, which is only 60 per cent. of minimum value called for in Pennsylvania and New Jersey.

Railroad-Shop Tools from Texas

By T. Paxton

The accompanying illustrations, taken in the El Paso & Southwestern System shops at El Paso, Tex., show some devices that have proved successful in practice. Fig. 1 is a commutator-truing device used on turbine generators in the powerhouse. The machine, which is similar to a small lathe, has crossfeed travel as well as longitudinal. It is placed on the turbine, and the commutator runs under its own steam, giving the work to be trued the same action as in a lathe. With this device the commutator does not have to be removed from the machine and taken to the shop to be turned and finished to shape.

Fig. 2 is a superheater-flue cutting machine. It is placed on the front end of the locomotive and held with the studs that hold the front end door in place. It is operated by one man and driven with the air motor shown. The cutter is made with an eccentric movement in the cutter holder, so that when applying the cutter to the flue to be cut, the cutter blade is out of the way. As the machine is started, the cutter falls out and pierces the flue, cutting it off with one revolution inside the front flue sheet.

Fig. 3 shows a portable platform placed over the steam dome. This is found very convenient in doing work of

FIG. 4. RACK FOR STORING AIR MOTORS

any kind in the steam dome, removing studs and taking off and applying dome caps.

We are also using lathe tools with welded tips. These tools have a tip of high-speed steel welded to a shank of tire steel. The size of the tool is 1 x 2 in., and oxyacetylene was used in welding.

Fig. 4 shows a convenient rack for holding air motors of all sizes. This needs no explanation. It takes up a floor space of only 2 x 7 ft. and is located in the toolroom.

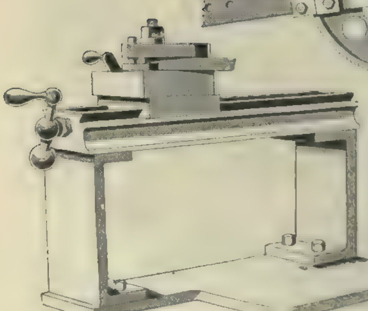


FIG. 1

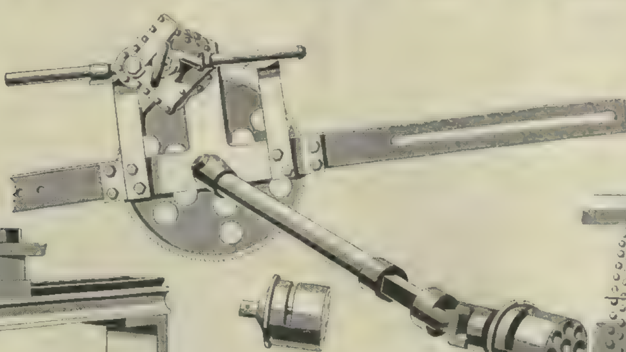


FIG. 2

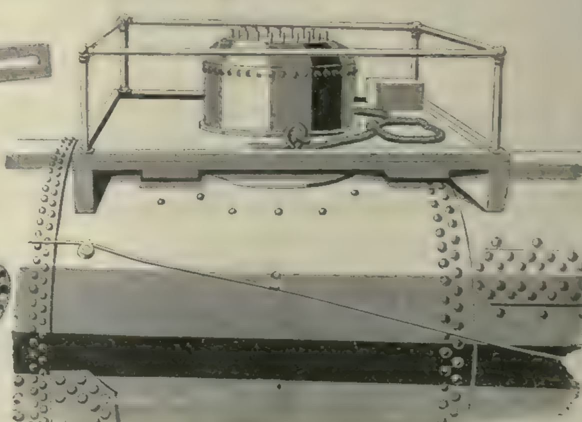


FIG. 3

FIGS. 1 TO 3. VARIOUS DEVICES USED IN A RAILROAD SHOP
Fig. 1—Commutator-truing attachment. Fig. 2—Flue cutter for front end. Fig. 3—Platform for dome work

Operations in the Manufacture of a Water Motor

BY ROBERT MAWSON

SYNOPSIS—Some of the operations followed in manufacturing a water motor are here shown. The methods are the practice of a small shop where only some 10 or 12 men are employed, but the motors produced are on an interchangeable basis. The article should prove of service to the small shop debating the advantage of special jigs and fixtures. An example is given of the advantage of special jigs.

Nowadays the tendency in machine shops is to eliminate as much manual labor as possible. This is evidenced by the large number of special and automatic machines and appliances that are manufactured for quickly performing certain kinds of work without the necessity of undue physical exertion on the part of the operator. Labor-saving devices have even entered the realm of the home, and one of these—a power washing machine—is being made by the American Water Motor Co., of Columbus, Ohio. Fig. 1 shows a machine assembled.

The water is admitted by means of a rubber hose into the pipe *A* and exhausted through the pipe *B*. The action of the water (which must be under a pressure of 20 lb. or more) is to propel and impel a piston by means of valves at each of the cylinders. A rack in mesh with a gear is attached to the piston by means of a rod; the gear is mounted on a shaft, the lower end of which carries the device for moving the clothes around in the washing machine.

It can thus be seen that as the piston is moved back and forth by the action of the water the clothes are kept in motion and the washing operation performed.

In Fig. 2 are shown the detail parts of the water motor for the power washing machine.

The first operation (not illustrated) when machining the valve is to bore, tap and face the back surface; the production is 100 pieces per hour. The second operation is shown in Fig. 3. The valve *A* is held on a threaded arbor attached to the machine. The outside of the piece is then rough turned, leaving it 0.015 in. over size; then the shoulders are faced, the threaded

FIG. 1. ASSEMBLED WASHING MACHINE

FIG. 2. DETAILS OF THE WATER MOTOR

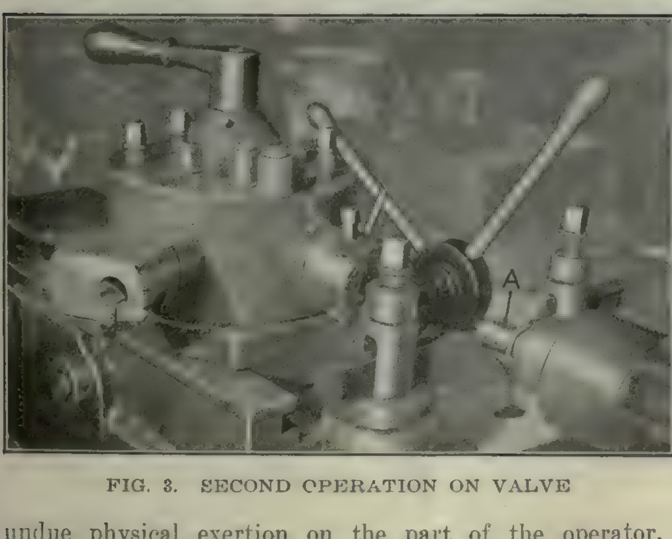


FIG. 3. SECOND OPERATION ON VALVE

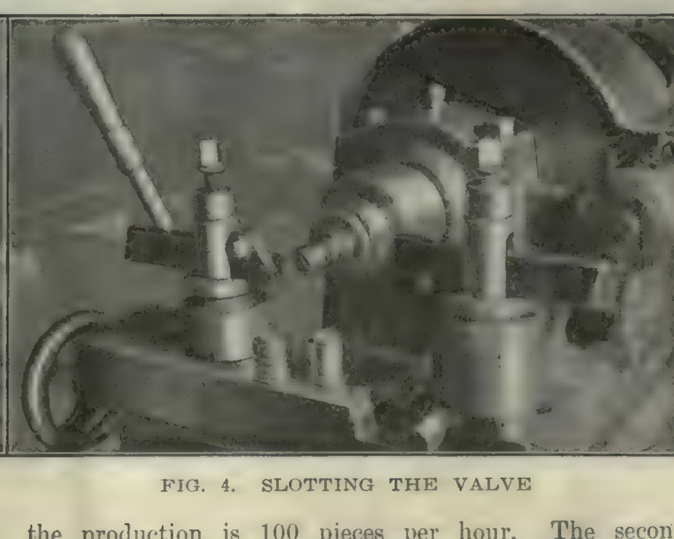


FIG. 4. SLOTTING THE VALVE

end turned to size, the front shoulder faced to length with the front cross-slide tool, the rear shoulder faced to length with the rear cross-slide tool and the thread machined as the last suboperation. The production for the second operation is 60 per hour. The parts as they appear before and after performing the suboperations are shown on top of the turret head.

The next operation is to machine the intake and exhaust slots in the valve, illustrated in Fig. 4. The valve is again screwed on a threaded arbor as shown. The first slot is machined with the tool in the front of the cross-slide and the second slot with the tool carried at the rear of the cross-slide. The correct depth of cut is obtained by means of stops placed on the under side of the cross-slide. These stops come in contact with the front and rear faces of the lathe bed. The number of valves that may be slotted per hour in the manner shown is 125.

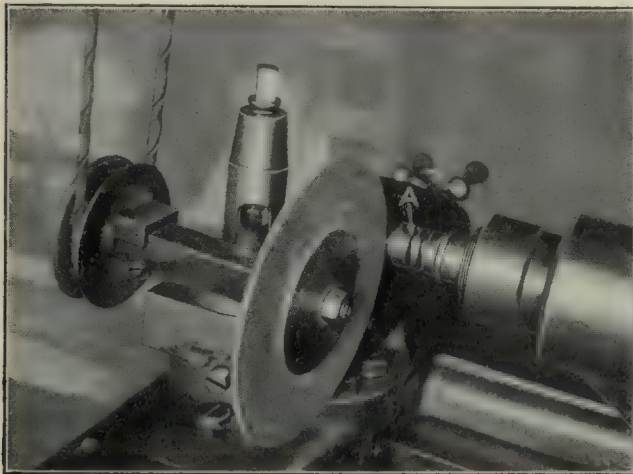


FIG. 5. GRINDING THE VALVE

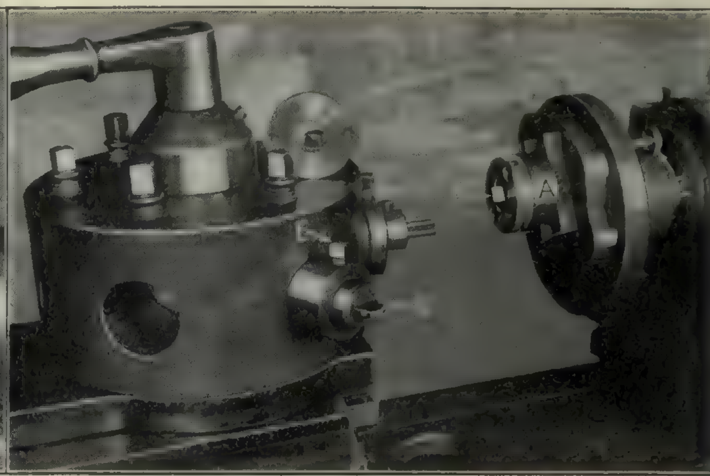


FIG. 6. THIRD OPERATION ON VALVE CASE

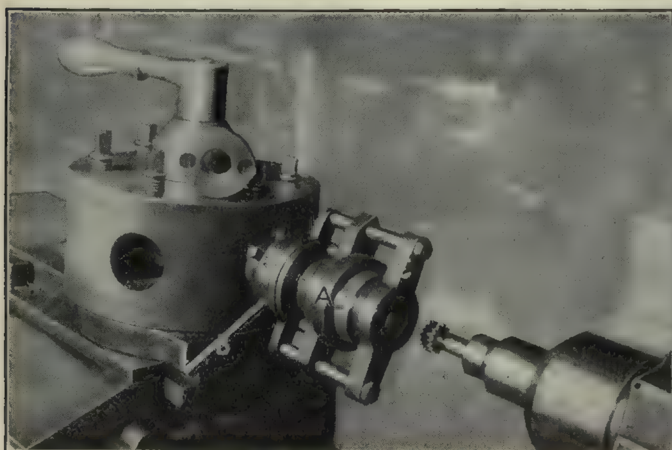


FIG. 7. SAWING THE TWO SLOTS

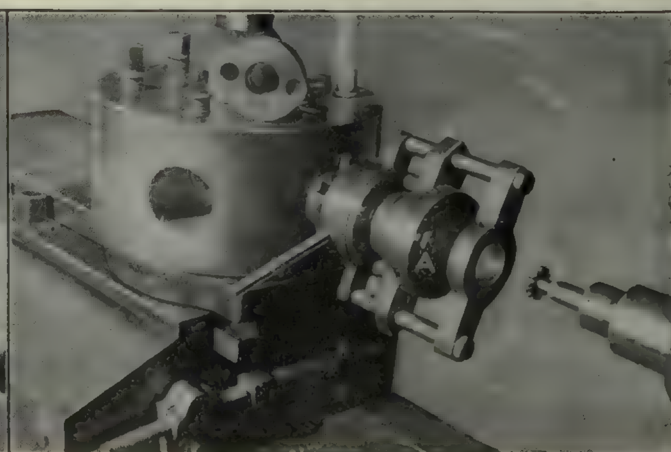


FIG. 8. SAWING THE SINGLE SLOT

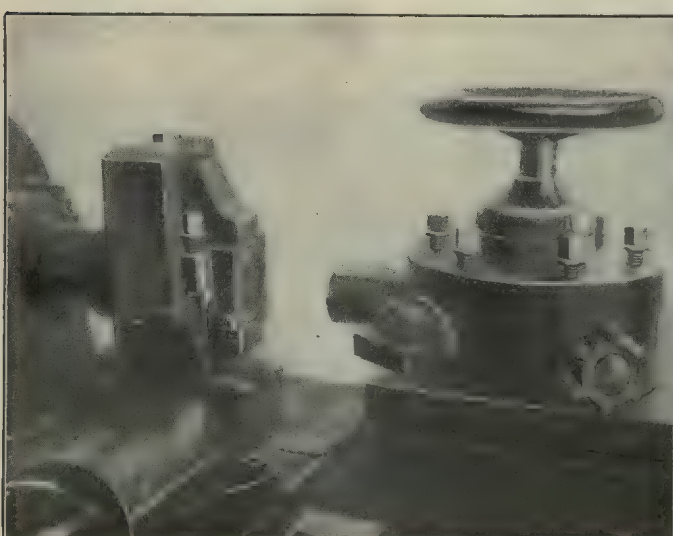


FIG. 9. FIRST OPERATION ON CYLINDER HEAD

FIG. 10. DRILLING THE CYLINDER HEAD

The valves are then screwed on an arbor and the outside turned to 0.002 in. over size, the production being 100 per hour. The valve is then ground on the periphery as the final operation, shown in Fig. 5. The valve *A* is again located and held on a threaded arbor. The grinding fixture is held in the tool post of the lathe and chuck and the rear surface faced and the center hole bored. This is the second operation, the production being the same as for the first. The case is then placed at *A* in the fixture shown in Fig. 6, and held with an expanding bushing operated by the square-headed screw *B*. One of the holes is then bored to size and threaded.

FIG. 11. WINDING THE SPRING

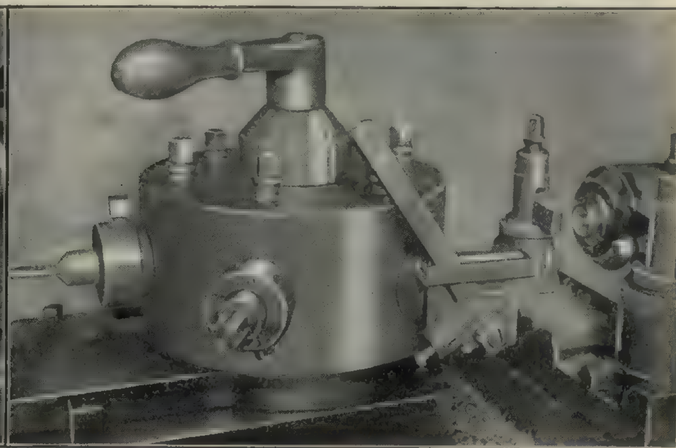


FIG. 12. MACHINING THE SPRING RETAINER

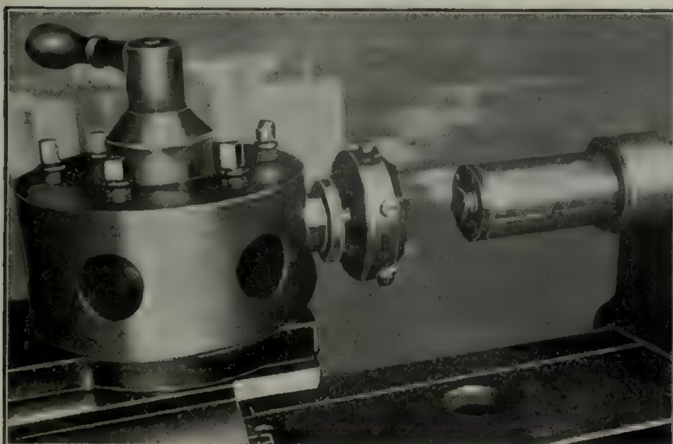


FIG. 13. CUTTING THREADS ON CYLINDER

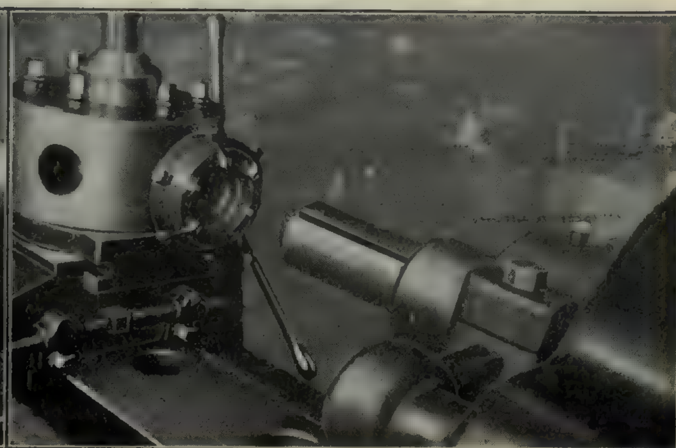


FIG. 14. VIEW OF ARBOR AND THREAD DIE

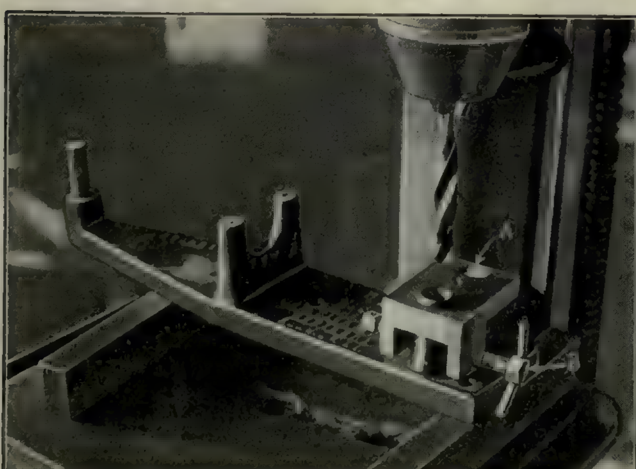


FIG. 15. SECOND DRILLING OPERATION ON BASE

FIG. 16. THIRD DRILLING OPERATION ON BASE

the revolving wheel is fed along the surface of the valve as the carriage is fed along with the lathe. The valves are ground to size at the rate of 100 per hour.

The first operation when machining the valve case is to face, turn the shoulder and thread. The production is 60 per hour. The piece is then held on a threaded

The sliding member of the fixture is then slid back, the two positions being determined with the index pin *C*. The other hole is then bored and tapped in the valve case. The two holes are for holding the inlet and outlet tubes. The production for the operation is 50 per hour. An interesting feature of the boring tool is worth

noting. This is made of flat steel *D* held in with a wedge, as shown. In this way the boring tool can be easily made and ground; also, it does not cost much to construct. By tightening the screw *E* the wedge is forced down onto the tool, thus holding it securely.

The final operation on the valve case is to saw the slots. The piece is placed at *A* in the fixture shown in Fig. 7, and by pushing down the lever *B* the forward end of the fixture *C* is drawn back. This part of the fixture has a bored recess that locates the piece in the fixture. The turret head is then fed along the machine to a stop and the cutters are made to revolve. The turret is then fed forward to a stop and the slots machined in the valve case to the proper depth. The double cutters are then removed and a single cutter substituted, as shown in Fig. 8.

The valve case is then turned around 180 deg., being located for this and the preceding operation by the pin *A*, which fits in one of the tapped holes. The machine is again fed along to the stops as described and the third slot machined.

The stops for the two machining operations may be seen on the cross-slide under the fixture. These machined slots are for exhausting the water from the cylinder and admitting it against the piston. The rate of production for machining the three slots is 100 valve cases per hour.

The first operation in manufacturing the cylinder head is shown in Fig. 9. The casting is held in a special two-jawed chuck as shown. The sequence of suboperations is as follows: Rough bore; finish bore and face; machine undercut with cross-slide; thread. A type of boring tool similar to that previously noted is again used on this machine. The rate of production for this operation is 28 heads per hour.

The casting is then reversed and held in a two-jawed chuck, the cored hole being bored out and tapped as the second operation. The production is 25 per hour.

The head is next drilled as shown in Fig. 10. The casting is placed on three pins and located by means of stop pins fitting in the two cored holes. The drill is guided through steel bushings in the usual manner, as shown. The rate of production is 200 per hour.

In another operation the two cored holes are bored and tapped, using a fixture somewhat like that in Fig. 6.

In Fig. 11 is illustrated the method of winding the conical spring. The wire is fed through a hole in the tool *A*, which is held in the toolpost of the lathe, onto the arbor *B*. This arbor is made conical and threads machined on its periphery. The wire is then fed onto the revolving arbor into the thread, to form the spring. A number of springs that have been wound are shown in the box on the lathe bed. The number of springs wound per hour is 125. The spring retainers are made from brass, and the first operation is shown in Fig. 12. The sequence of suboperations is as follows: Bore; tap; undercut; face and round corners with cross-slide; cut off. The rate of production is 100 per hour. The undercutting tool is operated by the lever *A*. As this is pushed over, the tool is slid against the inside of the part and the surface undercut. The tool may be adjusted to obtain various degrees of undercut. The piece is then screwed on an arbor and the outer surface faced and chamfered, the production being 150 per hour.

When manufacturing the cylinders, which are made from brass tubing, the first operation is cutting to length. This is performed at the rate of 200 per hour, a lathe with the tailstock removed being employed for the operation; a tool carried in the toolpost is used as the parting medium. The cylinder is then placed on an expanding arbor at *A*, Fig. 13, and the threads cut with the inserted tooth thread die *B*.

The construction of the arbor and die may be seen by referring to Fig. 14. The threads are cut on both ends of the cylinder at the rate of 60 pieces per hour. When manufacturing the base the first hole is drilled to size from the cored hole. The jig shown in Fig. 15 is then placed on the casting, being located at *A* by a pin that fits into the hole previously machined. The jig is held in position with the pin-headed screw *B*. A $^{31}/_{64}$-in. hole is then drilled, the production being 100 per hour.

The jig shown in Fig. 16 is then placed in position, being located by a pin fitting in the casting at *A* and held against the piece by the screw *B*. Two No. 6 holes are drilled at the rate of 80 castings per hour. The last drilling operation is performed with the jig shown in Fig. 17. The jig is made with an arm *A* that fits between bosses on the casting, as shown. The knurled-head screw *B* holds the jig in position. A $^{31}/_{64}$-in. hole is then drilled in each one at the rate of 100 bases per hour.

When machining the gear and rack shield the first drilling operation is performed with the tool shown in Fig. 18. This jig is made with slots that fit over the sides of the casting, thus centrally locating the boss to be drilled. A $\frac{1}{2}$-in. hole is then drilled at the rate of 200 castings per hour. The second drilling operation is performed with the tool shown in Fig. 19. This jig is made with an angular part *A* that fits into the channel section of the piece. A screw operated by the pin *B* holds the jig in position. The correct location lengthwise is determined by a pin *C* that fits in the hole drilled in the preceding operation. Two $\frac{9}{32}$-in. holes are then drilled at the rate of 150 castings per hour.

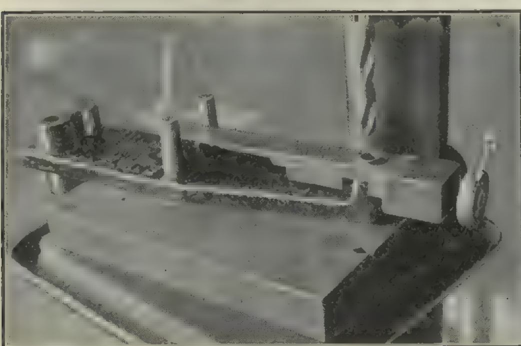


FIG. 17. FINAL OPERATION ON BASE

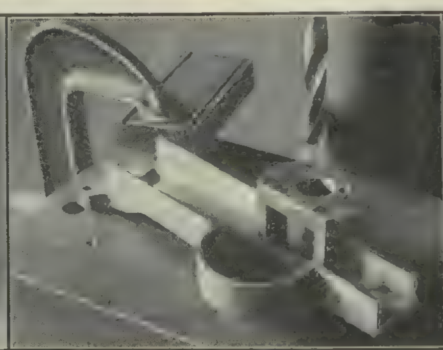


FIG. 18. DRILLING SHIELD

FIG. 19 SECOND DRILLING

United States Munitions*

The Springfield Model 1913 Service Rifle

Upper Band—II; Lower Band, Spring and Swivel; Butt Plate Swivel

SYNOPSIS—More small but important parts which require many interesting operations, fixtures and gages. The lower band and its spring involve more work than is apparent on the surface.

OPERATION 19. DRILLING SCREW HOLES AND FACE-MILLING BOSSES

Transformation—Fig. 1755. Machine Used—Pratt & Whitney three-spindle 16-in. upright miller. Number of Operators per Machine—One. Work-Holding Devices—Drill jig; closed in Fig. 1756, open in Fig. 1757; the leaf A swings over and is held by the arm B. Tool-Holding Devices—Drill chuck. Cutting Tools—Drills and counterbore, Fig. 1758; A for side screw lug; B for clamping lug. Number of Cuts—Three. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1759, location of holes; also plug form and radius gages. Production—35 pieces per hr.

OPERATION 20. PROFILING UNDERCUT FOR HAND TENON OF HAND GUARD

Transformation—Fig. 1760. Machine Used—Pratt & Whitney No. 2 profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on stud, upright at A, clamped by finger B and cam C, Fig. 1761; cam D clamps work at outer end; E is profiling form. Tool-Holding Devices—Taper shank. Cutting Tools—Profiling cutter, 0.5 in. in diameter, teeth 0.5 in. long; six teeth for roughing cutter, seven for finishing cutter, both right-hand; teeth cut on face and end. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Compound, 1/4-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Form. Production—35 pieces per hr.

OPERATION 20½. BURRING OPERATIONS 19 AND 20.

Number of Operators—One. Description of Operation—Removing burrs from operations 19 and 20. Apparatus and Equipment Used—File. Production—75 pieces per hr.

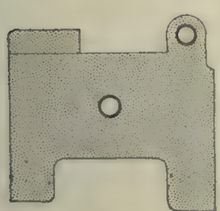


FIG. 1755

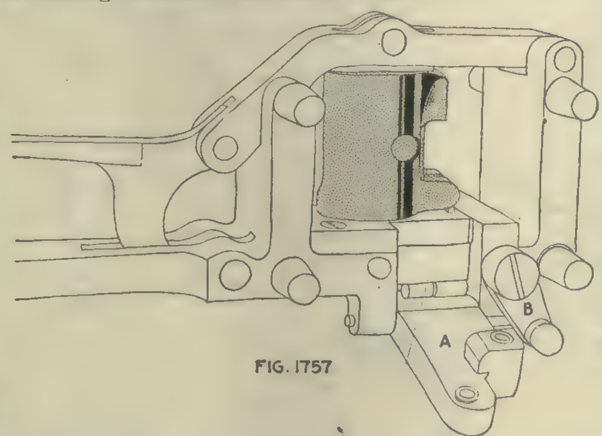


FIG. 1757

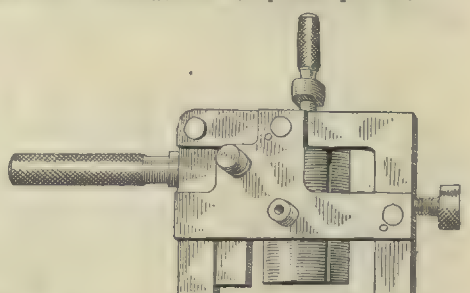


FIG. 1759

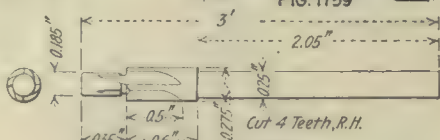
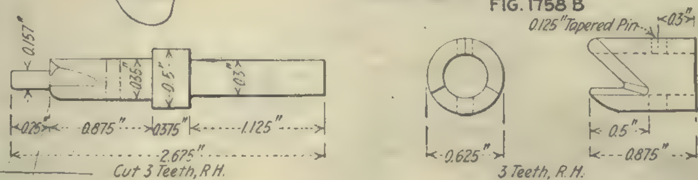


FIG. 1758 B


OPERATION 19

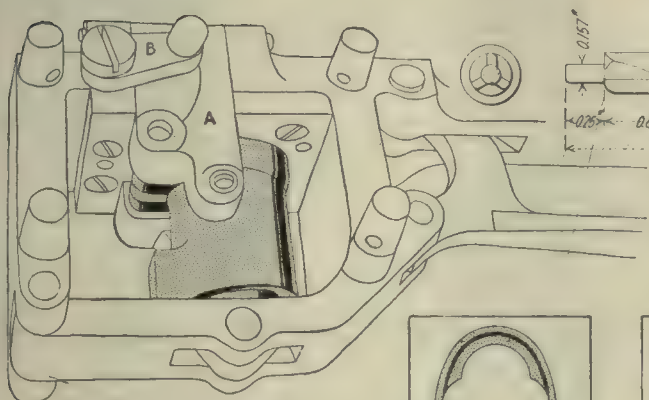


FIG. 1756


FIG. 1758A

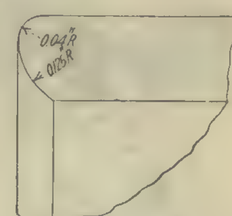

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FIG. 1760

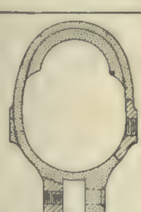


FIG. 1762

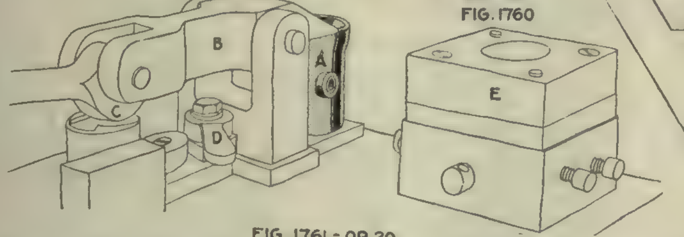


FIG. 1761 - OP 20

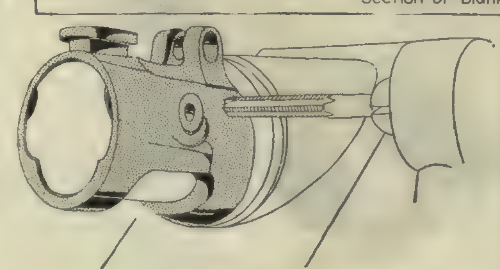


FIG. 1763 - OP. 21

OPERATION 21. TAPPING SCREW HOLES

Transformation—Fig. 1762. Number of Operators—One. Description of Operation—Tapping screw holes in special fixture, partly shown in Fig. 1763; the tapping spindle is mounted on the same base as the work-holding fixture and operated by a handwheel. Apparatus and Equipment Used—Tapping fixture, Fig. 1763, and tap, which is 0.185 in. in diameter, 26 threads per inch; it has three right-hand spiral flutes; thread-

ed part is 1.4 in. long. Gages—Threaded plug gage. Production—350 pieces per hr.

OPERATION 22. MILLING ACROSS TOP TO REMOVE STOCK

Transformation—Fig. 1764. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on mandrel, clamped by jaws, Fig. 1765; mandrel is shown at A. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1766. Number of Cuts—One. Cut Data—60 r.p.m.; ⅝-in. feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—50 pieces per hr.

OPERATION 21½. REAMING BARREL SEAT AND MANDRELING TO CORRECT INSIDE SHAPE

Transformation—Fig. 1767. Number of Operators—One. Description of Operation—Reaming barrel seat and correcting inside shape. Apparatus and Equipment Used—Bench lathe and block to hold band from turning; reamer is 0.6584 in. in diameter, 14 right-hand spiral flutes, one turn in 7.41 in.; fluted portion is 5.70 in. long. Gages—Fig. 1768; this is also used for operation 6½. Production—150 pieces per hr. Note—A mandrel is drawn through the hole to correct shape.

OPERATION 23. SLOTTING

Transformation—Fig. 1769. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on stud to prevent distortion; clamped by vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Slitting saw, 2 in. in diameter, 0.05 in. thick. Number of Cuts—One. Cut Data—650 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1500 pieces. Gages—Width of slot. Production—350 pieces per hr.

OPERATION 28. CORNERING

Number of Operators—One. Description of Operation—Filing and cornering. Apparatus and Equipment Used—File. Production—100 pieces per hr.

OPERATION 29. BLUING, HARDENING AND BROWNING

Description of Operation—The upper band is blued in the regular way, then the bayonet lug or stud is hardened in cyanide at 1500 deg. F.; after this the band is browned in the regular way; the object of bluing is to insure a rustproof coating on every part in case the browning solution should not be brushed into every corner, such as between the lugs; the bluing also effectually prevents a bright spot being left to reflect light in any direction.

OPERATION 30. ASSEMBLING

Number of Operators—One. Description of Operation—Assembling screw and swivel. Apparatus and Equipment Used—Screwdriver and hands. Production—350 pieces per hr.

The Lower Band

The lower band, Fig. 1773, holds the back end of the upper or hand guard in place on the barrel and the stock. It also carries the front swivel for the strap by which the rifle is swung over the shoulder. As made at present, it is a drop forging and goes through the 28 operations shown. Experiments looking to the making of these bands from sheet steel are now under way.

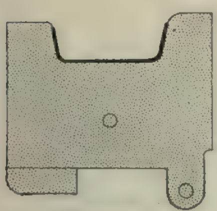


FIG. 1764

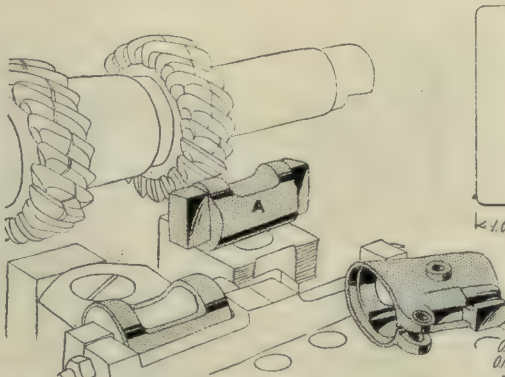


FIG. 1765

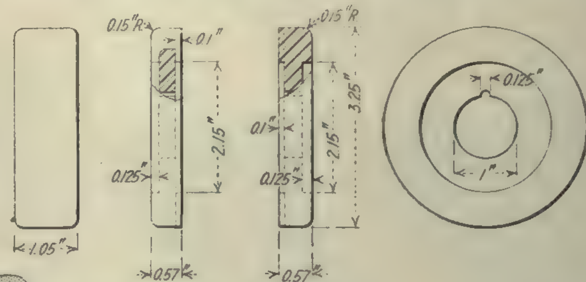


FIG. 1766

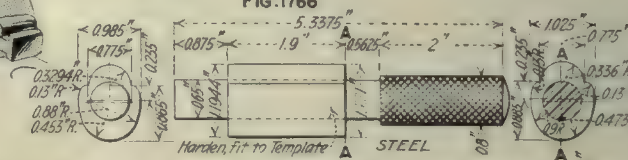


FIG. 1768

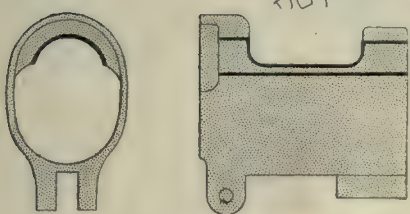


FIG. 1767

FIG. 1764, 1765, 1766 OP. 22
FIG. 1767, 1768 OP. 21½
FIG. 1769 OP. 23
FIG. 1770, 1771, 1772 OP. 24¼

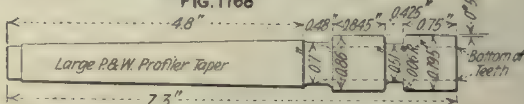


FIG. 1772

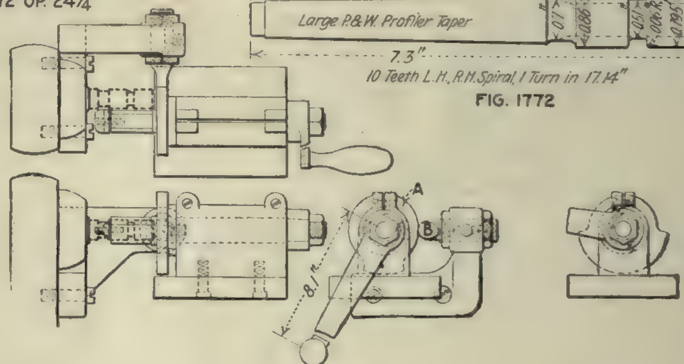


FIG. 1771

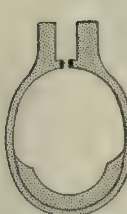


FIG. 1769

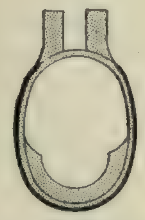


FIG. 1770

OPERATION 23½. STAMPING LETTER H

Number of Operators—One. Description of Operation—Stamping letter H. Apparatus and Equipment Used—Hand stamp and hammer. Production—600 pieces per hr.

OPERATION 24. FILING TO FINISH

Number of Operators—One. Description of Operation—Finish-filing. Apparatus and Equipment Used—File. Production—100 pieces per hr.

OPERATION 24¼. ROTARY-MILLING OUTSIDE

Transformation—Fig. 1770. Machine Used—Brainard large hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, Fig. 1771; the form A, in contact with B, gives proper shape. Tool-Holding Devices—Taper shank. Cutting Tools—Milling cutters, Fig. 1772. Number of Cuts—One. Cut Data—450 r.p.m. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—100 pieces per hr.

OPERATION 25. POLISHING

Number of Operators—One. Description of Operation—Polishing outside surface. Apparatus and Equipment Used—Polishing jack and wheel. Production—60 pieces per hr.

OPERATIONS ON THE LOWER BAND

Operation	
A	Blocking from bar
A–1	Pickling
C	Trimming outside
B	Mandreling to shape
B–1	Pickling
D	Dropping on mandrel
D–1	Pickling
E	Trimming ends
1	Edging sides to remove stock for forging
F	Dropping on mandrel to finish
F–1	Pickling
G	Trimming ends
2	Edging sides to width
H	Annealing
3	Pressing to size and shape and stamping U
3½	Straightening and correcting lug
4	Buffing to finish thickness
5	Milling lugs to finish
6½	Burring
7	Drilling screw hole in lugs and counterboring
7½	Filing inside and outside of lug
8	Tapping lug for screw
8½	Burring

10 Polishing
10½ Slotting
11 Filing inside and cornering
12 Assembling lower band and lower-band swivel
13 Bluing

OPERATION A. BLOCKING FROM BAR

Transformation—Fig. 1774. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 800-lb. drop hammer. Production—185 pieces per hr.

OPERATION A-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and put in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water; left in this for from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

OPERATION C. TRIMMING OUTSIDE

Machine Used—Snow-Brooks No. 1; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—450 pieces per hr. Note—This punch and die trims outside and inside in one operation.

OPERATION B. MANDRELING TO SHAPE

Transformation—Fig. 1775. Number of Operators—One. Description of Operation—Mandreling to shape, as with upper band. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer; taper mandrel of proper size and shape. Gages—None. Production—125 pieces per hr.

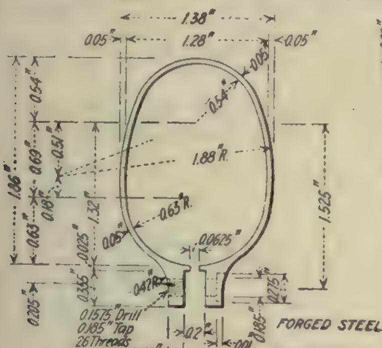


FIG. 1773

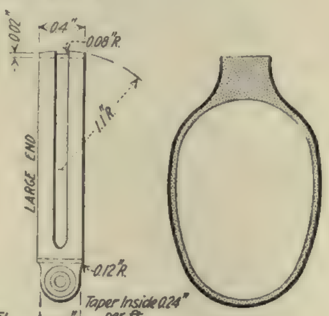


FIG. 1774

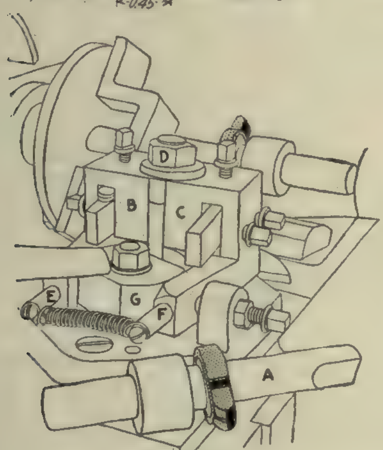


FIG. 1777

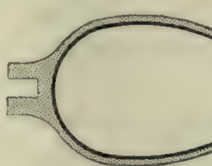


FIG. 1775

FIG. 1774, OP. A
FIG. 1775 OP. B
FIG. 1776, 1777, 1778, OP. 1
FIG. 1779 OP. G
FIG. 1780, 1781 OP. 2

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling.

OPERATION D. DROPPING ON MANDREL

Number of Operators—One. Description of Operation—Shaping flatwise on mandrel. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer; mandrel similar to operation B. Gages—None. Production—125 pieces per hr.

OPERATION D-1. PICKLING

Description of Operation—Same as previous pickling.

OPERATION E. TRIMMING ENDS

Machine Used—Perkins No. 19; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through dies. Average Life of Punches and Dies—About 15,000 pieces. Gages—None. Production—500 pieces per hr.

OPERATION 1. EDGING SIDES TO REMOVE STOCK FOR FORGING

Transformation—Fig. 1776. Machine Used—Machine built at Hill shop. Number of Operators per Machine—One. Work-Holding Devices—On mandrel A, Figs. 1777 and 1778. Tool-Holding Devices—Tools held in crossfeed of carriage, Fig. 1778; tool posts B and C are pivoted at D; the tails E and F are controlled by the cam G and moved into position to give correct width. Cutting Tools—Side tools, right and left. Number of Cuts—Two. Cut Data—250 r.p.m.; hand feed. Coolant—Compound, ⅛-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Width. Production—85 pieces per hr.

OPERATION F. DROPPING ON MANDREL TO FINISH

Transformation—Same as Fig. 1775. Number of Operators—One. Description of Operation—Dropping to finish, using mandrel similar to operation B. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Gages—Width and thickness. Production—125 pieces per hr.

OPERATION F-1. PICKLING

Description of Operation—Same as previous operations on pickling.

OPERATION G. TRIMMING ENDS

Transformation—Fig. 1779. Machine Used—Perkins No. 19; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through dies. Gages—None. Production—500 pieces per hr.

OPERATION 2. EDGING SIDES TO WIDTH

Transformation—Fig. 1780. Machine Used—Machine built at Hill shop, same as for upper band. Number of Operators per Machine—One. Work-Holding Devices—On arbor, Fig. 1781. Tool-Holding Devices—Cutters held in crossfeed carriage, same as Fig. 1778. Cutting Tools—Side tools, right and left. Number of Cuts—Two. Cut Data—250 r.p.m.; hand feed.

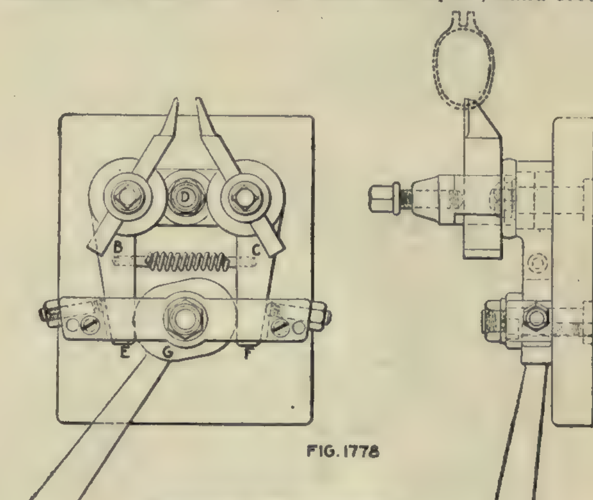


FIG. 1778

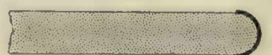


FIG. 1779


FIG. 1776

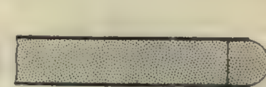


FIG. 1780

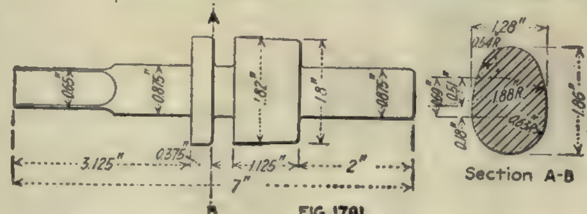


FIG. 1781

Coolant—Compound, ⅛-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Width. Production—85 pieces per hr.

OPERATION H. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal and heated to 850 deg. C. (1562 deg. F.); left over night to cool. Apparatus and Equipment Used—Iron pots, Brown & Sharpe annealing furnace, oil burner, powdered charcoal.

OPERATION 3. PRESSING TO SIZE AND SHAPE AND STAMPING U

Machine Used—Perkins No. 19 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe, by setscrew placed on mandrel pressed to shape. Lubricant—None. Gages—For size and shape of inside and size of lug. Production—150 pieces per hr. Note—Hand stamp and hammer are used to stamp letter U.

OPERATION 3½. STRAIGHTENING AND CORRECTING

Number of Operators—One. Description of Operation—Straightening lugs. Apparatus and Equipment Used—Hammer and block. Gages—None. Production—200 pieces per hr.

OPERATION 4. BUFFING TO FINISH THICKNESS

Number of Operators—One. Description of Operation—Buffing to thickness. Apparatus and Equipment Used—Buffing wheel. Production—125 pieces per hr.

OPERATION 5. MILLING LUGS TO FINISH

Transformation—Fig. 1782. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—

Four. Work-Holding Devices—A double fixture, held on studs clamped by vise jaws, Fig. 1783; for crossmilling, cam A holds band; for sides the stop B takes thrust of cutters, clamp C swings sidewise against work and locks on latch D; Fig. 2053 gives details, though side fixture is now changed. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters, Fig. 1784. Number of Cuts—One. Cut Data—70 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages Fig. 2055; ears from side; others for form of ears, width and thickness. Production—50 pieces per hr.

OPERATION 6½. BURRING

Number of Operators—One. Description of Operation—Removing burrs from operation 5. Apparatus and Equipment Used—File. Production—300 pieces per hr.

OPERATION 7. DRILLING SCREW HOLE IN LUGS AND COUNTERBORING

Transformation—Fig. 1786. Machine Used—Pratt & Whitney three-spindle 16-in. upright drilling machine. Number of Cuts—One. Cut Data—250 r.p.m. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—1500 pieces. Gages—Plug thread gage. Production—350 pieces per hr.

OPERATION 8½. BURRING

Number of Operators—One. Description of Operation—Removing burrs from previous operations. Apparatus and Equipment Used—File. Production—400 pieces per hr.

OPERATION 10. POLISHING

Number of Operators—One. Description of Operation—Polishing all outside surfaces. Apparatus and Equipment Used—Wheel and polishing jack. Production—20 pieces per hr.

OPERATION 10½. SLOTTING

Transformation—Fig. 1790. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Work A is held on stud by clamp B, operated by cam C, Fig. 1791; the ears D prevent spreading of ears. Tool-Holding Devices—Standard arbor. Cutting Tools—Slitting saw, Fig. 1792. Number of Cuts—One. Cut Data—650

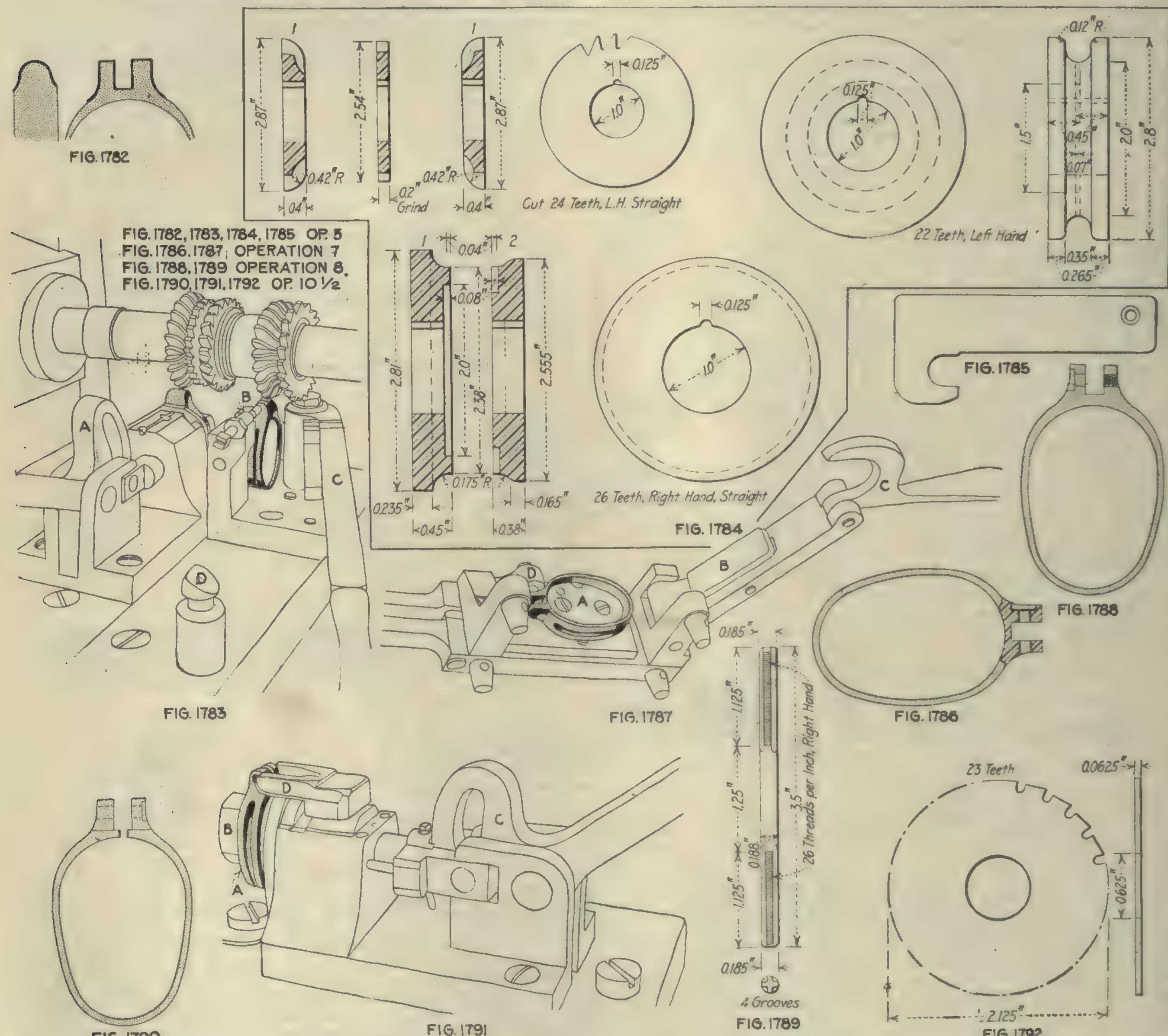


FIG. 1782, 1783, 1784, 1785 OP. 5
FIG. 1786, 1787; OPERATION 7
FIG. 1788, 1789 OPERATION 8
FIG. 1790, 1791, 1792 OP. 10½

FIG. 1782 FIG. 1783 FIG. 1784 FIG. 1785 FIG. 1786 FIG. 1787 FIG. 1788 FIG. 1789 FIG. 1790 FIG. 1791 FIG. 1792

of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1787; work located on plug A, held down by plate B, locked by hook C; bushing on side; knockout for removing work. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill, and counterbore for screw head. Number of Cuts—Three. Cut Data—750 r.p.m. for drill; 450 r.p.m. for counterbore. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—300 pieces. Gages—Diameter of both holes and radius of ear. Production—60 pieces per hr.

OPERATION 7½. FILING INSIDE AND OUTSIDE OF LUG

Number of Operators—One. Description of Operation—Filing lug inside and out. Apparatus and Equipment Used—File. Production—200 pieces per hr.

OPERATION 8. TAPPING LUG FOR SCREW

Transformation—Fig. 1788. Machine Used—Pratt & Whitney tapping machine. Number of Operators per Machine—One. Work-Holding Devices—Held in hands. Tool-Holding Devices—Tap-screw chuck. Cutting Tools—Double ended, r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages None. Production—350 pieces per hr.

OPERATION 11. FILING INSIDE AND CORNERING

Number of Operators—One. Description of Operation—General filing and cornering. Apparatus and Equipment Used—File. Production—90 pieces per hr.

OPERATION 12. ASSEMBLING LOWER BAND AND LOWER-BAND SWIVEL

Number of Operators—One. Description of Operation—Assembling lower band and swivel. Apparatus and Equipment Used—Brace screwdriver and wooden block to hold band. Production—350 pieces per hr.

OPERATION 13. BLUING

Description of operation—Blue in niter at 800 deg. F., same as other bluing operations.

Lower-Band Spring

The lower-band spring, as shown in Fig. 1793, is to prevent the band from sliding down on the gunstock, if for any reason the binding screw should be loosened. This spring allows the band to be slid over it, but catches it in the notch shown and prevents its removal unless the spring is pushed into the stock.

This piece, which is rather difficult to machine, owing to the round stud at right angles to the spring itself, is finished with a hand mill; and the spring itself is ma-

Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—125 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Same as all previous annealing operations; same equipment, etc., used.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Same as all previous pickling operations; same equipment, etc., used as previously described.

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 1 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Setscrew in shoe. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—650 pieces per hr.

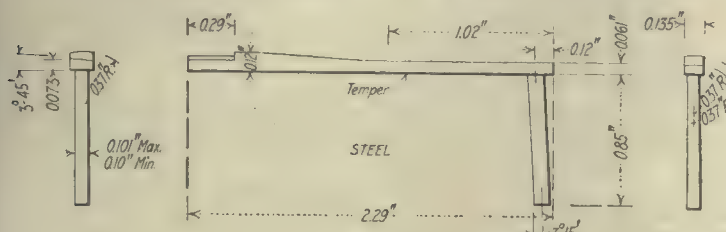


FIG. 1793

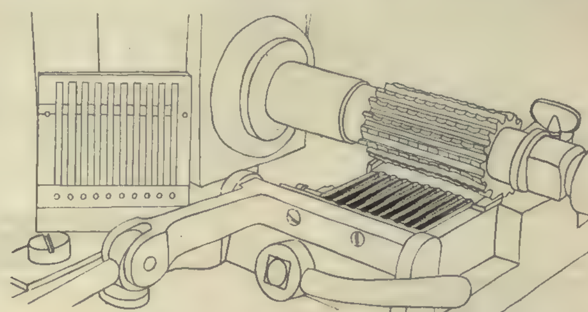
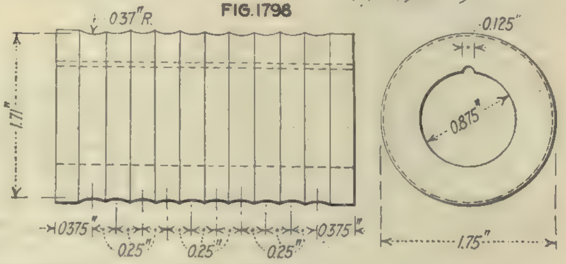


FIG. 1798

FIG. 1794

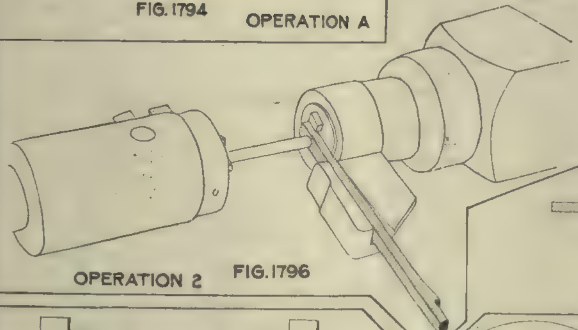
OPERATION A

FIG. 1795



OPERATION 4

FIG. 1799



OPERATION 2

FIG. 1796

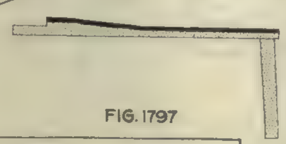


FIG. 1797

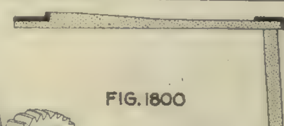


FIG. 1800

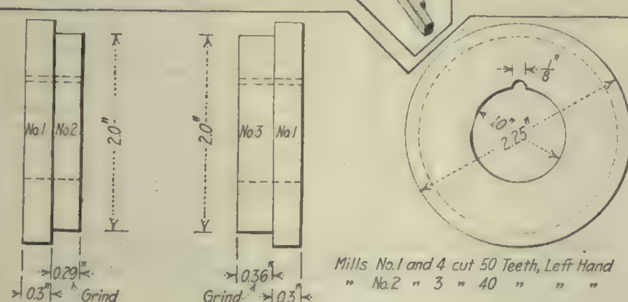


FIG. 1802

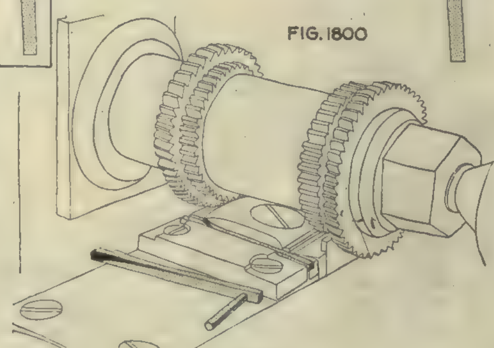


FIG. 1801

OPERATION 5

chined all over. It is then necessary to "set" the spring, and an ingenious little bench fixture is used for this purpose.

OPERATIONS ON THE LOWER-BAND SPRING

Operation	
A	Forging from bar
B	Annealing
B–1	Pickling
C	Trimming
D	Cold dropping
2	Milling pivot to size
4	Milling right side lengthwise
5	Milling ends and shoulder to length
AA	Removing burrs left by operation 5
1	Buffing left side
2½	Buffing top and bottom edges
3	Filing, general cornering
6	Setting spindle on angle
7	Tempering and hardening
8	Polishing right side and top and bottom edges and cornering end of spindle (on buff wheel)
9	Bluing

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1794. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

OPERATION 2. MILLING PIVOT TO SIZE

Transformation—Fig. 1795. Machine Used—Machine built at Hill shop. Number of Operators per Machine—One. Work-Holding Devices—Set on block in tailstock, Fig. 1796. Tool-Holding Devices—In screw chuck. Cutting Tools—Hollow mill, 0.102 in. in inside diameter. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, 1/8-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Diameter and length of pivot. Production—350 pieces per hr.

OPERATION 4. MILLING RIGHT SIDE LENGTHWISE

Transformation—Fig. 1797. Machine Used—Ames Manufacturing Co. Number of Operators per Machine—One. Work-Holding Devices—Work held in block, 10 to a block, Fig. 1798; block clamped by vise jaws; a bridge fixture is raised to give proper form. Tool-Holding Devices—Standard arbor. Cutting Tools—Multiple milling cutter, Fig. 1799. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Thickness and form. Production—175 pieces per hr.

OPERATION 5. MILLING ENDS AND SHOULDER TO LENGTH

Transformation—Fig. 1800. Machine Used—Miller built at Hill shop. Number of Machines per Operator—Two. Work-Holding Devices—Held by vise jaws, Fig. 1801. Tool-Holding Devices—On arbor. Cutting Tools—Milling cutters, Fig. 1802. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Thickness and length. Production—100 pieces per hr.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 5

Number of Operators—One. Description of Operation—Removing burrs left by operation 5. Apparatus and Equipment Used—File. Production—Grouped with operation 5.

OPERATION 1. BUFFING LEFT SIDE

Transformation—Fig. 1803. Number of Operators—One. Description of Operation—Buffing sides. Apparatus and Equipment Used—Buff wheel on special vertical spindle, Fig. 1804. Gages—None. Production—350 pieces per hr.

OPERATION 2½. BUFFING TOP AND BOTTOM

Transformation—Fig. 1805. Number of Operators—One. Description of Operation—Buffing top and bottom. Apparatus and Equipment Used—Similar to Fig. 1804, but with special holder. Gages—Thickness. Production—60 pieces per hr.

OPERATION 3. FILING, GENERAL CORNERING

Number of Operators—One. Description of Operation—Filing and general cornering. Apparatus and Equipment Used—File. Production—90 pieces per hr.

in the under side of the gunstock, just in front of the butt plate, and carries the lower swivel for the band by which the rifle is slung over the shoulder. This swivel is bent up from a straight rod about 0.16 in. in diameter and assembled in place. An opening is left between the points of the swivel so that a pin, forced into the plate between these points, effectually prevents end movement.

Both the lower-band swivel, Fig. 1825, and the stacking swivel, detail in Fig. 1838, are made from drop forgings. The lower-band swivel is of Class B steel, 0.47 in. round, while the stacking swivel is of Class D steel of the same size. These parts are drop forged, trimmed and swaged with suitable punches and dies, so that the only machining is on the lugs that fit between the ears of the upper and lower bands.

The stacking swivel has a piece cut out so as to allow three guns to be stacked by hooking the swivels together.

FIG. 1803

FIG. 1805

FIG. 1806

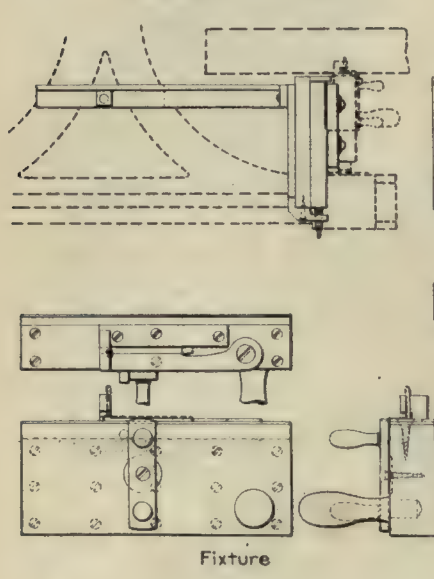


FIG. 1807A

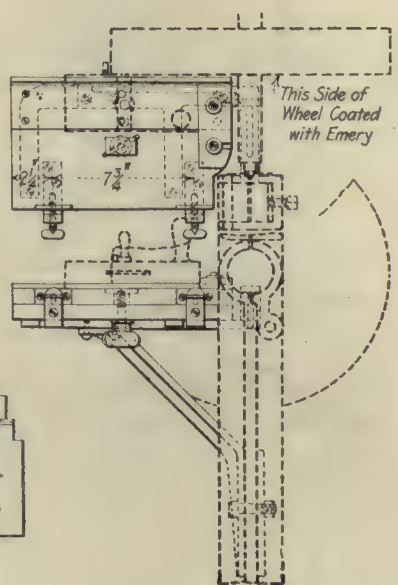


FIG. 1804

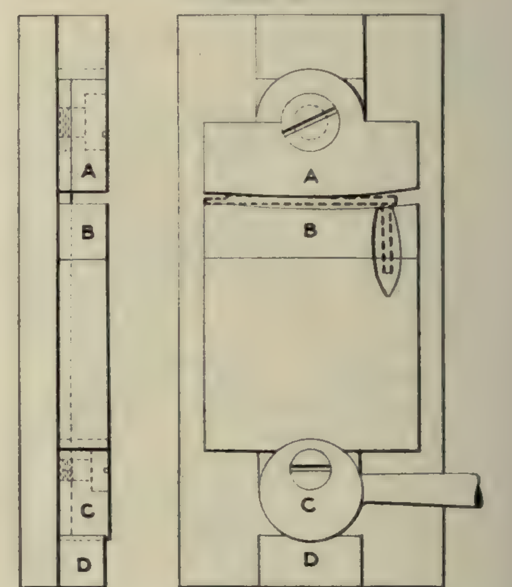


FIG. 1807

OPERATION 6. SETTING SPINDLE ON ANGLE

Number of Operators—One. Description of Operation—The spindle of the spring is placed in the opening of jaws B, and the jaw A is drawn in by the cam C, working against the block D, Fig. 1807. Apparatus and Equipment Used—Bench bending fixture, shown in Fig. 1807-A; jaw A and cam C fastened to a slide, so that the slide is moved in both directions by cam C.

OPERATION 7. TEMPERING AND HARDENING

Number of Operators—One. Description of Operation—Hardened in open oil fire at 1450 deg. F.; tempered in lead bath at 900 deg. F.

OPERATION 8. POLISHING RIGHT SIDE AND TOP AND BOTTOM EDGES AND CORNERING END OF SPINDLE (ON BUFF WHEEL)

Number of Operators—One. Description of Operation—Polishing sides and top. Apparatus and Equipment Used—Polishing jack and wheel. Production—90 pieces per hr.

OPERATION 9. BLUING

Description of Operation—Same as all other bluings.

Butt Swivel Plate

The butt swivel plate, as shown in detail in Fig. 1808, is made of Class D steel, 0.40 in. square, the same size and quality of material as was used for the extractor collar. This piece is a drop forging in which the screw holes are punched. The hole for the swivel and the retaining pin are both drilled in a suitable jig. The plate is located

The lower-band swivel has the thin slot through the lug to afford a spring or friction tension when tightened by the lower-band screw.

OPERATIONS ON THE BUTT SWIVEL PLATE

Operation	
A	Forging from bar
B	Annealing
B–1	Pickling
C	Trimming
D	Cold dropping
E	Surfacing
1	Punching screw holes
1½	Drilling swivel and pin holes
2	Reaming swivel and pin holes (1½, 2 and 3 grouped)
3	Counterboring screw holes
4	Profiling edges
CC	Removing burrs left by operation 4
5	Countersinking swivel hole
6	Polishing outer surface
7	Assembling with swivel and pin
8	Bluing

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1809. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—350 pieces per hr.

OPERATION B. ANNEALING

Description of Operation—Same as previous annealing operations.

OPERATION B-1. PICKLING

Description of Operation—Same as all previous picklings.

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 1; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—In shoe, by setscrews. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—About 15,000 pieces. Production—350 pieces per hr.

OPERATION D. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

OPERATION E. SURFACING

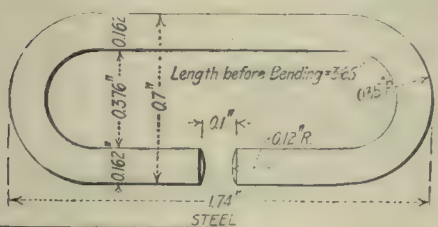
Transformation—Fig. 1810. Number of Operators—One. Description of Operation—Polishing bottom surface of butt swivel plate. Apparatus and Equipment Used—Horizontal polishing machine, built at Hill shops, and wood holder. Gages—None. Production—350 per hr.

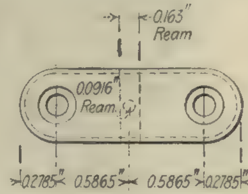
OPERATION 3. COUNTERBORING SCREW HOLES

Transformation—Fig. 1815. Machine Used—Ames 16-in., single spindle. Number of Operators per Machine—One. Work-Holding Devices—Work held on block with pin to hold from swinging. Tool-Holding Devices—Drill chuck. Cutting Tools—Double-size four-flute reamer; point, 0.2126 in. in diameter; body, 0.2187 in. in diameter. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—500 pieces. Gages—Plug for hole and counterbore. Production—350 pieces per hr.

OPERATION 4. PROFLING EDGES

Transformation—Fig. 1816. Machine Used—Garvin profiler. Number of Operators per Machine—One. Work-Holding Devices—Held on pins, which are also used to bind, Fig. 1817. Tool-Holding Devices—Taper shank. Cutting Tools—Taper profiling cutter. Number of Cuts—Two. Cut Data—1200 r.p.m.; hand feed. Coolant—Compound, ¼-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Fig. 1818, form, diameter and location of holes with the profiling. Production—90 pieces per hr.





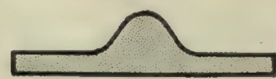


FIG. 1809
OPERATION A

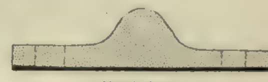


FIG. 1810
OPERATION E

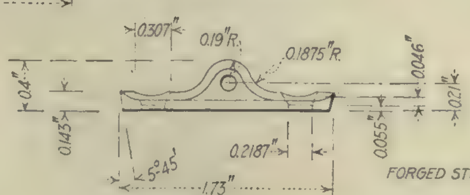


FIG 1808

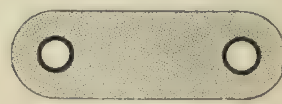


FIG. 1811
OPERATION 1


FIG. 1812

OPERATION 1½ & 2

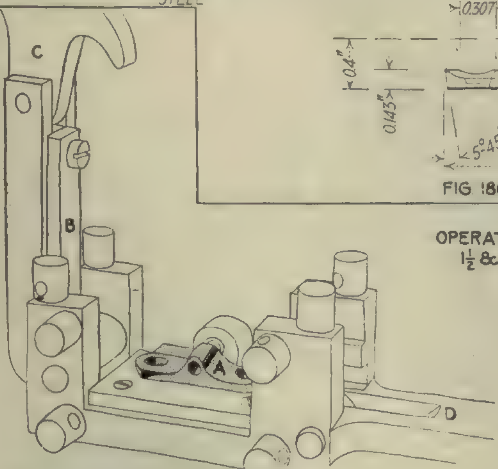


FIG. 1813

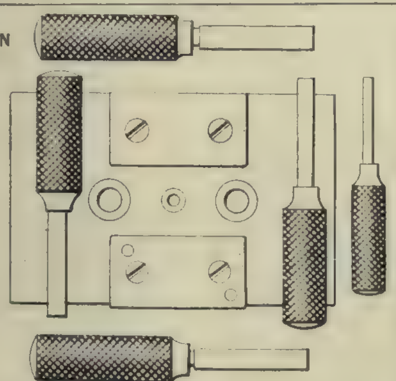


FIG. 1814

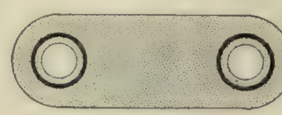


FIG. 1815
OPERATION 3

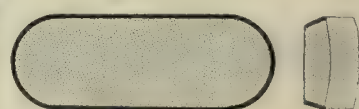


FIG. 1816

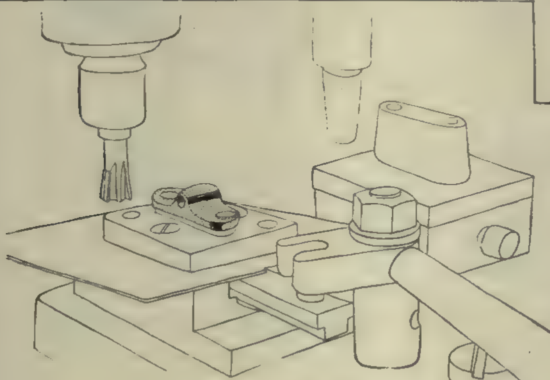
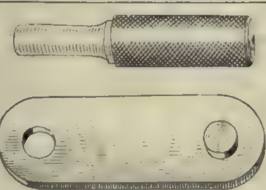


FIG. 1817


OPERATION 4

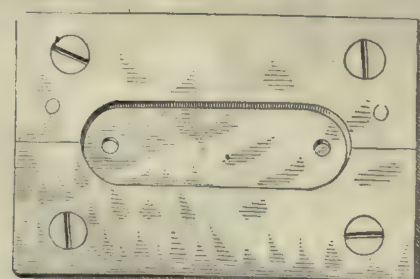


FIG. 1818

OPERATION 1. PUNCHING SCREW HOLES

Transformation—Fig. 1811. Machine Used—Garvin No. 1; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Steel strippers screwed to face of die. Average Life of Punches and Dies—5000 pieces. Production—650 pieces per hr.

OPERATIONS 1½ AND 2. DRILLING SWIVEL AND PIN HOLES; REAMING SWIVEL AND PIN HOLES

Transformation—Fig. 1812. Machine Used—Sigourney 16-in. two-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1813; work is located at A by pins in screw holes and held by plate B; hook C locks into D and holds work for drilling in two directions. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drills and two round-nose half-round reamers, one 0.0916 in., the other 0.163 in. in diameter. Number of Cuts—Two. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil. $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces. Gages—Fig. 1814, diameter and location of holes. Production—85 pieces per hr.

OPERATION CC. REMOVING BURRS LEFT BY OPERATION 4

Number of Operators—One. Description of Operation—Removing burrs from operation 4. Apparatus and Equipment Used—File. Production—Grouped with operation 4.

OPERATION 5. COUNTERSINKING SWIVEL HOLE

Transformation—Fig. 1819. Number of Operators—One. Description of Operation—Countersinking swivel hole. Apparatus and Equipment Used—Countersink and bench lathe; countersink, Fig. 1820. Gages—None. Production—2500 pieces per hr.

OPERATION 6. POLISHING OUTER SURFACE

Number of Operators—One. Description of Operation—Polishing outside surface. Apparatus and Equipment Used—Polishing jack and wheel. Production—50 pieces per hr.

OPERATION 7. BENDING SWIVEL AND ASSEMBLING

Transformation—Fig. 1821. Number of Operators—One. Description of Operation—Bending swivel from straight wire by means of fixture, Figs. 1822 and 1823. Apparatus and Equipment Used—Fixture screwed to bench; Fig. 1822 shows fixture open, and Fig. 1823, closed; the wire is clamped at the

FIG. 1819

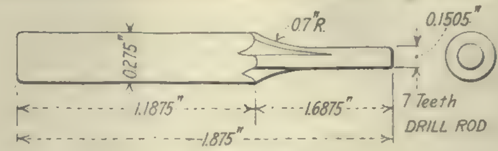


FIG. 1820

FIG. 1821

OPERATION 5

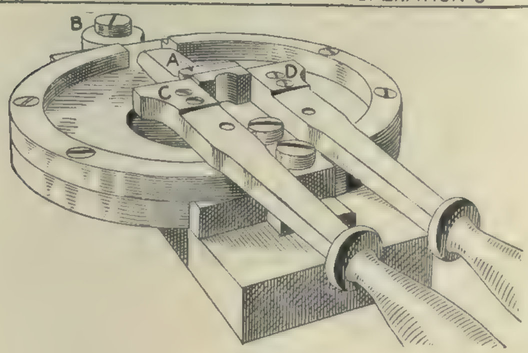


FIG. 1822

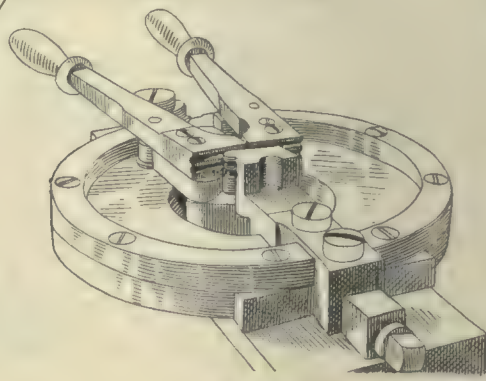


FIG. 1823

FIG. 1824

OPERATION 7

center by block A, operated by cam B; then levers C and D bend the ends of swivel to form around the center block. Gages—Fig. 1824, diameter, length and rounded end of butt swivel. Production—90 pieces per hr.

OPERATION 8. BLUING

Number of Operators—One. Description of Operation—Blue butt swivel plate in niter at 800 deg. F.

OPERATIONS ON THE LOWER-BAND SWIVEL, FIG. 1825

Operation	
A	Blocking from bar
A–1	Pickling
B	First trimming, outside
C	Dropping to finish
C–1	Pickling
D	Second trimming, outside
D–1	Trimming
E	Annealing
E–1	Pickling
F	Cold dropping
DD	Swaging to size
1	Hand-milling both sides of lug
2	Drilling screw hole
3	Reaming screw hole
AA	Removing burrs left by operation 3
4	Milling first side of lug
5	Milling second side of lug
6	Milling friction slot
CC	Removing with reamers the burrs left by operation 6
A–1	Rotary-filing circle, inside
B–2	Buffing circle, outside
C–3	Tumbling
7	Filing both sides of lug and matching circle, outside, near lug
8	Polishing lug and circle, outside, near lug
8½	Spreading lug for tension
9	Tempering, hardening

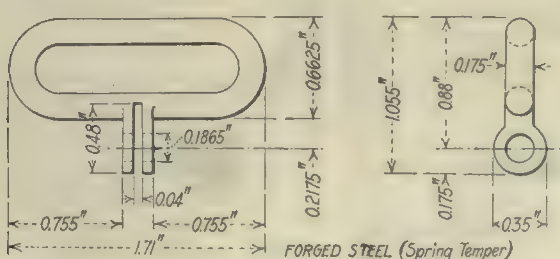


FIG. 1825

FIG. 1826

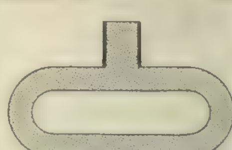


FIG. 1829

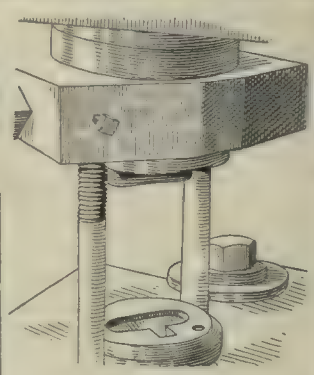


FIG. 1827

OPERATION A

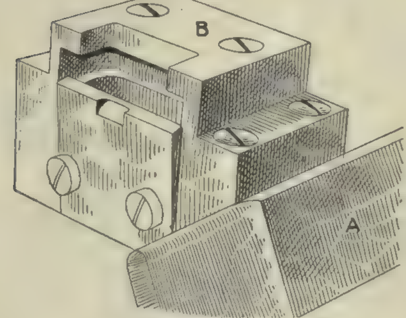


FIG. 1828

FIG. 1831

OPERATION 1

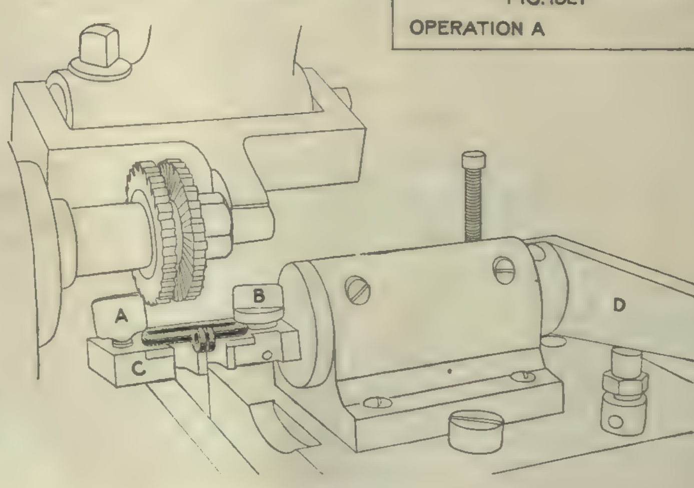


FIG. 1830

OPERATION A. BLOCKING FROM BAR

Transformation—Fig. 1826. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 pieces per hr.

OPERATION A-1. PICKLING

Description of Operation—Same as pickling previously described.

OPERATION B. FIRST TRIMMING, OUTSIDE

Machine Used—Niagara No. 36 press, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Pushed down through die. Average Life of Punches and Dies—15,000 pieces. Production—700 pieces per hr.

OPERATION C. DROPPING TO FINISH

Number of Operators—One. Description of Operation—Finish shaping. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 pieces per hr.

OPERATION C-1. PICKLING

Number of Operators—One. Description of Operation—Placed in wire baskets and put in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water; left in this for from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

OPERATIONS D AND D-1. SECOND TRIMMING, INSIDE AND OUTSIDE

Machine Used—Perkins No. 40 press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—In shoe, by setscrews; trimming outside and inside at one operation; dies shown in Fig. 1827. Stripping Mechanism—Guide pins at side of die are used in stripping; the collar, which lies over the die, is forced up by the pins on the return of the press, forcing the work off the die. Production—650 pieces per hr.

OPERATION E. ANNEALING

Number of Operators—One. Description of Operation—Put in iron pots packed with powdered charcoal and heated to 850 deg. C. (1562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Cast-iron pots, Brown & Sharpe annealing furnace, oil burner, powdered charcoal.

OPERATION E-1. PICKLING

Description of Operation—Same as previous pickling.

OPERATION F. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

OPERATION DD. SWAGING TO SIZE

Machine Used—Old crank draw press, made in Frankfort. Number of Operators per Machine—One. Punches and Punch Holders—Round shank, which holds punch A, Fig. 1828. Dies and Die Holders—Screwed to plate, bolted to bed of press B, Fig. 1828. Stripping Mechanism—Steel stripper screwed to face of die. Production—350 pieces per hr.

OPERATION 1. HAND-MILLING BOTH SIDES OF LUG

Transformation—Fig. 1829. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held in rotating fixture, Fig. 1830; thumbscrews A and B hold work to plate C, while lever D rotates the work under the milling cutters. Tool-Holding Devices—Standard arbor. Cutting Tools—Straddle-milling cutters. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1831, width of lug and location from ends. Production—350 pieces per hr.

Testing Tools for Lathes

By Thomas E. Gilmore

SYNOPSIS—For some time past large numbers of lathes had to be tested before shipment to foreign countries. In order to be able to do the work satisfactorily and quickly it was necessary to design a complete set of testing tools. A description of these tools and their use is given herewith.

The first tool is for testing the alignment of the head with the ways. This is shown in Fig. 1. The plate A is made of cast iron. It is gripped by the hub in a chuck and faced off true on the back. The chuck is then re-

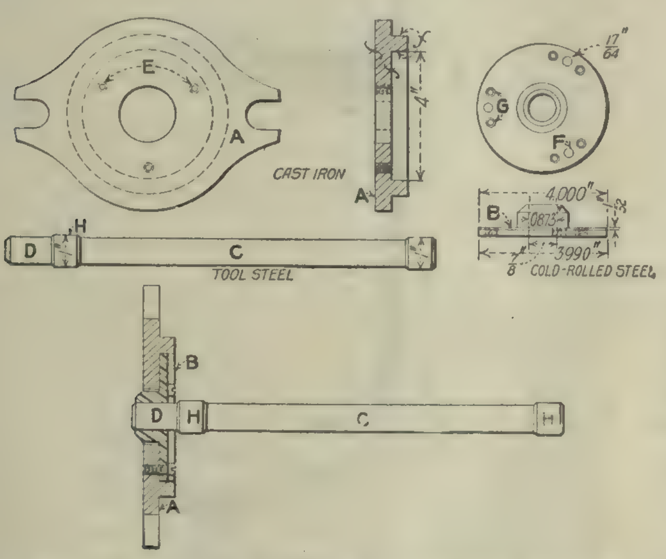


FIG. 1. TOOLS FOR TESTING ALIGNMENT OF HEAD WITH WAYS

moved and the large faceplate put on. The plate A is secured to this with two bolts through the slotted ears. It is trued up, and the hub is finished on the outside diameter and faced. It is then bored 4 in. in diameter and the bottom of the bore faced off. The corner where the bore meets the face should be square. The disk B is made of cold-rolled steel and should be a snug fit in the plate. The hole in the center is a snug fit for the test bar C. This hole is made slightly taper and also, of course, the part D of the test bar C, which fits it.

Three holes 120 deg. apart on the same circle concentric with the vertical flange are drilled and tapped at E in the plate A. Three clearance holes are drilled in B at F, so that ½-in. screws can be passed through them into the holes E in A. On each side of the holes F are two tapped holes G for adjusting screws.

In testing a lathe the plate A is clamped to the faceplate by two short bolts through the slotted ears; washers are placed under the nuts. To set the test bar the adjusting screws in the holes G are all slackened back, then the three center screws F are tightened, thus bringing the faces of B and A together. The spindle is rotated by hand or power, and a lead hammer is used on the disk to true it. The faceplate must be tight on the spindle, but need not be true or square. The test bar is then put in the hole and must be a wringing fit therein. The indicator shank is put in the tool post and tightened. The indicator ball is brought into contact with the spot H near the faceplate. Adjustment is again made, if necessary, as the spot must run dead true. The indicator is adjusted to bring the needle to the zero mark, then the carriage is run to the other surface H. By using the adjusting screws, that end can be brought true. The carriage is run back to the faceplate end of the test bar; and if it shows zero on one end and not on the other, the spindle is not parallel with the ways.

The tailstock test is made with the same setting of the test bar. The spindle is turned by hand or power. The indicator is adjusted with the ball on top of the test bar at the tailstock end and set at zero. The spindle is turned by hand or power. The tailstock is brought up to within

one inch of the test bar and tightened. The test bar being ground on centers, the centers are true with the body. The tail spindle is run out until its center comes in contact with the center of the test bar. If the tailstock is the same height as the test-bar center, the indicator will remain at zero. If the tailstock is of the set-over type, it can be set by placing the indicator ball at the front of the test bar, the needle at zero and the lathe allowed to run. The tailstock is adjusted by the screw at the back until the indicator needle remains at the zero mark irrespective of whether the tail center is in or out of the center in the test bar. This instrument can be used on any size of lathe. On engine lathes the allowance is 0.0015 in. in 12 in., but I have inspected lathes that were out as much as 0.010 in. in a length of 12 in. The reason for using a disk like B, which can be tilted, is the fact that less than 10 per cent. of the faceplates run true with the spindle.

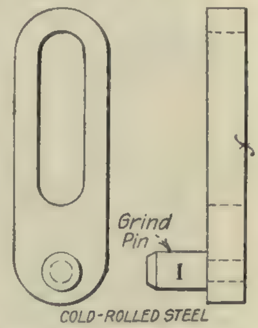


FIG. 2. TOOL FOR TESTING CROSS-SLIDE

In Fig. 2 is shown a post plate for testing the accuracy of the cross-slide. It is secured to the faceplate after making sure that the faceplate is tight on the spindle and that there is no backlash in the spindle itself. Its position on the faceplate should be such that the pin I swings through as large an arc as can be covered by the traverse of the cross-slide. The indicator is then placed in the tool post and the tool post run as far toward the apron as possible.

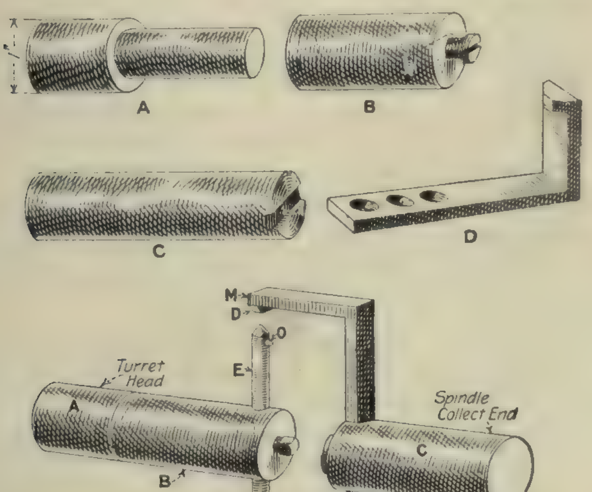


FIG. 3. TOOL FOR TESTING SCREW-MACHINE TURRETS AND SPINDLES

The post I is swung to the front, and the indicator ball is brought against the ground top of the post. The indicator is adjusted to zero and the carriage binder tightened. The spindle of the lathe is then given half a turn, bringing the post I to the back of the lathe. The tool post is run back to the end of the screw traverse (or if necessary it is slid by hand when the limit of the screw traverse is reached) to bring the indicator to contact with the surface of the post I. If the indicator reads zero, the cross slide is square with the spindle. For this test the faceplate need not be faced square with the spindle. I have tested with faceplates 0.008 in. out of square.

In Fig. 3 is shown a tool for testing alignment of screw-machine spindles and turrets: The part C is held tightly in the spring collet in the spindle. The sweep D is secured in the slot by a capscrew, as shown. The large end of A is then secured in one of the holes in the turret, just tightly enough to hold it rigid. The sleeve B, with the feeler E, is slipped over A, and E is adjusted until it touches D. By turning B, if the turret head and spindle are in perfect alignment E and D will just touch at any point in the entire circle. This test is made with the belt off the cone pulley and the spindle rotated by hand.

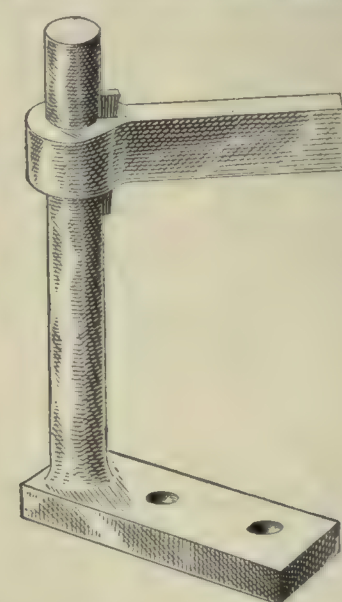
Testing the Cross-Slide

The cross-slide can also be tested with this attachment. To do this the part C is put in the collet and an indicator in the tool post. The spindle is turned until the end marked M is at the front of the lathe; the indicator ball on the cross-slide touches the end marked M and is adjusted to zero. The spindle is given a half-turn, the cross-slide is run to the back (taking the screw out if necessary), and another reading is taken. If the cross-slide is square with the spindle, the ball of the indicator will show zero on back and front alike. The spindle must be free from backlash when making this test. There must be no shake in the fit of B on A.

"Old Man" with Wedged Arm

By C. H. Willey

The illustration shows a kink for holding the arm on the "Old Man"; it does away with the setscrew, which is continually breaking and marring the post. A blow on the key tightens the arm, and a blow on the arm loosens the key. While this idea may not be new, I am sending it along, as I have never seen it in print before and think it is very good.

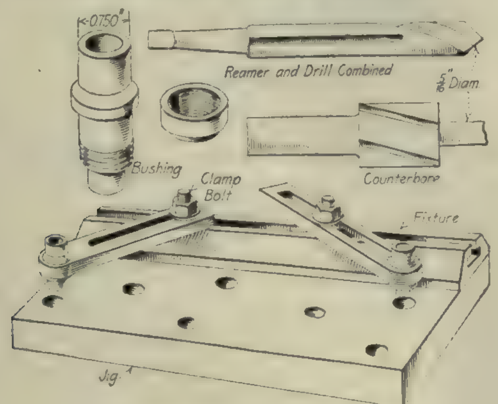

"OLD MAN" WITH WEDGED ARM

Letters from Practical Men

Jig Drilling Fixture

The illustration shows a fixture I have made to produce accurate jigs and fixtures on the drilling machine. The material for the fixture is machine steel, carbonized, hardened and ground accurately.

It is used the same as the button system, the top part of the bushing acting as the button. As many of the button bushings as desired can be employed. The arms are movable in all directions. They can be set with micrometers used on the top of the button bushings to obtain the desired location.



JIG DRILLING FIXTURE

It has the advantage over the button system on most jig work, as with buttons the work must be performed on the miller or lathe and each button trued up with an indicator previous to the slow process of boring holes. With this fixture you simply locate your button bushings and drill on the ordinary drilling machine, saving much valuable toolroom time. The fixture must be accurate, if close work is desired. I. S. WHISLER.

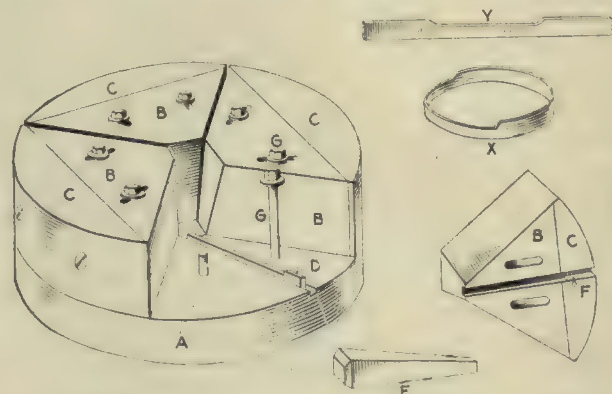
Peru, Ind.

Forging Accurate Steel Bands

There are numerous calls upon the forge shop for steel bands that must be accurately forged to closely dimensioned inside measurements. If these pieces are intended for shrink bands, the maximum and minimum allowances are very scant. If any machine work is required for finishing the inside and outside, the bands must be very accurate to shape or an excessive amount of stock must be removed in the machining.

The ring shown at X is one of this nature. In this particular case the ring is shrunk on the head of cast-iron electric-railroad motor-bearing heads that have become worn and undersize due to the constant wear and vibration. These rings are approximately 15 in. in diameter, $2\frac{1}{2}$ in. wide and $\frac{1}{2}$ in. thick. They are made of flat bar stock, as shown at Y, which has been trimmed out in the center by the shear in order to leave the narrow section in the center of the bar and put the weld in the wide section, so as to get the greatest possible strength at the weld. These rings must be so accurately shaped up and to size that only $\frac{3}{64}$ in. is allowed for the finish on each side.

The foregoing example illustrates the accuracy of the method as applied to round rings; but the method may be applied with equal satisfaction to the production of square or rectangular bands. It would be of even greater value in this case, since for an accurate fit the rectangular band would offer greater difficulty in the way of machining than a round band, and so perhaps the machine operation might be avoided.



THE WORK AND THE EXPANDING MANDREL

The jig for this operation may be readily understood from the illustration. It consists of a base block A of cast iron, upon which four movable cast-iron sections BC are forced to move radially from a common center, by means of the keys D, which serve as guides for this purpose.

The force required for moving out these sections is applied through the taper wedge E, which is machined to an equal taper on each side and fits in the tapered opening in the center between the sections. One section has been removed in order to show the key. It is shown bottom up at the right. It may be noticed that the keyway is deeper in the section C at F than it is at B; this forms an accurate stop when the block is driven out to the point where F engages with the offset in the key D. The key is pinned to the block so as to prevent any movement. All sections being similarly provided with stops insures getting the form always of an exact size when the sections have been driven out against these stops. The sections are clamped down to the base block by means of the stud-bolts G, on which the nuts are left sufficiently loose to permit motion. The blocks BC, as originally made, were formed from a one-piece cast-iron block that was turned and faced off in the lathe. It was laid on the planer to cut the keyways and was finally separated into four sections by using a saw blade $\frac{1}{4}$ in. thick. The purpose in selecting a thick blade was to make it possible to push the parts together undersize when putting on the forged ring.

Rings are always forged up so as to come slightly undersize while hot. Consequently, there is no chance of their coming oversize after the stretching operation. In turning the outside diameter of the movable sections a shrinkage allowance is made of $\frac{1}{8}$ in. in 12 in. greater than the desired diameter of the finished cold ring, to allow for the shrinkage that will occur in the hot band after the stretching and forming operation.

As has been stated, the first set of movable blocks was made with *B* and *C* in one piece; in making up the blocks for a second size it was observed that a great saving in the amount of toolroom work could be gained by separating these blocks into two sections, thus avoiding the necessity of the keyway cutting, the sawing to sections, slotting the holes for the stud-bolts, planing the bevel for the wedge, etc. Consequently, the two-section piece has been adopted for a standard.

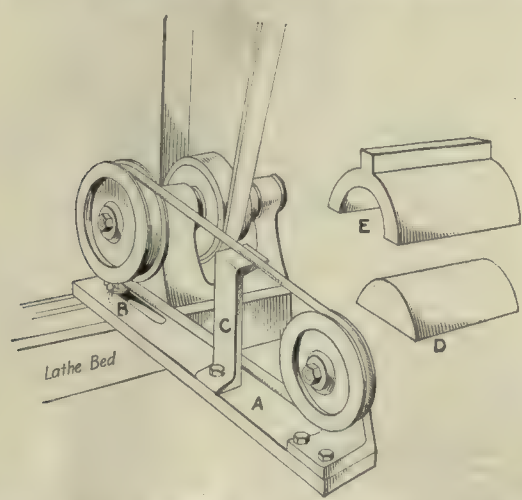
In making up the movable blocks the part *C* is planed to a finish at the joint with *B* and is fastened to it by heavy flat-head machine screws. The sections *B* are then pushed out against their stops and firmly bolted down to the base block. Then the whole tool is chucked in a lathe, and the blocks *C* receive their finishing cut.

It will be noticed in the sketch that the movable blocks are of the same outside diameter as the base block. This is not necessary by any means. In fact, it is better to have the base block slightly larger than the others. Then the blacksmith will have a guide to work the ring down to a true edge against the base as a stop and get out any weave that may have occurred in the welding.

Minneapolis, Minn. J. V. Hunter.

Emery Belt for Finishing Metal Patterns

Where there are a great many patterns to a gate, finishing them with a file requires a great deal of time. To eliminate this handwork, I made two flanged pulleys about 8 in. in diameter and 1 in. wide between flanges.



EMERY-BELT MACHINE FOR FINISHING PATTERNS

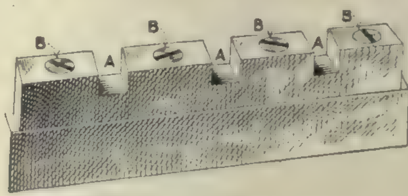
One I made with a shank to fit the speed-lathe spindle; the other is mounted on the bar *A*, as shown. This bar is made with a slot about 6 in. long to engage the steady-rest bolt *B*, the slot permitting adjustment of the belt. An endless belt made of strip emery cloth is used.

The plate *C* is placed about 1 in. below the belt. The pattern is put on the belt over the plate *C*. Slight pressure is applied to make the pattern rest on the plate, with the belt between. In this way a flat surface is obtained. By making forms like *D* and fastening them to the plate *C*, I am able to finish circles like *E*. Almost all work on patterns can be finished on this device, leaving good sharp corners, in one-fourth the usual time.

Naugatuck, Conn. F. L. Thornton.

Cutter-Setting Gage

The illustration shows a setting gage secured to the tailstock of a triple dividing head. The slots *A* are



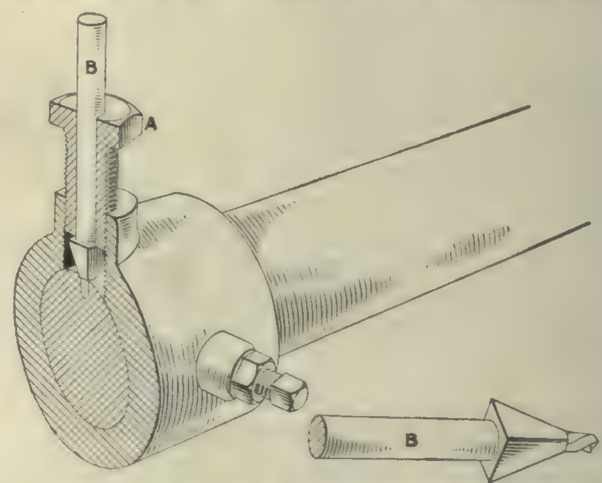
CUTTER-SETTING GAGE

spaced to conform with the center distances of the spindles. The screws *B* secure the gage to the fixture.

Denver, Colo. F. T. Goodrich.

Spotting Shafts in Place

Some time ago I was called on to finish the erection of some textile machinery and found that most of the work was done with the exception of a few details, which included the spotting of some 3-in. shafts, each with eight levers secured to it by means of two $\frac{3}{4}$-in. setscrews in



A TOOL FOR QUICK AND ACCURATE SPOTTING

the lever. As the shafts were long and heavy and close to the roof of the building, and as the levers were properly set, I did not want to take them down and carry them to the shop for drilling. It was impossible to move the levers sideways, so I made the tool illustrated; this did the spotting quickly and accurately.

A $\frac{3}{4}$-in. capscrew *A* of a suitable length was drilled $\frac{3}{8}$ in. through the center and casehardened. The tool-steel countersink *B* was hardened and tempered and had a short $\frac{1}{8}$-in. twist drill forced into a hole in the point. The setscrews were removed one at a time and the tool inserted. The projecting shank was held in the chuck of a light electric drill and the drill fed by the setscrew.

Chicago, Ill. James Tate.

Discussion of Previous Question

Actual Sizes of Drills

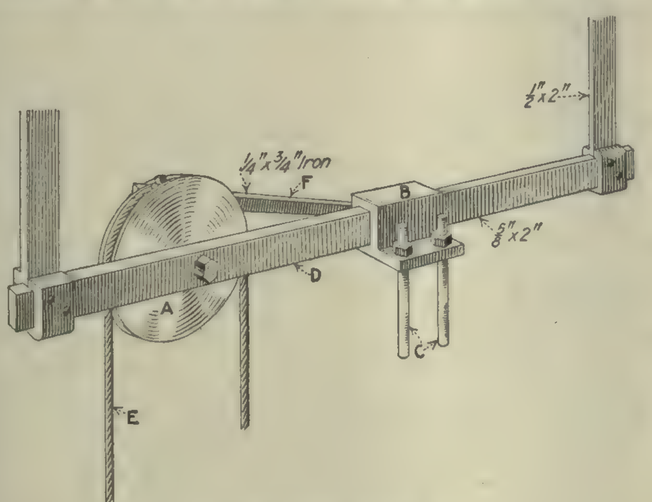
On page 212, R. W. Green criticizes the information I gave Mr. Shirley. By putting micrometers on 48 different drills of varying sizes and of three different makes, I found that some were several thousandths oversize at the point and about exact size near the shank, just as I said; about as many others were nearly exact size at the point and undersize at the shank, just as Mr. Green said.

Mr. Green also says, "If made oversize, there would be trouble with drills used through hardened bushings." I have experienced this trouble. Many a time drilling-machine hands have come to my window with a twist drill and a hardened-steel bushing stuck fast. I also told Mr. Shirley that drills soon get smaller with use, until they are several thousandths undersize. (Mr. Green says he thinks this is misleading also.) This question I will leave to be answered by drill users and toolmakers. The information I gave Mr. Shirley was gained from practical experience, and I believe that if he followed my instructions he has not been misled. However, I am grateful to Mr. Green for his criticism, as I now believe that there is a difference in methods. J. A. RAUGHT.

Janesville, Wis.

Simple Positive Belt Shifter

Contributors to the *American Machinist* have experienced trouble due to belts shifting. I have made a successful belt shifter that "stays put" and have fitted one to every machine in the shop. It is made up of a light sheave wheel A and a slide B into which the forks C are



THE BELT SHIFTER

screwed. The slide B operates along a piece of flat iron D when the sheave A is turned by the light chain of rope E. The sheave and slide are connected by a piece of $\frac{1}{4}$ x $\frac{3}{4}$-in. iron F. The belt fork can either be connected to the shaft hangers or fastened to timbers, whichever is most suitable. JAMES OWENS.

St. Catharines, Canada.

Hiring Men Away from Other Shops

The question broached by J. P. Brophy on page 410 is serious, but is not to be answered offhand or by looking at only one side. We are fast learning that modern manufacturing involves far more than the shop, the men and the machines. It includes the health of employees, the houses they live in, their recreation and all that goes to make up life, not forgetting the contentment that comes in a man's knowing that his services are appreciated and rewarded.

If no other firm offered a man a job or, worse yet, if others agreed not to hire a man from Mr. B's shop without his consent, Mr. B could pay any wage he pleased and maintain poor shop conditions. Of course, he would not do anything of the kind, because he is a fair-minded man; but he probably knows some employers who would.

It is certainly exasperating to have a man who is trained in your particular work leave your employ. But if he has reached his limit with you, while others feel that he is worth more to them, how else can he advance his income? The housewife who trains a green girl into an efficient maid has a much greater right to feel hurt, because all her training is lost. But in Mr. Brophy's case he is probably the financial gainer every time this happens, even though he is sore at the time. The chances are that every man who goes out with a Cleveland automatic and stays with the firm buying the machine is the best salesman Mr. Brophy can have, for he is right on the inside and can urge Cleveland machines whenever new equipment is to be bought. And he is much more apt to do this if he leaves with unstrained relations.

Amos Whitney attributed much of his early success to the fact that he repeatedly let some of his best foremen be hired by other shops who wanted good men. Every one became a booster for Pratt & Whitney machines and greatly aided in distributing them so largely over this country in the earlier days. I firmly believe that, if Mr. Brophy will look at the matter calmly, he will find that he has been benefited every time a man of this kind has left him.

But entirely aside from this, the man deserves consideration. How many times is it necessary for a man to take a job in another shop to get a raise in pay, and how often does the old shop offer a still higher price to get him back? I can recall many instances; and I am quite sure all of us, Mr. B included, have left the old firm because it would not meet the new offer. Until there is a fixed standard of wages in all shops (which heaven forbid), men must be free to take the best job that offers. And this means that other employees must be able to offer jobs to any man they think is fitted for their work. If this can be done openly and frankly, so much the better; but where the present employer resents a man's leaving to better himself, the submarine method seems to be the only way. FRANK C. HUDSON.

New York City.

Uncle Sam's Millions and Uncle Sam's Men

By Berton Braley

Cheer up, Tommy Atkins and Johnny Crapaud,
Your road has been weary and bloody, we know;
You've fought through discouragement, sorrow, defeat,
When failure seemed certain and gloom was complete;
But always our hearts and our prayers were with you
And now all our wealth and our power are too;
We've picked up the sword, and we've laid down the pen
And Uncle Sam's coming with millions and men!

* * *

Our vessels shall come to you loaded with grain,
So many the U-boats will fight them in vain;
From mills and from shops, from farms and from mines,
Munitions and foodstuffs shall come to your lines;
And soon we shall send, with our steel and our guns,
A million or so of our gallantest sons;
We'll help to bring peace to the world once again
With Uncle Sam's millions and Uncle Sam's men!

* * *

We hate all the bloodshed and horror of war,
But freedom and justice are worth fighting for;
And therefore we join with your battle-scarred clan
To make the world safe for the future of man;
Fight on, brother nations, be steadfast of heart,
We're coming to join you and take up our part,
To fight till democracy conquers again
With Uncle Sam's millions and Uncle Sam's men!

Practical Patriots and Production—An Editorial*

Money, even if of gold, is but a symbol. Germany has about as much of it in circulation today as it had when the war started, and yet Germany cannot provide three square meals a day for its subjects. What money will buy, and not the figure stamped upon it, determines its real value. Most of us during the last two years have had experience in the decreasing purchasing power of money in our own country.

Being practical men, let us look into the complicated mechanism of industry a bit—take its gears apart, as it were—and see if we can find the cause of this slowing down of purchasing power.

Suppose that half of the men in the shops of this country that are making the same product that you are making in your shop should suddenly take a notion to stop work. If the demand for this product continued as before, there would soon be a serious shortage in your line of goods, just as unfilled orders would pile up in any one factory where half of the men quit and no more could be hired to take their places. Demand would exceed supply, and the price of your product would rise as a result of the desire of many people to purchase from an insufficient supply. Even if laws were passed fixing the price, it would not increase the number of these machines nor would it help the people who needed them and could not get them.

This same shortage of labor that has been pictured as applying to one line of industry in one country actually applies to all products and industries of the world today. The shoe factories, and the farms, and the packing houses, and all manufacturing and producing concerns have been deprived of nearly half of their workers, either through participating actively in the war or by making products that are of use in warfare only. We face a shortage not of your machines alone, but of all of the things that are necessary to life and real prosperity. Government regulation can fix the prices of these lessened commodities and thus prevent the vile speculation in human needs that is attempted by unscrupulous harpies, but no law passed by man can produce shoes where there are no shoemakers to make them, nor satisfy hungry stomachs, unless there is food sufficient to fill them. Laws cannot alter the situation and create what does not exist. Increased wages will not buy, unless there are products to be bought. And as things are now in this world, every dollar added to wages makes it easier for a few to buy what they want; but, by reducing the total supply of commodities, makes it harder for all of us to buy what we need.

When supply falls short of demand, when scarcity holds a mortgage on mankind, when the family loaf is too small to go around the table, then indeed, in the words of our President, "We must all speak, act and serve together." Strikes and lockouts, by taking men from the now insufficient supply of producers, make our great world factory still more shorthanded. Struggles between capital and labor merely pile up the deficit. Teamwork is what we need, teamwork to increase the sum total of our available resources; first, that we may thereby win this war, and afterward so that this sum total divided by humanity will give as a quotient, more per individual man. We must make war on waste.

We must fight waste moments and, overcoming them, enlist them as useful ones.

We must fight waste motions, making every blow count against the high cost of living.

We must fight waste of materials; for iron and steel—not gold and silver—are the precious metals today.

We must fight waste of thought; for the world now, as never before, is in need of right thinking.

And when we have won our fight and no longer waste our moments or our motions or our materials or our thoughts, there will be no more conflict either between nations or classes; and there will be no more want, for every man will have enough of this world's necessaries and comforts.

And now you ask, "What can I do in this war on waste?"

Why, brother worker, there is so much that you can do, be you laborer or be you captain of industry, that once you open your eyes to the possibilities, you will see opportunities every day on every hand.

You, brother shop sweeper, as you go about with your broom, see that the fire buckets and the water barrels are full and that kerosene and gasoline and other dangerous materials are protected against a chance spark. If you do this, you will be fighting the waste of *two hundred millions of dollars* a year in America alone, which fire takes out of your pocket and mine.

You, brother oiler, as you go about with your oil can and grease pot, remember that you are the man to fight loss of time arising from lack of lubrication; that as you do your job well or poorly, so runs the world's workshop. Neglect one bearing, and a hundred men and machines may stand idle through one man's oversight. And not only do you fight loss of time, but waste of material as well; for upon your work in eliminating friction depends the consumption of coal in the power house. Save but a pound or two of this a day through your work well done, and you have played your part in keeping "the fires going in ships at sea" and in warming your fellowman.

You, brother millwright, train your eye not only to the recognition of inefficiency of belts and shafts, but to the dangers of improperly guarded mechanisms as well, remembering that the daily casualties of industry are greater than the daily casualties even of this world war, and that you can do your part and do it well in keeping your fellow workers in the world's workshop and out of the world's hospital.

You, brother machinists, who direct the daily flow of thousands upon thousands of horsepower through gears and mechanisms to their final work at the cutting edges of millions of tools, remember that you are applying the world's supply of energy to its mechanical work. You are not working for the boss—the boss is but a necessary part of the world's machinery. Strike your blow against waste of time and waste of material, not for the boss' sake, but at the call of our President and for the sake of your sons and my sons who will reap what we sow.

*Copies of this editorial for distribution will be sent on request.

You, brother blacksmith, have to do also, not only with waste of time, but waste of material—of coal and steel and iron. As an able smith you know a strong blow from a weak one and a strong act from a weak act. Two irons in your fire at the same time will not hurt your job nor your brother smith's job. A long pull and a strong pull, not against but with the boss in the war against waste will do more to banish hard times and the high cost of living, to shorten hours and increase the buying power of wages. than all that the legislators and lawmakers can do.

And you, brother superintendent—yours is the hardest task of all, for you must fight waste of thought and win a victory of right thinking, first for yourself and then for your fellow workers. You must forget the art of running a shop and acquire the greater art of leadership, which will make men do your bidding, not because they must, but because they admire and respect your judgment. You must learn to distinguish real efficiency from that false and dangerous imitation that parades in its name and that chokes initiative and skill in its deadly tentacles of red tape and useless requirements.

The call has already gone forth for volunteers to enlist in this great industrial service army to fight waste to a finish. It comes straight from the President of the United States to every man, woman and child in industry. A million volunteers are wanted in the machine shops of America alone. Enlist today!

"This is the time for America to correct her unpardonable fault of wastefulness." In the drafting room it is the time for the draftsman to lay each line with thought to economies of material and labor. It is time for the tool designer to cut corners in production means, for the planner to do away with unnecessary finish and useless operations and to avoid undue closeness of working limits. In the toolroom it is the time for the toolmaker to make tools that will last longer and cut better than those he has made before. In the shop it is the time to speed up and feed up; in the inspection room it is the time to avoid foolish quibbling and stick to commonsense. And these things will help and help wonderfully. The foundry foreman who takes the shift out of his flask pins, thereby releasing labor from the cleaning shed to the farm, is a more practical patriot than many who drill in home guards or raise home gardens.

Ten million industrial volunteers, owners, managers, superintendents, foremen, producers, helpers and shop sweepers, all pulling together against waste of time, waste of materials and waste of thought, will whip Kaiserism and the high cost of living so decisively that our dreams of world democracy and freedom will come true.

As you sow, so shall you reap—as you waste, so shall you want. All together now, you practical patriots—for production!

Learning Aviation by Correspondence

False pretenses are always deplorable; and when they are designed to induce young men to part with hard-earned dollars, they tread dangerously near the legal line. They would be bad enough in times of peace, but with the nation at war, preparing to conserve every effort and to make every dollar count for what may well be the greatest crisis of its history, such methods are, if possible, even more questionable.

In the April issue of *Popular Mechanics* is an advertisement of the National Aëro Institute, Morton Building, Chicago, Ill., which is so clearly misleading, so full of preposterous statements, that it is difficult to see how any magazine publishing it could pass the post office censorship; and a magazine that accepts such an advertisement shows beyond question that it has no censorship of its own. Among the choice morsels of bait held out to the young and unsuspecting reader who desires to become an aviator or an engineer in the new industry we find the following:

"Become an aviation expert. Opportunity is awaiting you; $50 to $250 a week and *independence* with the rapid expansion of the industry. Everywhere aviation experts are in demand. Government and private enterprises are taking up aviation seriously. They need men who *know*."

While these glittering generalities are misleading, they are not in themselves illegal; but coupled with the next paragraph, they become a positive menace both as an economic waste and a source of discouragement at a time when both these things are little less than criminal. The old satirical verse about learning to swim without going near the water is outdone by the following:

"Learn at home! Yes, you may learn the science of aviation right in your own home and in your spare time. No longer need you sacrifice the time and money of years of practical experience on the flying field. Send the coupon and find out how we have condensed into a short course, all the knowledge which is necessary to equip you to take your place upon the field as a practical aviation expert."

Much of the theory for any trade or profession may be learned from books. The little boy who said his "baby brother knew how to walk because they showed him, but he couldn't do it yet" fits the case exactly. The student who takes his place on the field as a practical aviation expert after a correspondence course in the National Aëro Institute will be the rarest specimen of "rocking-chair aviator" yet discovered and will compare with a real student of aviation in about the same way as the girl who learns to swim away from the water compares with Annette Kellerman.

Tool and gage makers are also in demand at the present time; and if this sort of advertising is permitted, we expect to see some correspondence school advertise to make expert tool and gage makers without wasting time learning to run a lathe, or miller, or grinder. A few spare hours in the evening, either before or after the movies, ought to make a man just as competent to earn top-notch wages in a toolroom as in an airplane.

The same magazine carries another similar advertisement of the American School of Aviation, also of Chicago, Ill. While not quite as blatant, it makes practically the same impossible promises, more by inference than by direct statement. Both claim expert indorsement, but the only name mentioned has no standing in the better circles of aviation engineering.

Both of these advertisements should be suppressed, and no publication with any regard for its readers ought to be guilty of publishing such arrant nonsense, even if it were not attempting to induce them to invest their money in this particular form of gold brick. This is no time for promoters to be allowed to advertise such schemes as this.

Latest Advices from Our Washington Editor

By Fred H. Colvin

Washington, D. C., Apr. 28, 1917

Washington Alive with Activity

Washington is full of men from all over the country, the shipyards of Seattle and the west coast being represented as well as the localities nearer home. And all want to help the nation in its crisis. The great question at the present moment is, How can we begin to utilize the vast resources that are at our command? Everyone is in dead earnest, and there is no attempt at show. Even the coming of Marshal Joffre and his escort from the navy yard to the White House was unheralded by a band or music of any kind—merely an escort of cavalry and motor-cycle police to see that no enthusiast of any particular persuasion got too close for comfort. But it is no easy task for a nonmilitary country to say just what to do first. The situation may perhaps be likened to a serious accident where all the friends are waiting and anxious to do something, where they get terribly impatient at the doctors, but where it is necessary to wait until the doctors diagnose the case and find out just what to do. It is hard for the friends, but neither is it easy for the doctors, especially when they know that they will be criticized anyhow by some of the friends.

Just at the present time it is probably better to stay at home and put your offers in writing, being careful to state just exactly what you have to offer. State plainly just what kind of work you have been doing, exactly what your equipment is and how many men you can work in the shop. This record can be filed with the right man of the Council of National Defense, and the more clearly you state your qualifications and capacity the sooner you can be of service.

Even if your shop was inventoried last year, it will do no harm to write another statement showing the added equipment and any changes that may have taken place. If it was inventoried before, a statement to this effect will make it easier for the shop to be classified properly. Many replies on the inventory blanks were facetious and entirely beside the questions asked. Exact information is needed at this time, just the kind of information that you would want if you were buying a shop or considering the letting of a large and important contract on which you must have prompt and continuous deliveries. Full information of this kind placed in the hands of the committees is of more value than personal visits at this time. The committees must have time to make their plans and to decide as to what is best for the nation. Conference after conference is absolutely necessary, and long days are the rule for every man on the board. Two signs, which appear in the outer offices of two of the boards, are significant and to the point. One is: "Be brief. Sit down but don't intern." The other reads: "We are at war. Minutes count. Be brief and to the point."

We can help most at the present by being as patient as possible and getting our plants into the best possible shape to handle orders rapidly, accurately and continuously when the time comes. Repairs that will avoid breakdowns when the rush is on are a very essential part of preparedness.

A Universal Inventory Blank

The great desire to do something that shows and counts at the same time is apt to lead to criticisms that have little basis when all the facts are known. And we all know how much easier it is to criticize than to offer a constructive policy or to suggest just what should be done. This desire to do something has led the legislatures of many of the states to make inventories of their own, in addition to that taken by the Council of Defense. These are usually based on the inventory carried on by Mr. Coffin's board, but vary enough in some cases to make it difficult to know just what information has been secured. In addition to this, some states have county and town inventory as well, making a duplication that seems hardly called for except in rare instances. Nothing could show more clearly the need for Federal control of matters of this kind, both for securing uniform data and to prevent the waste of time and effort in the duplication that ensues.

In order to make all these data available with the least effort, a universal inventory blank is under consideration, which will make it easy for all the data to be used, whether they are collected by the states or by the Federal board. The less time we waste in unnecessary duplication of effort the sooner we can utilize our great resources and the sooner we can end the war.

Elements That Go To Make Up a Single Complete Army Division

As the machine and other shops will have much to do with equipping the new army, we are all interested in what is required and what constitutes a "division," of which we hear so much on the western front. A division of the U. S. Army will consist of 28,082 men, 6834 horses and 4875 mules, being about 65 per cent. larger than a division of the German army.

The division consists of three brigades of infantry, with 18,579 officers and men; one field artillery brigade of 4030 officers and men; one regiment of cavalry, 1579 officers and men with 1541 horses; one regiment of engineers, 1098 officers and men; one field signal battalion of 259 officers and men; one air squadron of 173 officers and men and 12 airplanes, a total of 25,718 officers and men. Then there are 2364 officers and men with the wagon train, requiring 1009 wagons and 67 motor trucks.

This equipment includes over 20,000 rifles and 8600 pistols; fifty 3 in. field guns and twenty-five 3.8 in. howitzers. The number of machine guns according to the old rating would be 72 for the division proper and 20 for the wagon train. But by the later developments this may be increased to 600 for the division proper, a proportion of 30 for every 1000 rifles. Such a division in machining order would stretch out to over 14 miles with the wagon trains occupying about 6 miles more. And the cost of equipment totals up, at present-day prices, to $9,000,000, so when we talk of a million men under arms, we begin to see why billions are needed for the war loan.

Perfecting the Organization

When Congress passes its appropriation bills, so that orders for materials can be placed promptly, we shall know more definitely what will be of most service. In the meantime it is obviously sane and patriotic to produce standard tools and implements that are sure to be needed. There has been a shortage of small drills and taps, and it would therefore be unwise to curtail their production in any way. The production should be increased by every efficient means available.

Every day's delay of Congress gives us that much more time to perfect an organization for economical manufacture, to put our machinery in the best possible shape for long hard service. That is the kind of preparedness that counts and is far more truly patriotic than some of the fantastic schemes that are proposed.

It is better to stop a moment and consider what you are likely to be called upon to do and what you do that will be of the most service than to waste time and energy in training for unlikely emergencies. Toolmakers in Kalamazoo can better spend their time in studying new and improved toolmaking methods than in emergency Red Cross work, as the need for the latter in that section is very remote.

One institution, for example, is urging its women to take up farming and at the same time advertising for *men* stenographers. In view of the acknowledged efficiency of women in clerical positions, it would seem as though they would be of far more service at the typewriter than following the festive plow.

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The Question of Labor Supply

There seem to be misgivings in some quarters as to labor being thrown out of employment, but this can only be temporary and because of ill-advised decrease of production at the present time. The real problem that is being faced by manufacturers and that troubles more than either reduced profits or increased taxation is the securing of labor with which to produce the immense amount of munitions and machinery sure to be required.

With a million or more men taken from industry for the army, and with the increased production that will be needed to provide for this force, the already difficult problem of labor is vastly increased. Shops must be run not only economically, but more hours a day, to secure the necessary production. Three shifts of eight hours each have many advantages; but it may be difficult to find the three shifts, even if women are employed, as they are bound to be. Then too, there is the question of repairs to equipment, which always requires attention, especially when pushed to a high rate of production. The three-shift shops must allow a surplus of machine equipment, which is not always easy to secure at present.

For this reason some of the munition manufacturers feel that two 10-hour shifts may have to be adopted, even if they are based on an 8-hour day, as with the railway employees. This method gives 4 hours a day for machine repairs and adjustment, which allows a smaller machine equipment. But in either case no fears as to a surplus need be entertained. In fact, labor-saving devices will undoubtedly be used to a much greater extent than ever, as whatever invention releases a man or woman for other useful work adds so much to our total productiveness.

Executives Work Long Hours

Regular hours of labor do not, it seems, apply to the heads of bureaus and committees. Theirs seem to have no limit. This condition is one of the penalties of having marked executive capacity, which at times it is impossible to delegate or to divide with others. Here again, however, we have the great satisfaction of seeing men of known ability handling important problems. The Munitions Board, headed by Frank A. Scott, includes Howard E. Coffin, who will look after the utilization of the industries that his committee inventoried last year; Bernard M. Baruch, who, through his copper and steel connections, will look after raw materials; Julius Rosenwald, the head of Sears, Roebuck & Co., who will attend to supplies of all kinds; and Dr. Franklin Martin, who is in charge of the medical department. Working with them in various capacities are such practical engineers and manufacturers as W. H. Van Dervoort, of Root & Van Dervoort Engineering Co.; Samuel Vauclain, of the Baldwin Locomotive Works; and J. E. Otterson, general manager of the Winchester Arms Co., whose experience in making rifles for the British Government is particularly valuable at present.

Then there is the Advisory Council, which, in addition to Messrs. Coffin, Baruch, Rosenwald and Martin, includes Daniel Willard, of the Baltimore & Ohio, for transportation matters; Dr. Hollis Godfrey, for chemistry, and Samuel Gompers, representing organized labor.

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Another important committee is that known as the National Advisory Committee for Aëronautics, the officers and members of the Executive Committee being Dr. Charles D. Walcott, chairman; Naval Constructor H. C. Richardson, secretary; and Prof. Joseph S. Ames, of Johns Hopkins University; Rear Admiral Taylor, U.S.N., who is director of aëronautics for the Navy Department; Prof. Charles F. Marvin, of the Weather Bureau; Prof. M. I. Pupin; Lieut. Col. George O. Squier, of the War Department Signal Office; and Dr. S. W. Stratton, director of the Bureau of Standards.

This committee is again divided into 17 subcommittees, which are aëronautic mail service; torpedoes; communication; mapping; bibliography; building; design; construction and navigation of aircraft; governmental relations; nomeclature; patents; physics of the air; power plants for airplanes; production of aircraft quarters; relation of the atmosphere to aëronautics; standardization and investigation of materials; and foreign representations. The membership of these subcommittees, in addition to those named on the Executive Committee, includes also Prof. William F. Durand, of Leland Stanford University; Prof. John F. Hayford, of Northwestern University; Hon. Byron R. Newton, of the Treasury Department; Henry Souther; Dr. A. F. Zahm; S. D. Waldon; and others well known in engineering, scientific and productive lines.

Not only are these men trained in their special lines, but they have access to all sorts of information as to developments both at home and abroad; and they are thoroughly posted as to both the good points and the shortcomings of all the planes and motors in common use. Having this knowledge, they can be depended on not to make such exaggerated and questionable statements regarding American aircraft as have appeared recently in

the daily press, credited to an "advisory board." Whatever or whoever this alleged advisory board may be, the real National Advisory Board never gave out such statements. The object in naming the members of the National Board in detail is to assure our readers that reports by these men can be relied upon, that this body must not be discredited by being confused with any other organization, which in the case in question evidently had an ax to grind. When the censorship bureau is in running order, such statements will probably have a hard time getting into print.

Problems in Gaging

The necessity not only for accurate gaging, but for knowing that the gages themselves are correct, is a self-evident part of any large manufacturing operation. This assurance is difficult enough when the work is all done in one plant; but when it is scattered all over the country, the problem becomes a man-size one. It has been proposed, and the proposal seems likely of adoption, that the care of gages be placed in the hands of the Bureau of Standards in Washington, in much the same way as it is now handled by the Canadian board in Ottawa. This plan seems the logical procedure, as there must be a central and responsible headquarters for this work, and the bureau could hardly be used in a more practical manner.

The Canadian inspection bureau is always informed as to where gages are being made; and instead of trusting to luck that they will be done on time, inspectors visit the different shops making them, to note the progress made, to advise and assist in any way possible in their making and to see that the quality of the work is satisfactory. Then the gages go to Ottawa for final inspection to be accepted or rejected as the case may be.

Other inspectors visit the shops making munitions and test the gages in use there, to be sure that the amount of rejected work is kept at the minimum. Time and material, as well as shell-making capacity, are too valuable to be wasted in any way. These inspectors have what is known as checking gages, which show how and where the munition makers' gages have worn below or above size.

Then there is a salvage department, where a small force of expert gagemakers save as many of the worn gages as possible and in any way that can be devised. The method, of course, varies with the gage in question; but many are saved, so that this department has proved well worth while.

The problem of gaging brings up the question as to just what a master gage really is. Some contend that it is a gage that will enable the working gages to be duplicated should they be destroyed. Others hold that the master gage is a duplicate of the piece to be made, to which other gages can be fitted. In still other cases the master gage is considered as both a male and a female gage of the proper size and by which both male and female working gages can be made and tested. Checking gages for gage inspectors are generally conceded to be the opposite to the gage to be tested, a checking gage for a ring gage being a plug of proper size to detect wear in the ring.

Dependence on master gages of any kind, however, sometimes gets us into difficulties, as they are apt to wear a trifle in places without the wear always being detected. This is perhaps the case where the master is a duplicate of the piece itself, or a model or sample, as it is called in some shops, more often than elsewhere. For this reason many contend that the blueprint or drawing is the real master gage and that actual measurement of the gage being tested is the court of last resort.

But no matter what system is adopted, it must be uniform and controlled from one central bureau. Nor should there be a minute's more delay than absolutely necessary. Gages require the kind of skill that cannot be found in large quantities, and those who are not familiar with the problem do not realize how long it takes to make the gages necessary to manufacture munitions in large quantities. The sooner authority is given to the men who understand these problems from actual experience the sooner we can begin really to prepare to do our part in the great conflict. The most able mechanical men of the country are waiting for the opportunity to get at the work for which they are so well qualified.

One of the greatest aids to production is a proper and rational system of inspection. But on the other hand, inspection can be made a great drawback unless it is handled intelligently and by men who are familiar with the requirements of the particular work in hand. This does not apply nearly so much to the mere matter of gaging as to the matter of whether certain minor defects in forgings and castings warrant the rejection of the part.

The Job of Balancing Production

The need of not only centralizing the various activities, but co-relating them so that the best interests of the whole country may best be served, is shown by the present condition in the sheet-steel market situation. According to one version, the American Sheet Steel Co. has been directed by the Government to divert its supply of sheet steel to those companies making containers for canned goods, in order that food may be preserved for future use. This action, according to the makers of agricultural implements, makes it absolutely impossible for them to turn out over 50 per cent. of the farming implements needed. The shortage will be even greater if the backyard garden assumes its expected proportions, as materials cannot be secured for hoes and similar tools.

It is of course very necessary to can as much produce as possible, but without hoes and similar tools it is impossible to raise enough produce to be canned. It is one of those cases where it becomes necessary to balance the importance of one industry against the other and to apportion the supplies so that the very best results can be obtained for the nation at large. Whoever decides the question must consult with the heads of all the departments concerned.

Our Council of National Defense and the Munitions Board are doing their part; the rest of us must do ours. Actual orders often hang fire in your own business, yet, knowing they are coming, you get machines and tools and fixtures in readiness. It is the same in this case. Congress holds the pocket book and has the last guess. As soon as it acts and passes these bills, you will find that no time has been wasted by the committee. In the meantime all possible preparations are being made.

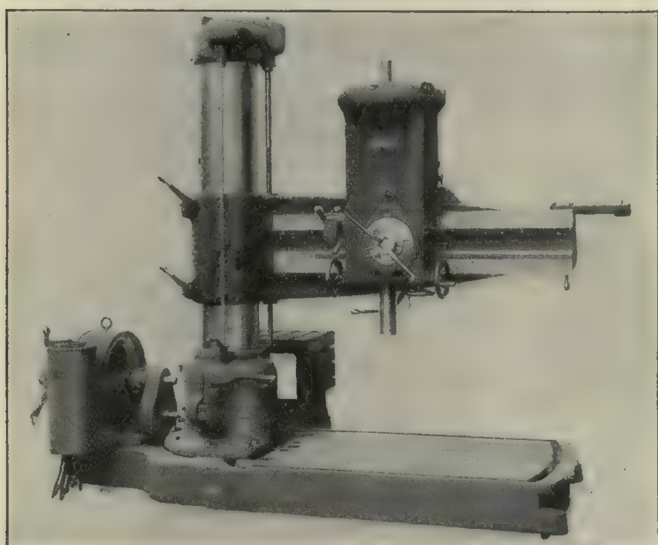
Shop Equipment News

Radial Drilling Machine

The American Tool Works Co., Cincinnati, Ohio, is placing on the market the machine illustrated, which is known as the 6-ft. "Triple Purpose" radial drilling machine. It is intended not only for drilling and tapping, but for boring as well.

A quadruple geared head is used, which provides two separate ranges of two speeds each, one for heavy tapping and boring and the other for high-speed drilling and light tapping. These four speeds, together with the eight gear-box speeds, give 32 spindle speeds arranged in geometrical progression from 15 to 500 r.p.m. For producing these speeds only 15 gears are required.

The head mechanism is inclosed in a large casting or housing that prevents all liability of accident from exposed moving parts. The gears are so arranged and sized that a speed of 1000 ft. per min. is not exceeded. The large internal gear used for the slow speeds is double splined to the spindle and is mounted on ball bearings.



HEAVY-DUTY RADIAL DRILLING MACHINE

Maximum distance spindle to base, 6 ft. 6 in.; spindle speeds, 32, 15 to 500 r.p.m.; feeds, 8, 0.005 to 0.040 in. per revolution; taper in spindle, No. 6 Morse; drills to center of 12-ft. circle; spindle movement, 20 in.; head movement, 63 in.; vertical arm movement, 46¾ in.; horsepower required, 20

The mechanism for tapping is inclosed and runs in an oil bath. The gears are of steel, bronze bushed; and the friction bands are 8 in. in diameter, adjustable from the outside.

All operating levers are within convenient reach of the operator, two handwheels being provided for the head movement, one at either side. Two levers are supplied for moving the spindle, and the eight feeds are controlled from one dial. To facilitate an easy movement of the column, roller and ball bearings are used; a conical roller bearing is placed between the column and sleeve at the bottom, while a ball bearing is interposed at the top to take the radial thrust of the sleeve.

All gears are of steel or manganese bronze, the majority of those of steel being heat-treated and hardened. The shafts in the head and gear box are of crucible steel, while the long vertical and horizontal driving shafts are of carbon steel ground to size. All cylindrical bearings are equipped with phosphor-bronze bearings that are renewable in case of wear. The counterweight is inclosed in the head casting and has a safety stop that operates automatically, should the supporting chain break.

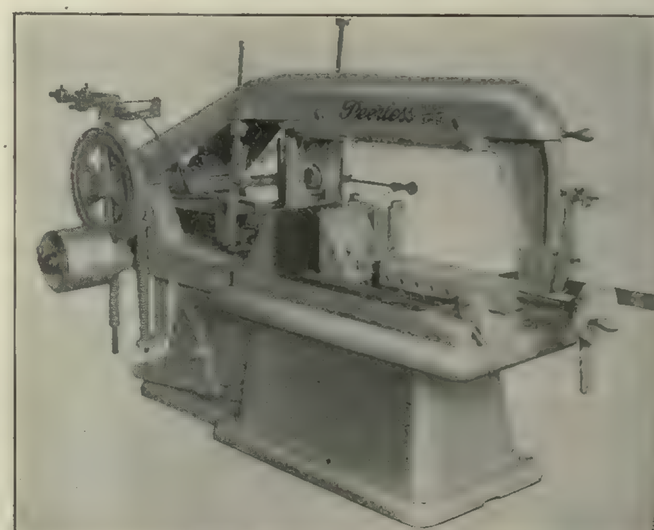
Eight feeds are provided, being arranged in geometrical progression from 0.005 to 0.040 in. per spindle revolution. An adjustable friction of the expanding-band type protects the feed mechanism. The wormwheel for the feed runs in an oil bath. An automatic feed trip is supplied.

The arm binders are of such a type that the use of a solid girdle is permitted. The elevating mechanism includes a friction device and automatic knock-outs at the extreme positions of the arm. The base has four T-slots, an oil channel surrounding the working surface, and a slot to accommodate the swinging support for the arm, which can be supplied as an extra.

The machine can be had equipped with a constant-speed motor driving through the speed box, with a variable-speed direct-connected motor, or with a double friction countershaft. A plain box table is mounted on an extension of the base at one side of the column. A universal table, furnished as an extra, has a swivel base and a tilting top.

Heavy-Duty Hacksaw

For the purpose of providing a machine to handle either heavy or light work, the high-speed heavy-duty cutting-off saw shown in the illustration has been placed on the market. Its capacity is stock up to 13 x 16 in. The saw guide is controlled by four coil springs, being over-balanced so that the saw frame always tends to move



HEAVY-DUTY CUTTING-OFF SAW

upward. The feeding mechanism consists of a ratchet bar and a set of dogs, the latter being mounted on one end of an oscillating arm. On the other end of the arm is a roller engaging a cam on the crankshaft, being held in contact with the cam by a coil spring.

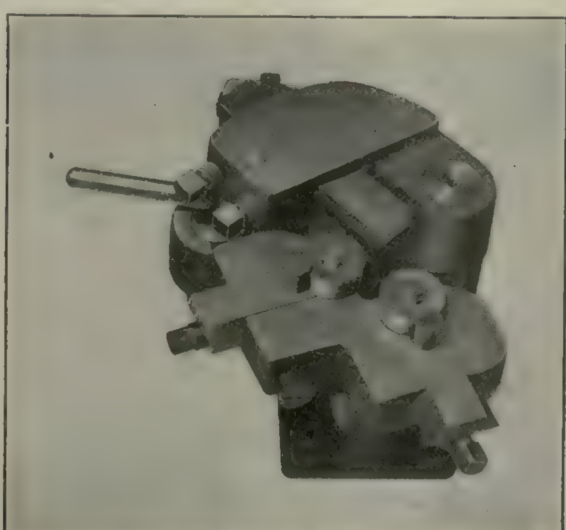
The feed pressure is controlled by adjusting the tension in the spring. When the cutting stroke is completed, the tension in the feed spring is relieved, thus allowing the saw to clear the work on the back stroke. At the end of the back stroke the roller runs off the cam and the spring forces up the oscillating arm, thus pulling down on the ratchet bar at the other end. The two ratchet dogs operate alternately at every thirty-second movement of the ratchet bar, in order to keep the feed pressure constant through the entire cut.

If the saw is started above the work, it will feed rapidly until the cut is started, when the feed is automatically reduced. If the saw blade breaks, the frame feeds down rapidly until the stop is operated, which automatically raises the frame to whatever height the adjustable gage is set for. A device is provided for relieving the feed at the start of a cut.

The saw frame has rectangular ways, with provision for taking up in case of wear. The machine is driven through a set of 4 to 1 reducing gears, the pinion being cast integral with the pulley. The rear vise jaw swivels for miter work, and the front jaw is equipped with a handwheel and quick-acting mechanism. A complete lubrication system is included, the reservoir and brass gear pump being located in the cabinet-type base. The table has two T-slots, one at each side of the blade, for securing irregular work. The machine is also supplied for motor drive, equipped with a six-speed gear box. It is the product of the Peerless Machine Co., Racine, Wis.

Box Tool for Turret Lathe

The box tool shown has a turning capacity of from ½- up to 1¾-in. bar stock. The turning tool is clamped down on a hardened-steel tool block by two dog point setscrews. The toolpost is a malleable-iron casting swung on a large hardened and ground steel stud with a tool-clearing cam lever placed in such a convenient position that the operator can release the tool on the back stroke of the turret and avoid leaving any tool marks on the finished diameter.



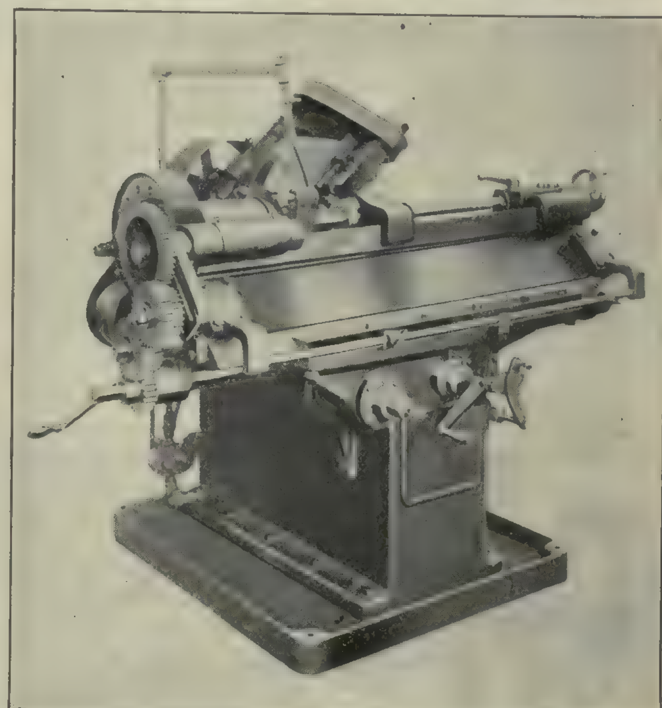
BOX TOOL FOR TURRET LATHE

The two adjustable stock-supporting rollers have both adjustable and clamping screws. The rollers are mounted on dovetailed steel slides. After proper adjustment of the rollers the slide is clamped in position by the clamping screws, and the adjustment is maintained throughout the entire setting of the tool. The rollers are made of hardened steel, ground all over, and are mounted on hardened-steel pins. By tightening the rollers a trifle they leave behind them a planished finish on soft steel that in some cases obviates the necessity for grinding to secure a high degree of finish.

This box tool is made by the W. K. Millholland Machine Co., Indianapolis, Indiana.

Thread Miller

The illustration shows a new heavy-duty thread miller that has recently been placed on the market. The machine is of the traveling-table type, the cutter having only sufficient traverse to move it in and out of the cut. For ordinary work a large gear is used on the cutter arbor,



HEAVY-DUTY THREAD MILLER

Capacity, 8-in. swing, 30 in. between centers; spindle bored to allow work 3¾ in. in diameter to pass through; approximate weight, 5000 lb.

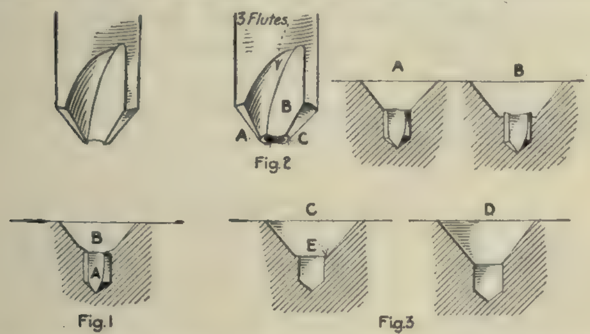
but this can be removed and a small one substituted in its place when necessary.

The cutter arbor is hardened and ground, runs in bronze bushings and has a tapered bronze-bushing support outside of the cutter. It is driven through a train of spur and spiral gears. The indexing device consists of a plunger that fits into holes in an index plate set into the back of the main-spindle driving gear. The work may be held on centers, in a collet chuck or in a three-jawed chuck screwed to the spindle nose. Regular equipment includes steadyrest block, lubricant pump and piping with a tank in the base, two-speed countershaft, one index plate, one bushing for the steadyrest block and change gears. The machine is the product of the Moline Tool Co., Moline, Illinois.

Removing Broken Center Drills

By Hugo F. Pusep

The center drill is one of the handiest little tools for the machinist, but it is also the greatest little trouble maker; for nothing is so annoying as to have the drill break just when it has nearly completed its task. Of course, it is easy enough for the mechanic to procure a



FIGS. 1 TO 3. REMOVING BROKEN CENTER DRILLS

new center drill from the "tool crib," but not quite so easy to remove the broken end from the hole.

Various remedies have been suggested, but it seems to be the knack center drills have of always breaking when it is the least looked for, and then defying all efforts at extracting—no matter how the lips of the drill were ground. It has been pointed out that if the lips of the center drill were ground of uneven length in case of breakage the end would fall out of the hole. In theory this works out all right, because a drill with lips of uneven length will produce a hole larger in size than the body of the drill; but with the average center drill this does not work successfully.

The reason for this trouble seems apparent from Fig. 1, *A* being the broken end of the center drill in the bottom of the 60-deg. countersunk hole *B*. At the moment of breakage the drill is in motion, and before it can be withdrawn it has made a few more revolutions, the jagged point of fracture throwing up a burr at the bottom of the 60-deg. hole; thus securely holding the broken end *A*. Mechanics, in some instances, even go so far as to heat the whole job red hot in order to anneal the broken end of the center drill, so it can be drilled out. Of course this can be done with some jobs, while with others it is entirely out of the question.

Having once determined the cause of the trouble, I made the tool shown in Fig. 2. It is made of drill rod, hardened, and conforms in size to a standard combination center drill with but this difference: It has a hole at *A*, drilled centrally, a few thousandths of an inch larger than the drill part of the combination center drill, whose broken end it is to remove; three flutes *B* are milled or filed along the 60-deg. taper and across the flat end *C*. Sufficient flat should be provided at the end to break the sharp corner where the 60-deg. taper joins the hole *A*. After making a set of these countersinks—for that is what they really are—one for each different size of center drill, all my troubles in removing the broken ends were over.

In Fig. 3 is shown how this countersink works. At *A* is a cross-section of a center with the broken center drill end lodged in the small hole at the bottom; *B* shows the same center after the countersink has done its work. The broken end can now be easily removed with a pair of pincers, making the center appear as at *C*. At *D* is shown the center, how it looks when the shoulder *E* has been removed by redrilling with a new center drill.

Personals

Rudolph L. Hanau has become associated with Bacharach Industrial Instrument Co., Pittsburgh, Pennsylvania.

H. A. Howard has been appointed manager of the New England office of the C. & C. Electric Manufacturing Co., Garwood, New Jersey.

Charles S. Vought has been appointed assistant general manager of sales of the American Steel Export Co., Woolworth Building, New York City.

F. C. Cutler has resigned as sales manager of the Worcester Pressed Steel Co. and will become secretary and sales manager for the Worcester Stamped Metal Co., Worcester, Massachusetts.

Eugene R. Seiter has severed his connection with the Warner & Swasey Co., Cleveland, Ohio, to become associated with the Foster Machine Co., Elkhart, Ind., in the capacity of sales engineer.

Prof. C. R. Richards, head of the department of mechanical engineering of the University of Illinois, Urbana, Ill., has been appointed dean of the College of Engineering and director of the Engineering Experiment Station at the same institution.

Business Items

Bilton Machine Tool Co. is the trade name adopted for the consolidation of the Standard Manufacturing Co. and the Parsons Foundry Co., Bridgeport, Conn.

The Russo-American Merchants and Manufacturers Exchange, Inc., has recently been formed for the purpose of bringing together the Russian consumer and the American manufacturer. Its offices are located at 120 Broadway, New York City. It is the company's desire to secure the co-operation of all concerns interested in the Russian market; and one of the features will be a directory of American industries and manufacturers, which will be distributed throughout Russia to the number of 40,000 copies.

Trade Catalogs

Wet Universal Cutter and Tool Grinder. Matson Machine Co., Concord, N. H. Circular. Illustrated.

Universal Angle Plate. Boston Scale and Machine Co., 381 Congress St., Boston, Mass. Circular. Illustrated.

Reid Surface Grinder. Boston Scale and Machine Co., 381 Congress St., Boston, Mass. Circular. Illustrated.

Inspector's Compound Bench Plate. A. P. McCulloch Machine Co., 216 High St., Boston, Mass. Circular. Illustrated.

Milwaukee Milling Machines. Kearney & Trecker Co., Milwaukee, Wis. Catalog No. 20. Pp. 83; 6 x 9 in.; illustrated.

Brownhoist Overhead Hand-Traveling Cranes. Brown Hoisting Machinery Co., Cleveland, Ohio. Catalog P. Pp. 36; 6 x 9 in.; illustrated.

Brass and Iron Nuts, Screws, Bolts, Etc. Chicago Nut Co., 2513-39 West 20th St., Chicago, Ill. Catalog and Price List No. 12. Pp. 52; 5x7 in.; illustrated.

Barker Chucks. Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill. Bulletins, 6 x 9 in. Illustrating and describing wrenchless and wrench operated chucks.

Hill Clutch Equipment. The Hill Clutch Co., Cleveland, Ohio. This is the first of a series of bulletins which will describe and illustrate the installation of Hill friction clutches, bearings, rope drives, etc. The series will be sent on request to those interested.

Forthcoming Meetings

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The Society of Automotive Engineers will hold its annual convention at Ottawa Beach on Lake Michigan during the last week in June.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio, on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

The Society for Electrical Development, Inc., will hold its annual meeting in the United Engineering Societies' Building, New York City, on May 8.

The American Society of Mechanical Engineers will hold its annual spring meeting at Cincinnati, Ohio, May 21 to 25. There will be a joint session with the National Machine Tool Builders Association on May 21. The headquarters will be at Hotel Sinton.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

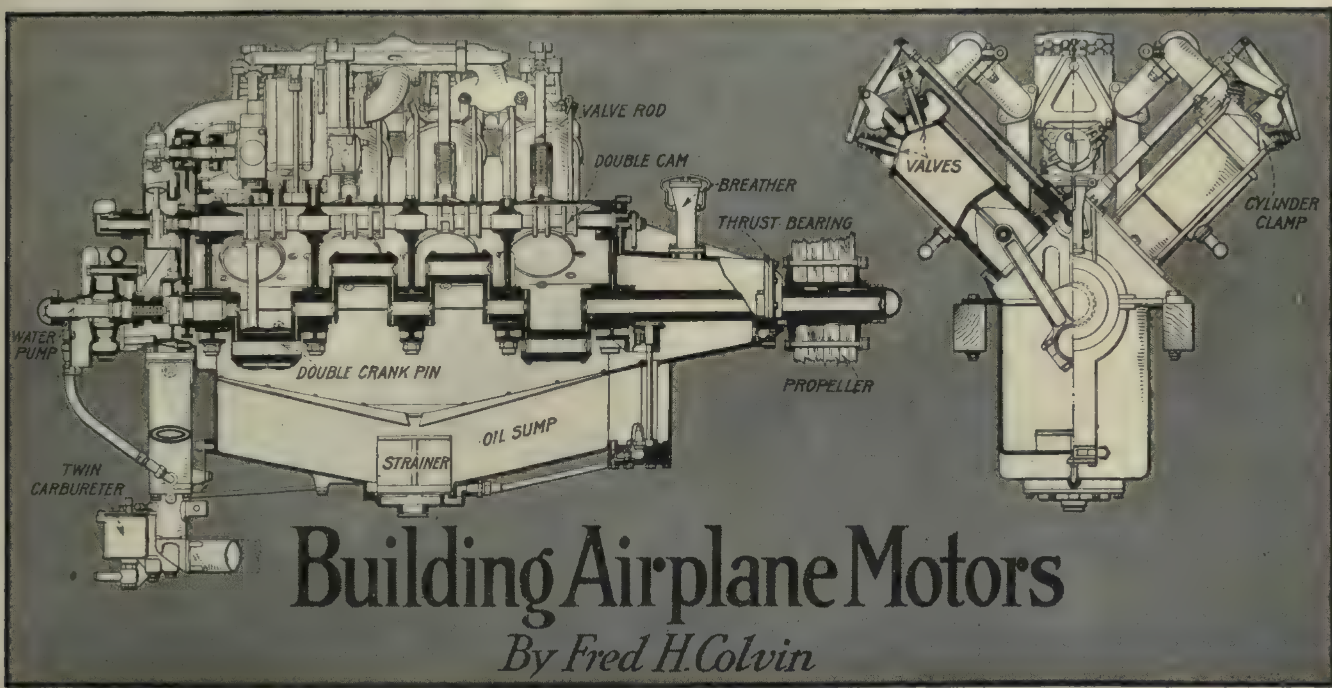
Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.



Building Airplane Motors

By Fred H. Colvin

SYNOPSIS—The builder of airplane motors is confronted with many problems that do not bother those whose motors are used in either automobiles or motor boats. Some of these problems may be seen by a study of the 100-hp. motor itself in the heading illustration; and others will be noted in the description of the various operations which follow.

The building of the Curtiss motor for airplanes is the outgrowth of a number of years of experience, and many interesting methods have been developed. It must not be forgotten that the Curtiss shop at Hammondsport was a real pioneer in the building of both motors and planes, and that its equipment is radically different from what would have been the case had a new shop been established recently to manufacture these motors. Here it was that the motors for the "June Bug" and the "Silver Dart" were built, as well as the machine with which Glenn Curtiss himself won the famous James Gordon Bennett trophy in France in 1909. With the shops up on the side hill by the old Curtiss homestead, about a mile from the flying field and the lake, handicapped in the means of transportation for material and finished product, was laid the foundation for the largest practical airplane development in the United States.

The cylinders are quite difficult to cast, owing to the rather intricate core over the head through which the valve stem guides project. Then, too, the walls are quite thin (only $\frac{5}{32}$ in. thick when finished), which prevents heavy cuts being taken either in boring or turning. For this reason, it has been found advantageous to use engine lathes and Jones & Lamson machines instead of the usual heavy cylinder-boring machines, which could materially reduce the time necessary for machining if the cylinder castings could stand the stress imposed by heavy cuts.

Turning the Pilot

One of the first operations is to turn the pilot (or as our English friends would say, "spigot") on the lower end of the cylinder. This pilot, which projects through the cylinder base and acts as a guide to prevent side movement of the cylinder, is turned in an engine lathe, as shown in Fig. 1, the cylinder head being held in a special chuck while the open end is supported on a three-point spring center, as shown in Fig. 2. A hardened and ground bushing A is fastened to the tailstock spindle after the nut B has been put in place. Then the hardened and

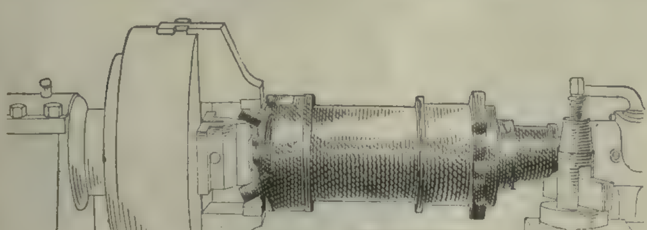


FIG. 1. TURNING PILOT ON CYLINDER

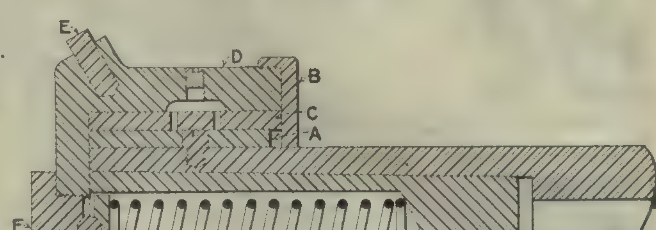


FIG. 2. SPRING CENTER FOR CYLINDERS

ground bushing C is slipped over A, and the head D, which carries the three points E, goes over this bushing, and the nut B is screwed in place. The spring inside the tail center tends to force the head D forward through the ball and cap F, the movement being limited by the distance G between the end of the bushing A and the nut B. As will be seen, there is an oil reservoir formed by the annular chamber in the head D, which, in connection with the oil-hole grooves, enables the oil to reach all the bearing surfaces throughout the entire mechanism.

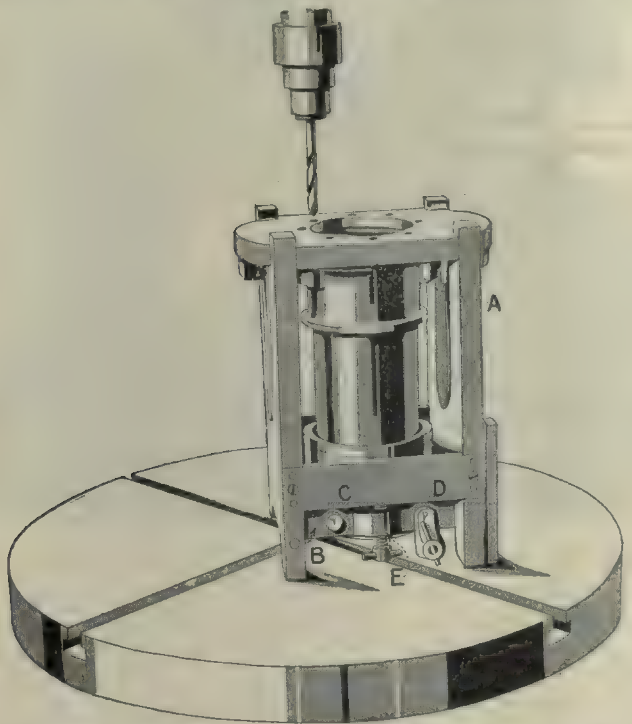


FIG. 3. DRILLING CYLINDER-FLANGE BOLT HOLES

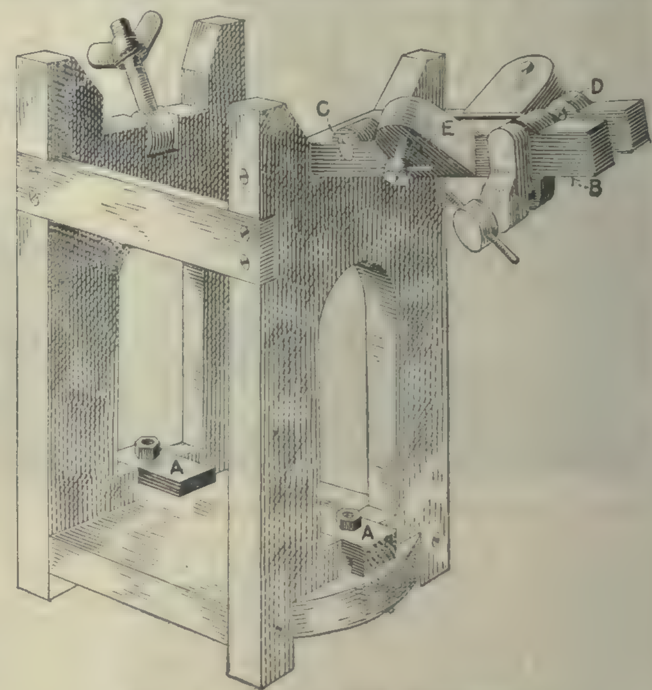


FIG. 4. DRILL JIG FOR CYLINDERS

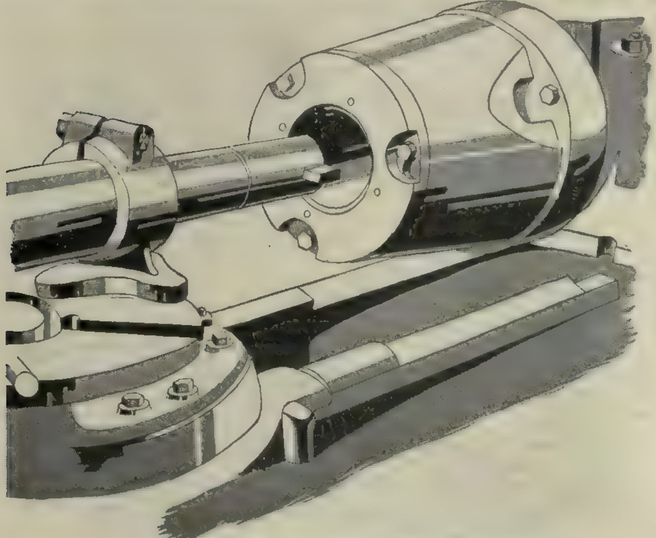


FIG. 5. ROUGH-BORING CYLINDERS

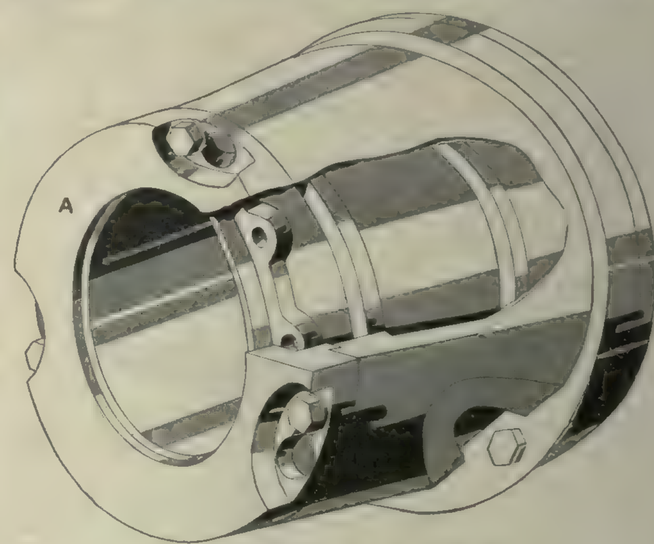


FIG. 6. CYLINDER-BORING JIG

Next comes the drilling of the bolt holes through the lower flange, this being done in the skeleton box jig shown in Fig. 3. The drilling is done with an eight-spindle drilling head, so that all the holes are put through at one operation. The details of the drilling jig are shown in Fig. 4 and require almost no description. The cylinder flange slips under the arms AA, the cylinder being clamped against the flange by the swinging arm B. The cylinder is positioned by the stops C and D, the final clamping being accomplished by the screws E. The fixture is then turned upside down for drilling, as shown in Fig. 3.

The cylinders are next rough-bored on a Jones & Lamson machine, being held in a special chuck, shown in Figs. 5 and 6. This is a form of pot chuck that screws onto the lathe spindle and in which the cylinder is placed after the outer flange A has been removed. The cover is then replaced, the enlarged hole being slipped over the bolt head, and the plate turned slightly so as to afford a bearing for the capscrew. The back end of the cylinder is then supported by a central screw, and the work is ready for boring.

The water jacket of the Curtiss cylinder is formed between the casting and a sheet monel-metal jacket, which is brazed on the outside of the cylinder body. The turning of the cylinder to receive this jacket is shown in

Fig. 7, the pilot of the cylinder fitting inside the chuck *A*, while the cylinder is driven by dowels that project from the chuck face and enter the bolt holes in the cylinder flange. The outer end is supported by a false center, as shown. This operation turns the upper end of the cylinder to the correct diameter and also leaves a shoulder for the sheet-metal jacket. At the lower end

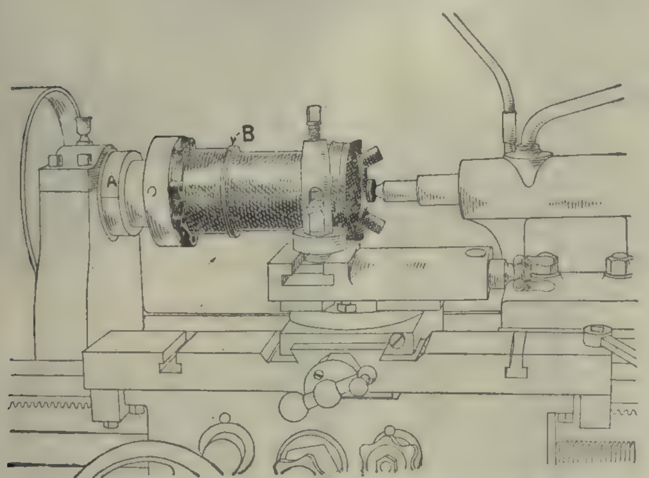


FIG. 7. TURNING CYLINDER FOR JACKET

there is a flange, shown at *B*, to which the lower end of the jacket is brazed.

Fig. 9 shows how the cylinder is held for drilling the spark-plug hole. The base *A* has its top inclined to the proper angle and makes a drilling jig unnecessary for this work. The side opening to the valve chamber, as well as the angular projecting valve-stem guide *B*, is also shown in Fig. 9.

The brazing is shown in Fig. 10, a Tobin bronze bead having previously been brazed around the cylinder head

posite side of the cylinder is controlled by the latch *B*. This view shows the jacket in place and a water connection at *C*.

The cylinders are finish-bored in an engine lathe, as shown in Fig. 12, being held in the same sort of chuck

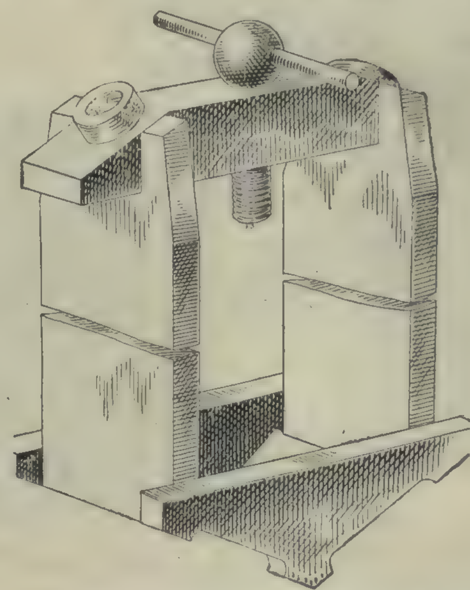
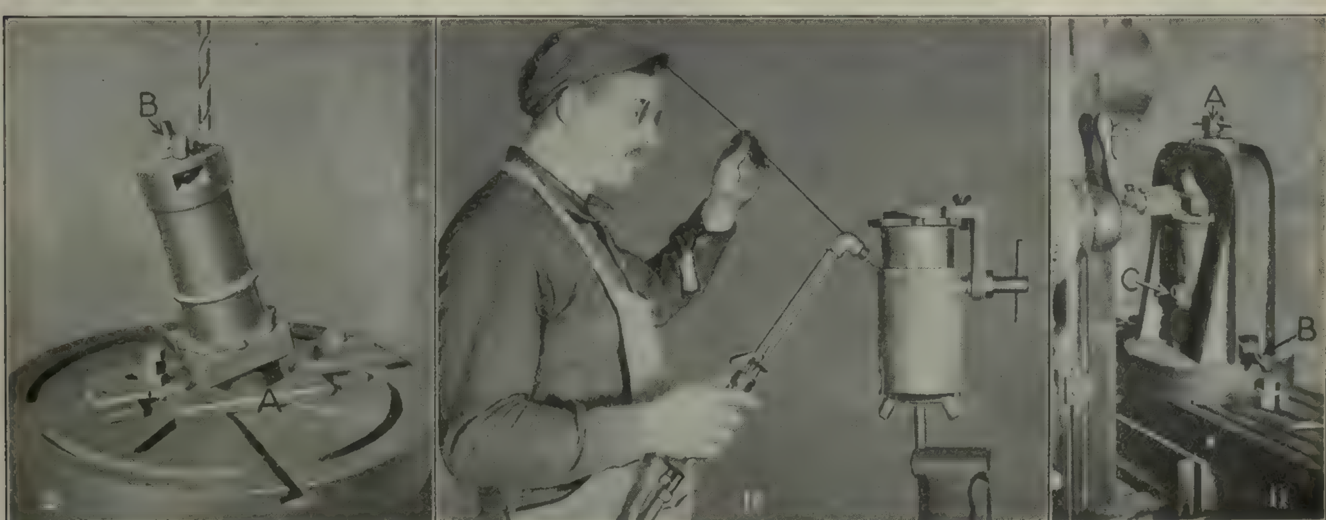


FIG. 8. DRILL JIG FOR VALVE-STEM HOLES

as for rough-boring. The finished boring is done with a single point tool, so as to remove any inequality due to distortion caused either by spring or overheating during the brazing operation. This operation leaves the cylinders true, so that the grinding can be done quickly on the Heald cylinder grinder, as there is little stock to be removed. Water is used in the jackets to keep the cylinders cool and prevent distortion during the grinding.



FIGS. 9 TO 11. VARIOUS OPERATIONS IN THE MANUFACTURE OF THE CYLINDERS
Fig. 9—Drilling spark-plug hole. Fig. 10—Brazing on water jacket. Fig. 11—Milling intake and exhaust ports

to form the upper joint for the sheet-metal jacket. This figure also shows the device for holding the jacket in position while it is being brazed.

After the jackets are brazed in place, the cylinders go to the miller, shown in Fig. 11, to have the intake and exhaust ports milled flat to receive their proper connection. The cylinder, which is held in the yoke-shaped fixture shown, is clamped in position by the screw *A*, while the indexing from one port to the one on the op-

The next, and final, operation on the cylinder is to test the water jacket for leakage, this being done under water pressure in the fixture shown in Fig. 13. The side and top outlets are connected, the latter being held in the vise. The boring and casing of the valve sheet is an awkward, and consequently an interesting job. The valves are on the inside of the cylinder head, and the seat must be cut on the curved portion of the hemispherical compression chamber, but at exact right angles to the valve-

stem guides which project from the cylinder itself. This necessitates cutting the valve seat with an inserted tool on a bar which bears in the guide holes already drilled.

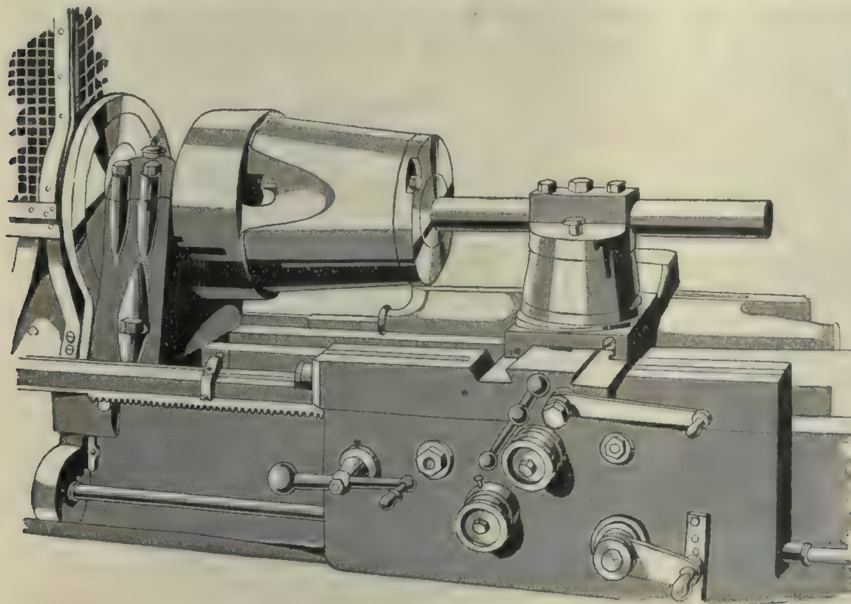


FIG. 12 FINISH-BORING OF CYLINDERS

The crank case was formerly rattled by a special method, but this has been abandoned, and it is now completely scraped inside and out in order to remove every particle of sand which may have adhered to the casting. The inside is scraped to prevent the possibility of any foreign substance getting into the lubricating oil and thus injuring the bearings. After this has been done and the casting inspected for flaws, the bottom face is milled and the bearing seats are roughed out with a half-round end mill, as shown in Fig. 14. The cutter itself consists of four flat blades nested around the center so as to give radial cutting edges, as shown in Fig. 15. The holder is shown at *A,* one of the blades at *B,* the branching nuts at *C* and the assembled cutter at *D.* These are sharpened on a radius grinder. After the engine base has been surfaced on the lower side for the joint with the crank case, it is placed in the drilling jig shown in Fig. 16 and all

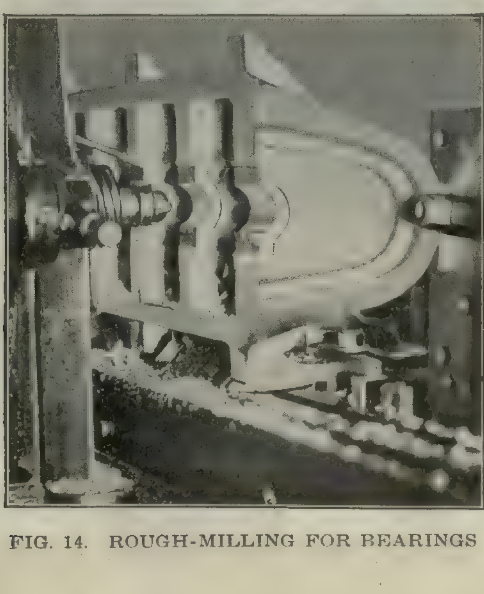


FIG. 14. ROUGH-MILLING FOR BEARINGS

the holes drilled under an American sensitive radial drilling machine. This includes holes for bolting the crank case and also the main bearing, the drill being shown in

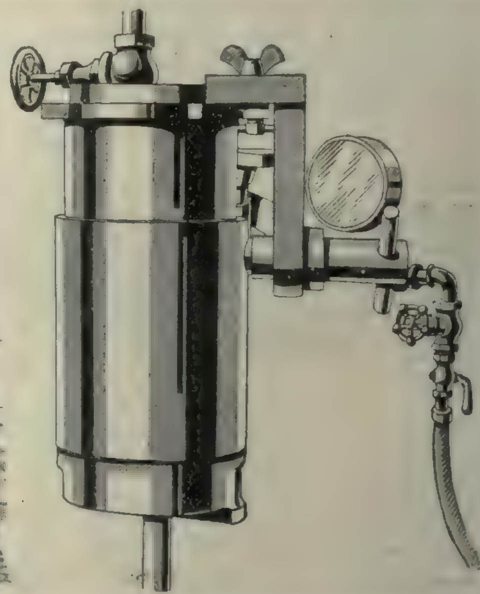


FIG. 13. WATER TEST FOR JACKETS

position for one of these holes. The main bearings are now finish-bored in a special fixture on a Lucas hori-

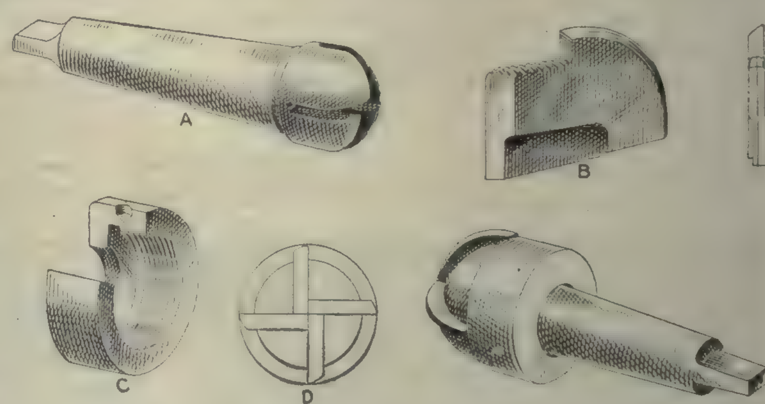


FIG. 15. MILLING CUTTER FOR BEARINGS

zontal boring machine, as shown in Fig. 17. As can be seen, the bar is well supported against springing, so that the holes are bored true and are then ready to receive the composition shell which forms the bearing.

Facing the Cylinder Surfaces

The cylinder surfaces are faced on a miller with a large cutter, special fixtures being used for supporting the aluminum casting at numerous points, so that a heavy cut may be taken. The holes for the cylinder pilots are then bored, as shown in Fig. 18, this operation being followed by the drilling of the eight cylinder-bolt holes, as shown in Fig. 19.

A special eight-spindle drilling head is used for this purpose in connection with the locating jig, which fits the pilot holes already bored and locates by the holes drilled for the valve guides. Fig. 20 shows the milling of the joint flange on the lower half of the crank case, the case being supported by the stops on each side and positioned by the central mandrel, which prevents the case being held in too high a position.

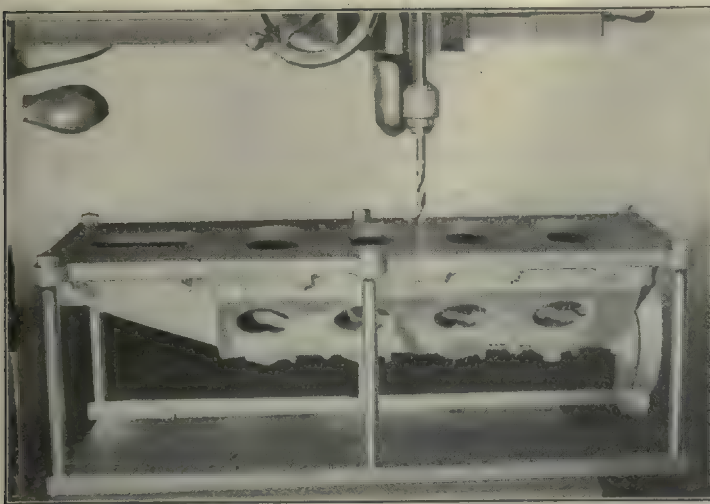


FIG. 16. DRILLING FACE OF CYLINDER BASE

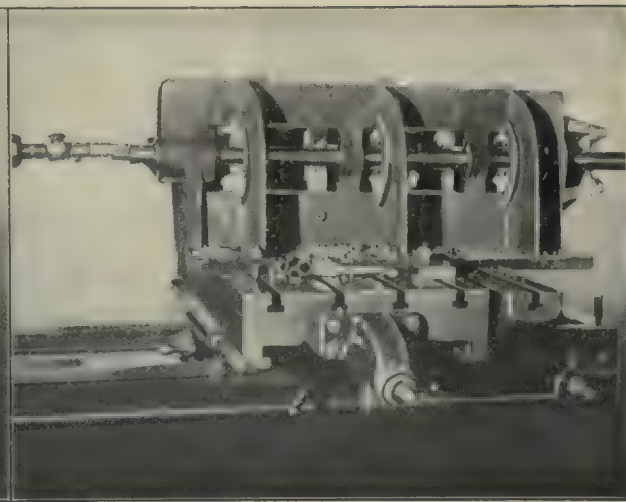


FIG. 17. BORING MAIN BEARINGS

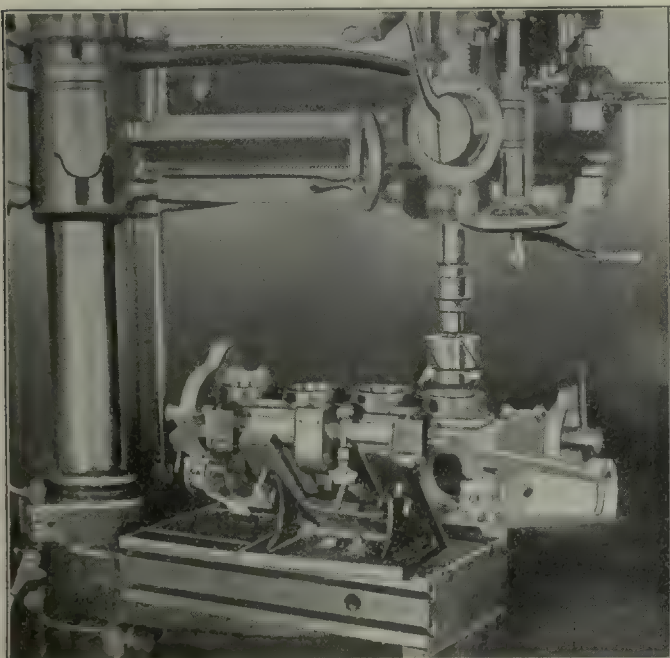


FIG. 18. BORING CYLINDER HOLES IN CRANK CASE

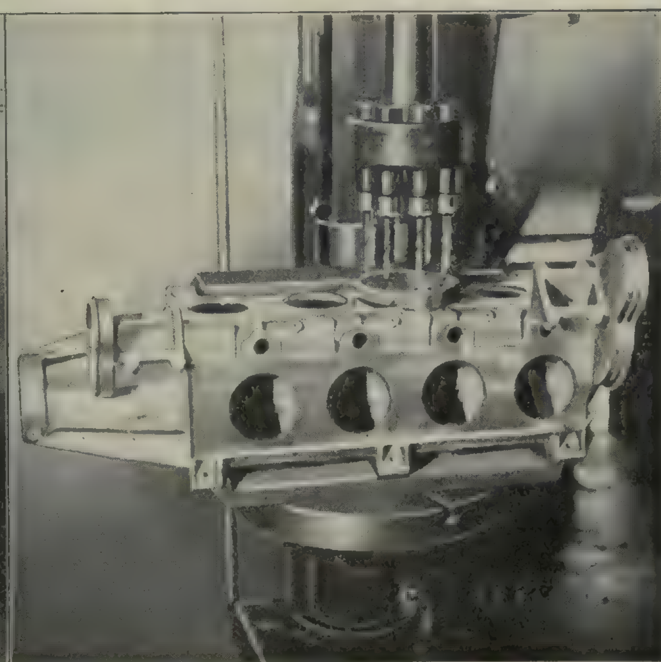


FIG. 19. DRILLING ENGINE BASE FOR CYLINDERS

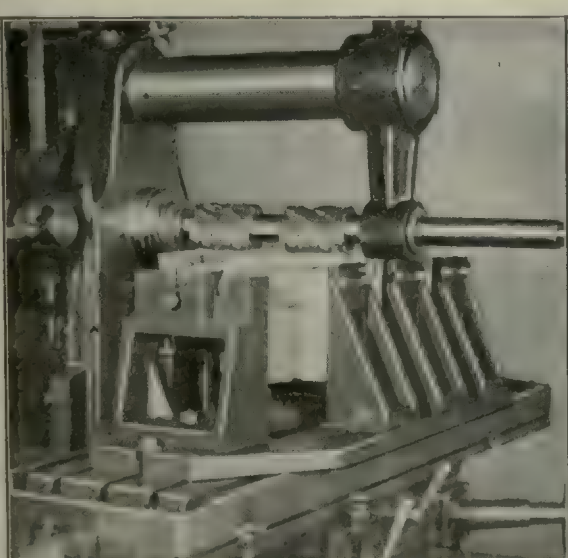


FIG. 20. MILLING THE JOINT FLANGE

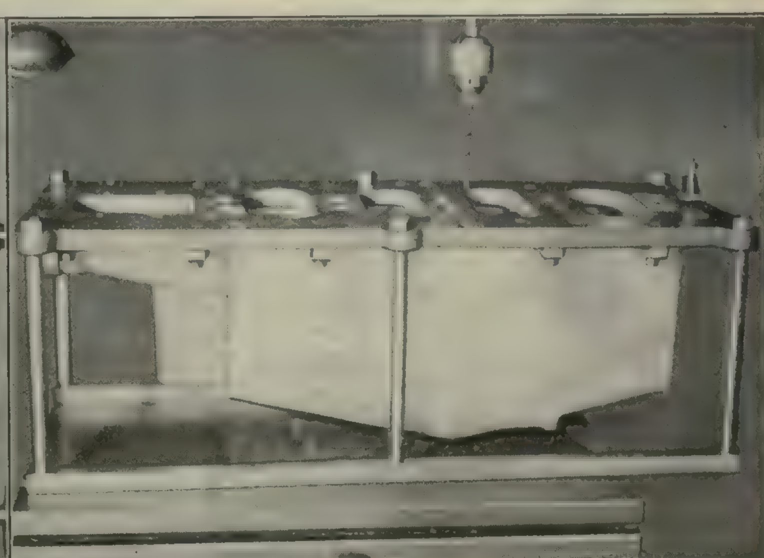


FIG. 21. DRILLING LOWER HALF OF JOINT FLANGE

The drilling jig for the joint bolt holes is shown in Fig. 21. This work is also done under the American sensitive radial mentioned before. Both halves of the crank case are then bolted together and swung in the upper spindle of a McCabe lathe, as shown in Fig. 22, a mandrel being clamped in the crankshaft bearings and stand the thrust of the propeller. The magneto bracket base is milled to the proper height and drilled to receive the magneto. After this, the crank cases are allowed to season, in order to relieve themselves from internal stresses, and are then given the final line reaming for the crankshaft bearings, and also for the ball thrust.

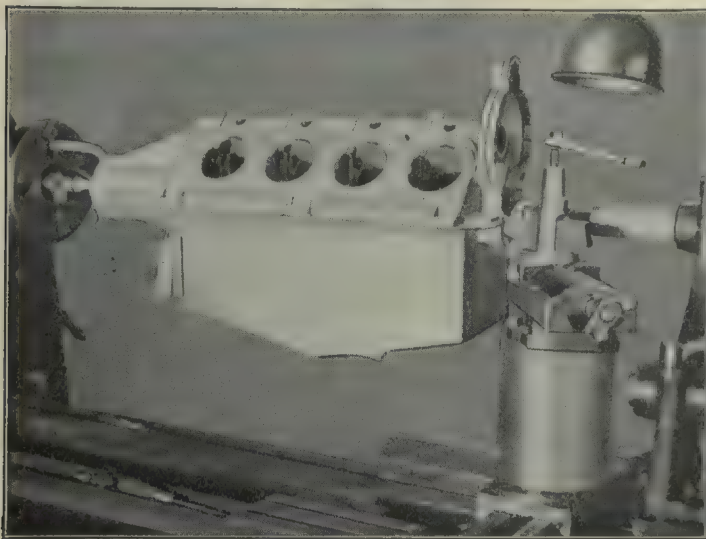


FIG. 22. FACING CRANK CASE ON MANDREL

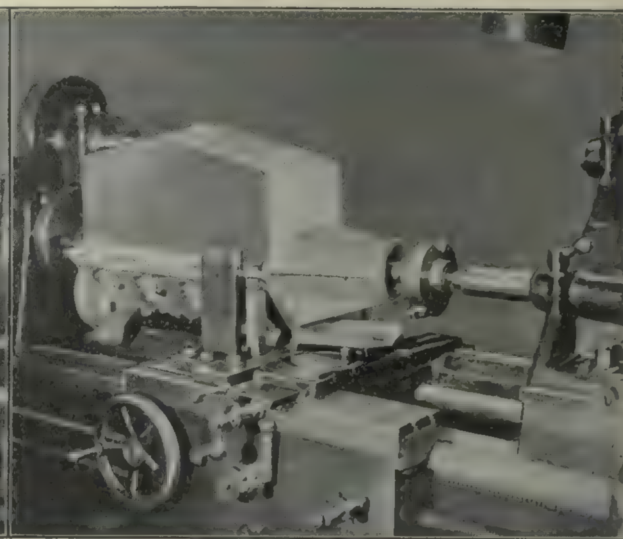


FIG. 23. BORING THE THRUST BEARING

driven by the bent tail dogs. The end of the gear case is then faced with a single point tool, as illustrated.

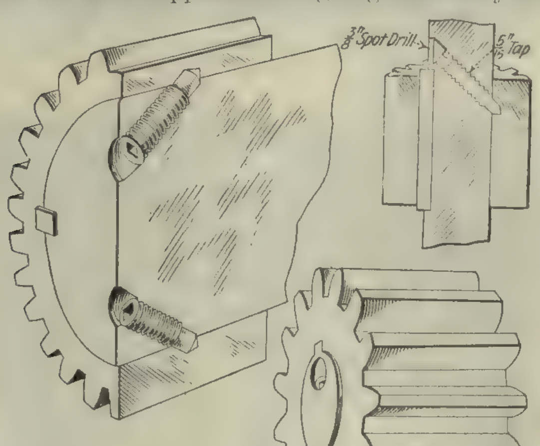
The case is next bolted to the lathe carriage, as shown in Fig. 23, and the thrust bearing end bored with a bar driven from the lower spindle of the lathe. This thrust bearing recess takes the ball bearing that has to withstand

The end clamp holes and the holes at the rear end of the crank case are then drilled, together with the oil holes for the various bearings. The making of the camshafts and connecting-rods and other parts will be treated in another article that will be published at some time in the near future.

Methods of Setscrewing Gears

By Phillias P. Monfils

The accompanying illustrations show a method that I have used to hold gears from sliding off over the ends of shafts. It often happens in designing machinery that all



METHODS OF SETSCREWING GEARS

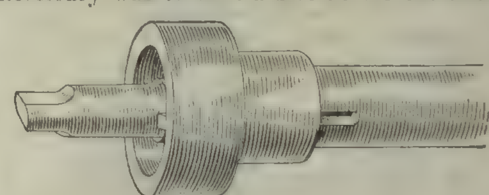
the available space on the shaft, on both sides of the gear, is taken up by other mechanism, no chance being left for elongating the hub of the gear. I therefore devised this method of applying the setscrew, which is very simple and effective. I believe that it is even better than the usual method of tapping through the hub at an angle not vertical to the shaft.

A setscrew thus applied tends to draw the gear away from the shoulder on the shaft, when tightened, especially if the shaft is not very carefully spot drilled for the point of the setscrew. By the method shown herewith the setscrew tends to crowd the gear against the shoulder instead of away from it.

A Driver for Large Reamers

By J. A. Raught

The illustration shows a driver I designed for driving large reamers, core drills, counterbores, etc. The only thing necessary was to mill a slot across the bottom end



A DRIVER FOR LARGE REAMERS

of the drill-press spindle to receive the two keys in the large end of the driver. The taper shank is driven in the spindle socket as usual, then the driver is pushed up until the keys enter. This device has done away with the twisting off of tangs.

The "Tramp" Draftsman

By Charles M. Horton

SYNOPSIS—A sympathetic disclosure of the viewpoint and nature of the draftsman who roams from one job to another, staying but a little while in each place. He is the pioneer of the drafting room; he is independent, skillful, courageous. He deserves to be better understood by his chief, for he can do an enormous amount of good work.

Every trade has its "tramps." Indeed, not a few of the professions are similarly endowed. I know of consulting engineers, for instance, who frequently shift their offices from New York to Chicago, and from Chicago to San Francisco, and from San Francisco to New York again in pursuit of activity in their chosen branches—or promise of activity or prospect of activity. Consulting engineers, more than other scientific folk, live with their ears close to the ground for new developments. By tramps I mean those persistent followers of "hunches" that ever breathe of fields that are fairer and more fertile than the one at the moment under foot—that mystic, elusive, fascinating place just over and beyond the next hilltop.

Emerson—Ralph Waldo, not Harrington—speaks of it so often and so eloquently in his essays! Always and ever it is the place or thing just out of our grasp; and always and ever, therefore, it is the place or thing we most desire. Some of us in this life go after it—pursue it from the cradle to the grave. Nor are mechanical draftsmen, any more than any other workers in Martha's vineyard, immune as a class from its call. Next to steel workers and pattern makers, draftsmen probably are most prone of all to heed it.

Individually, the tramp is a growth. Originally, he entered upon the work as any other draftsman enters upon it—conscious of home ties and inclined to remain with one organization. As time wears on, however, and the tramp becomes more and more conscious of his skill and mastery of the game—he almost invariably is an exceptionally capable man—he finds a kind of irksome monotony in the work gripping him and in consequence longs for new fields to conquer. He wants difficulties. Accustomed to his present work, he no longer has these difficulties—the thing has developed into a matter of routine for him. He chafes under it, itches to get away, does get away, finally, and to the great surprise of his immediate superiors. Nor is he always able to explain why he is going, as he takes leave of the organization. He calls it a hunch and lets it go at that, packs away his tools, shakes hands all around and turns a light and eager step toward the door for the last time. One of God's big men—take it from me!

The Tramp of Today Is Like the Pioneer of Yesterday

The world's pioneers—men who broke fresh ground for all mankind in any direction—were such men. Individual in thought, they had the courage to be individual in deed. How many successful men there are who can look back to the day and hour and minute—yes, second—when a like step proved to be the turning point in their career! It was a hunch—sure! And all men have such impulses at one time or another. But the number who lack the courage to heed the still small voice are legion and may be measured accurately on the scale of failures in life. It requires courage to step out and up and away from the steady flow and direction of the masses, and the courage thus required is born only of confidence in one's own ability.

Tramp draftsmen are competent men, as are the tramps in any trade or profession—the best pattern maker who ever struck a certain small plant located in the Hudson Valley rolled off a freight with all of his tools in a wad of overalls under his arm; and while they do not last, it certainly is worth while putting them to work for the amount of work you get out of them while they abide in your midst—or mist, take your choice.

The Tramp Is Unjustly Looked Down Upon

Curiously enough, the average chief draftsman will not hire such a man if he knows it. The tramp is considered undesirable as an employee. He does not stay. Nor will he. That is true enough. But if your work is plentiful and hurried, as all drafting work usually is, why do you seek clerks when what you need is trained mechanics? There lies the keynote of the trouble. Executives are prone to regard draftsmen as a species of clerk—a man to come in, learn the peculiarities of the line and remain to become increasingly competent as time passes. That is the executive viewpoint. It is based on error. Your skilled draftsman knows your work before he enters your employ. Drafting is drafting—get that—and the principles involved, whether the work be tracing or detailing or designing, are the same everywhere and anywhere. Draftsmen know this.

But your executive never, or rarely, realizes it. Or if he does know it, he refuses stubbornly to regard the matter in this light. Almost invariably he will ask what the draftsman's previous experience has been and, much depending on the urgency of his need for a man, hires the applicant or fires him out, on the nature of the reply. That this same applicant, while admitting that he has never worked on a similar line, might show the executive a trick or two worth knowing never occurs to the latter. How could he?—the draftsman, I mean. He has never worked on conveying machinery! Bosh! And from the list of places where he has worked, he will not stay. Right! Not forever. But he will turn out a surprising amount of work while he does stay—and, after all, is not that what you pay him for?

The Independence of the Tramp

Your tramp draftsman is independent, naturally. It is part and parcel of his nature. He regards your job in its relation to himself as a dead, flat, fifty-fifty proposition; not forty-sixty, with the advantage lying either way; just a plain fifty-fifty deal. If he works overtime, he wants pay for it; if he takes a day off, he does not want pay for it—and will say so if you put it up to him. He may not, probably will not, refuse the money if it comes to him in his envelope. That is a straight matter, too.

The competent draftsman does not abide on this earth who can forget his work while he is away from it. The thing continually haunts him. Therefore, unless the matter of money is raised, he accepts what is given him, even though his absence that one day was due to the fact that the fish were biting good off the dock, and considers it justice. As an executive, you may not. If you are one who rose from the ranks of draftsmen, however, I have faith that you will. Competent men do not seek favors, do not have to. Your tramp draftsman is a competent man.

He is other things. He is a philosopher, a man of marked ideals, a man who views life broadly. A trained thinker—if not at first, then eventually so, due to the exacting nature of his work—he spends long hours in solemn pondering of things not always having to do with his work. What draftsman (and this is one of the elements that go toward the formation of a tramp) but knows the delights to be found in traveling in his thoughts around the world and up and down in it, the while—Oh joyful moment!—he solemnly and carefully cross-section lines a drawing of a casting?

At one time or another such work comes to every draftsman. At such times, naturally, his thoughts dwell on things foreign to the task. If he is a reader—and most draftsmen and all tramps are—he permits his thoughts to go whirling off into distant places, places established in his mind, either by his own travels or by his especial brand of fiction, and races down a mountainside at the throttle of an engine or else canters or gallops or runs a broncho straight into a nest of Injuns; or if none of these, then he reflects on the philosophies and metaphysics to be found in the books of any public library.

Timmins, Who Had a Hobby

There was once a draftsman named Timmins. Timmins, on the surface, was just an ordinary draftsman, crawling hither and yon over his board. He was one of thirty-five like crawling specimens of humanity employed in a large organization in Milwaukee. But underneath he was a man possessed of exceptional wit. Frequently joshed because of his big feet, he one day in a moment of grinning irritation offered to wager a large sum of money that there was a greater pressure per square inch bearing upon his "pedics" than there was pressure per square inch on those of his tormentor.

The wager was accepted, and Timmins calmly removed his shoes. It was during the lunch hour. Having removed his shoes, Timmins then placed his foot upon a piece of drawing paper, drew a line around it with a pencil, and then had his tormentor do the same. With these two outlines of very differently shaped and certainly different-sized feet in hand, Timmins went to his board, ascertained the area within each outline with a planimeter—and won the money. Needless to say, Timmins blew in the five dollars at the next session of the Sons of St. Olaf and St. Patrick, our secret social organization.

But that is not exactly what I started out to tell you. He was a true tramp draftsman, was Timmins. He had worked in every large organization almost in the United States. And he had developed his peculiarities. One of these peculiarities took shape in a mysterious disappearance from the office about once a month. These regular disappearances puzzled the rest of the "Sons"; but when Timmins was asked about them, he would only grin his infectious smile and consign us to the region of the "hot hinges." And then suddenly one day the mystery was cleared up. It was brought about by an accidental discovery made by one of us. And then we knew, and somehow respected Timmins more than ever for it. It appeared that, soon after coming to the city, he had discovered a quiet nook in a corner of one of the large libraries; and there once a month he would bury himself in Kant's philosophy and let the world of mechanics wag.

Timmins was as deep as the stuff he read and had the makings of a big man in him, and eventually he rode up to his due. But in those days, on the surface, he was just an ordinary skate of a draftsman, given to sudden notices and departures; and while working, he took petty criticisms from his foreman with all the solemnity of an owl, sometimes regarding the man with an expression that, interpreted, seemed to say, "How can any one man know so much!" One of the tramp bunch, was Timmins—draftsman.

The True Nature of Draftsmen

I trust you will understand me. I am trying to reveal as best I can the true nature of a body of men whose part in life is a silent one, because of the character of their work; and who, because they play a silent part, are more subject to being misunderstood by their superiors than any other group of employees. Draftsmen as a class are not the men of slow mentality a glance into any drafting room would seem to indicate. A corps of clerks will dash here and there in an office and give the impression of great mental alertness. So will a group of salesmen—that branch of the manufacturing industry eternally pampered and petted because they happen to be associated closely with the thing that means continued life—money, as picked up through sales.

But your draftsman never dashes hither and yon. He does not dare. Every minute he spends away from his drafting board is time lost, as viewed by the organization, unless he is sent away somewhere to measure up work; and so mutely he remains in a bent and meek and somewhat imploring posture a certain number of hours a day. If he shows a marked inclination to duck out on the minute of closing, he is rated as a clock watcher. He probably is. But it is not because of undue laziness on his part, nor because he loathes the character of work upon which he is engaged. Merely, he ducks promptly to take the kink out of his spine and the knots out of his lower intestines and the cramp out of his legs. A weak and troublesome stomach and a draftsman are synonymous. I am strongly inclined to believe that the president of any corporation would duck promptly also, under like circumstances.

The Tramp Draftsman Needs Few Tools

The tramp draftsman usually travels light, as any traveler will who travels much—he eschews the excess baggage. He knows that he does not need it. Like that pattern maker who appeared for work in the Hudson Valley plant and possessed as his working kit a hammer and a square, the tramp draftsman can and does perform miracles with a T-square, one angle and a pencil, while some of his coworkers struggle along in the game with a $125 set of instruments, ranging from a beautiful Brown & Sharpe protractor in a velvet-lined and morocco-

covered case down to and including five sizes of spring dividers, each set to a fixed distance.

The tramp gets through, and by, on working ability alone. I have known tramps, whose 8-in. compasses had been lost somewhere in the shuffle of frequently changing jobs, who could describe circles, circles that defied criticism, with a pencil drawn around a French curve. It requires skill to do this sort of thing, but the average tramp possesses that skill; and this, to repeat, is what, more than any other factor, makes him a tramp. He knows that he knows, and this knowledge is the foundation of the courage that is his to quit a job and move on when the mood strikes him. A job to him is about as important and gives him just about as much apprehension as the nature of the food that will constitute his next meal. It will be something to eat, and he knows that he will get it. Therefore, why worry? A month's pay in his clothes—two months'—three—and he is up and away to new, fresh, inviting and more interesting fields. He has the courage to do it.

He is generally unmarried. He is often a man without ties. These facts, of course, help. Many men of courage, men who would dare to do, deny themselves the joy of unrestrained movement for reasons honorable and private to them. These men are not tramps and therefore are not to be considered in this article. I speak of the wanderer as he is and as I have found him in my own more or less frequent migrations. I speak of him with profound sympathy in my heart and, I feel, true understanding of him as a human. Possessed of rare moral courage, capable as a workman, born with an inquiring and restless mind that must be satisfied—he comes into your drafting room, abides for a time and performs his work with a zest and interest that appeal. Then suddenly and without apparent cause he shifts out of your sphere—the tramp long ago became a reality in drafting-room circles, as in circles of labor not the drafting room, and will continue to be a reality as long as wheels whirl and cutting tools chatter and oil smells in the heat of friction of metals.

And now I think I hear a footstep that sounds very like that of the chief. Presto! My back is bowed over my board, my pencil is marking a line on the paper, I am meekly and soberly silent, attending to my work.

Operations in the Manufacture of Adding Typewriters

By Robert Mawson

SYNOPSIS—In this article various jigs and fixtures used in the manufacture of the parts of an adding typewriter are described. These parts must be finished to such limits as will make them interchangeable.

An essential in the manufacture of either adding machines or typewriters is that the different parts be interchangeable. The Ellis Adding Typewriter Co., of Newark, N. J., is making a machine that combines both the adding apparatus and the typewriter, and it seems

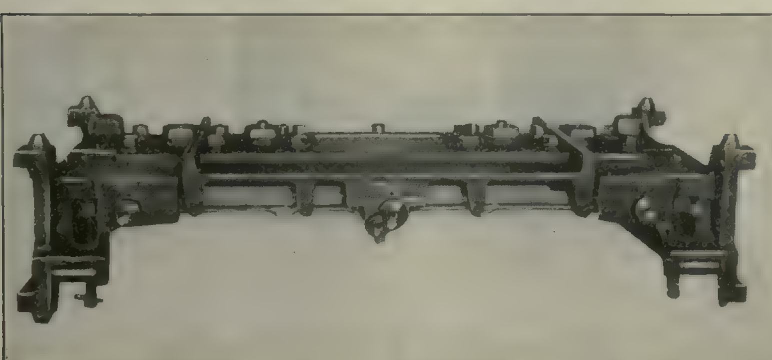


FIG. 1. DRILL JIG FOR CARRIAGE FRAME

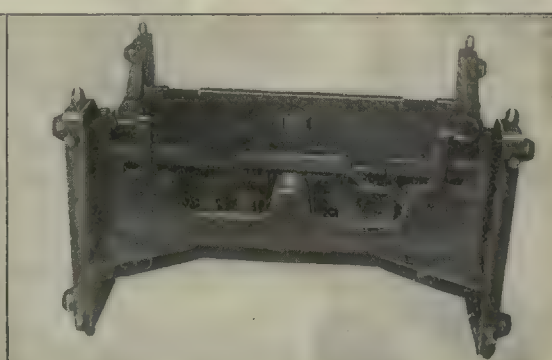


FIG. 2. JIG FOR CROSS-BAR

that even greater accuracy in the machined parts is demanded in this product. To obtain this result high-grade tools are called for, and some of those in use at this factory are shown here.

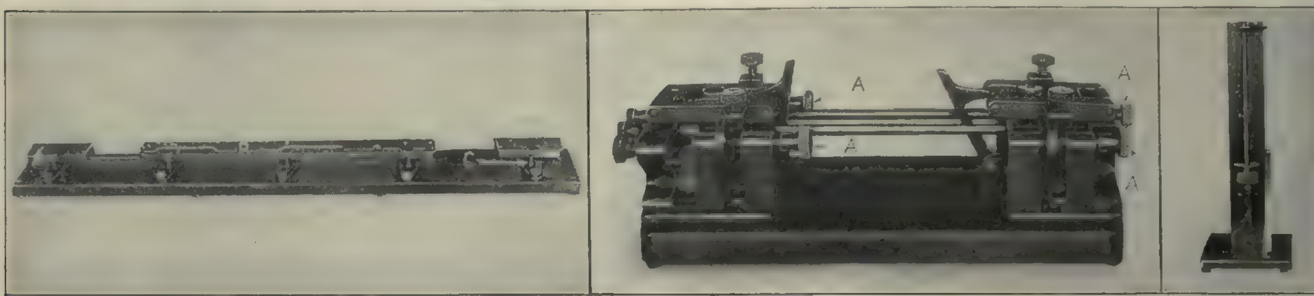
In Fig. 1 is illustrated the jig employed when drilling and reaming the carriage frame. The casting is placed on height pins and located at the end by stop pins, set-screws being tightened against the casting to hold it securely. The jig is provided with two covers, which are held down with latches. The casting is made of aluminum and the following holes are machined: Ten No. 41 drilled; thirty-one No. 50 drilled; one 1-mm. drilled; one 7-mm. spot drilled and reamed, and one 9-mm. spot drilled and reamed. The time required for the machining operations is 45 min.

The jig employed when drilling and reaming the cross-bar carrying escapement is shown in Fig. 2. The casting is placed in the jig, resting on height pins, and slid against the locating pin at one end of the jig. A knurled-head screw is tightened against the casting to force and hold it against the locating pin. The cover is afterward dropped down, being held by means of latches.

Two knurled-head screws in the cover are tightened against the casting to hold it down in the jig. The piece is made of cast iron and approximately 45 min. is taken to machine the following holes: Sixteen No.

32 drilled; four No. 29 drilled, which are then reamed to 3.5-mm.; two No. 41 drilled; four 2.5-mm. drilled; three 4.04-mm. drilled; one 5.04-mm. drilled; five 7.04-mm. drilled; two 4.47-mm. drilled; one 7.98-mm. and two 10-mm. drilled.

In Fig. 3 is shown the jig used when drilling tabulating stopbars. The piece, which has been previously machined on all surfaces, is located against a stop at the end *A*. The four cams are then swung against the piece as shown, to hold it in position. Six No. 31 and four No. 23 holes are then drilled in the piece. The production for this operation is six per hour.



FIGS. 3 TO 5. VARIOUS JIGS AND FIXTURES
Fig. 3—Drilling tabulating stopbar. Fig. 4—Assembling drilling and pinning jig. Fig. 5—A spinning fixture

As this jig is used for two different lengths of bars, the plate *B* is made so that it can be slid to another setting for the other casting. The second casting is also longer, and the cam *C* is utilized to hold it at this end, the piece being located at the opposite end in the manner described.

An Assembling and Drilling Jig

A jig that is used when assembling drilling and pinning the accumulator cams on the shafts is shown in Fig. 4. The shafts are placed in the jig with the cams slid onto them. The cams are then located with the pins *A*, being forced against the stop plates as shown. The covers are dropped down and held with latches, to keep the shafts in position in the jig. Two No. 47 holes are then drilled in each shaft and cam hub and pins driven in, thus uniting them.

In Fig. 5 is shown a fixture used when spinning the end of the paper-feed bail tubes. The tube is placed in the fixture after the arms have been slid on, resting on a steel block at the lower end. The hook shown at the upper end holds the tube securely in the fixture. The upper end of tube is then spun over the bushing and bail arm, thus holding them firmly together.

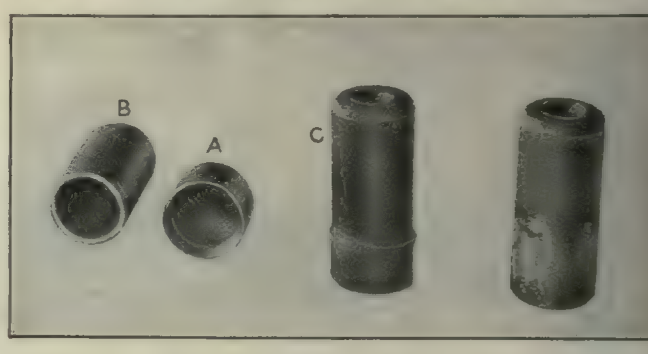
Military Trucks Standardized

The Truck Standards Division of the Society of Automotive Engineers, of which H. D. Church is chairman and many leading truck designers are members, has done excellent work in the formulation and revision of specifications for military trucks so vital to transportation of troops and supplies. Tens of thousands of trucks will be needed for the armies now being organized in this country. The army divisions have been thoroughly motorized, regimental transport mediums alone remaining animal drawn. The United States has done more than any other country to standardize motor trucks. In the specifications to be issued shortly by the Government the features of construction that are vitally important have been given due effect. The truck is naturally one of great capabilities, having a very low gear reduction and a large engine. Particular stress is laid on the inclusion of a four-speed transmission and on provision for adequate road clearance, making possible negotiation of the roughest ground on which the trucks will travel. Demountable tires are considered essential, owing to operations at points far distant from supply depots. Large gasoline tanks will be installed. Other items of interest are electric lighting, three-point engine suspension, locking differential and large power-plant cooling capacity. Particular attention has been given to the spring suspension and the details of body construction. The gage of the wheels will be uniform.

Making Valve Push Rods with the Electric Butt Welder

By A. Towler

The Studebaker Corporation, Detroit, Mich., finds that the Toledo electric butt welder simplifies the machining operations required in manufacturing valve push rods. These pieces have two parts, as shown in the illustration; *A* is the head, and *B* is the body. The head is bored out from bar steel, and the body is drawn in a punch press to the shape shown.



MAKING A PUSH ROD WITH THE ELECTRIC WELDER

The two elements are then united with the butt welder to form the push rod *C*, the outside diameter being 1.155 in. The production for this operation is 200 per hour. The outside is then finish-ground to 1.124 in. in diameter. By this method of making the push rod, a light-weight and yet a strong part is obtained. If it were to be made from a solid bar, it is easy to see that a somewhat difficult machining operation would be necessary.

Practical Training of Apprentices

By W. Rockwood Conover*

SYNOPSIS—An outline of what constitutes practical education and training of apprentices. The selection of the kind of work, entering examination, shop and class instruction year by year for a four-year course, wages and bonus are all discussed. The weekly expense per boy for a shop course is given as $1.25 to $1.50. Over 60 per cent. of the boys graduated from the General Electric school are still with the firm.

Present conditions in the field of industrial labor have caused the subject of educating and training apprentices to receive unusual attention, both from the school boards of our large municipalities and from factory managers generally. The establishment of trade schools in cities and of training classes and mechanical training departments in industrial plants, as institutions of economic value and of public and private good, are being agitated and discussed with increasing earnestness and interest.

Without attempting to analyze the relative difference in basic costs of these two methods of instruction, the practical and urgent necessity for boys and girls of the present generation to be prepared to earn their own livelihood, under conditions of daily increasing competition, requires no extended argument or demonstration.

It is of evident value in any industry to train as many hands as possible within the walls of the industry itself. Boys who have served their time and graduated from the apprentice course have not only become, in some degree, familiar with the different methods of performing various mechanical operations and the use of machine tools peculiar to the factory in which they are employed, but have also become conversant with the practices of the factory relating to shop discipline, production routine, use of materials and many other details that render the boy at the expiration of his course of more value to his employer than a stranger unfamiliar with the shop practices. It is evident, however, that the degree of efficiency and skill of the force thus trained will depend largely on the thoroughness and kind of instruction.

Where the work in a factory is all of one uniform class or kind, the problem of training the apprentice is greatly simplified, and he may be taken directly into the shop at the beginning of his course. In such establishments a separate training department and school will usually not be judged a necessity. But in the larger manufacturing plants doing a general mechanical or miscellaneous manufacturing business, it is essential that there be a separate training department and also a school where the boys may gather from the several shops for regular classroom instruction.

In the small shop the training of the apprentice must necessarily be of the most simple and practical kind. It consists of such instructions and explanations as the foreman is able to give, in connection with the actual experience that the boy receives in the performance of various manual and mechanical tasks. His progress and final knowledge depend in a large degree on his own energy and interest throughout the years of his apprenticeship. Many foremen take a personal interest in boys placed in their hands for training and do much to keep up the boy's enthusiasm in his work, spending no small amount of time in showing him how to do things and the reasons why.

FIG. 1. TRAINING ROOM FOR FIRST-YEAR MACHINIST APPRENTICES

But this training is nearly all on the physical, or practical, side and lacks the mental exercise and discipline received in the classroom of the apprentice training school. There is a lack of balance and adjustment in the instruction. A boy needs not only to do things with his hands and perform mechanical processes with his physical powers, but he needs, also, to know why he performs these processes in one specific way and not in any one of several other ways. He needs to work, and work

*Industrial Economist, General Electric Co., Schenectady works.

hard, both physically and mentally throughout the four years of his course. His mental development is as important as his physical practice, if he is to become a fully rounded-out and competent mechanic, able to make his own way. Night study is the only recourse for the boy apprenticed in the small shop. If he is fortunate enough to live in a city having a trade school with night classes, his opportunity for rounding out his mechanical education and training is excellent. In any event he must devote a portion of his evenings to the study of such mathematical and mechanical subjects as will be of future benefit and necessity to him in his work.

Advantages of Apprentice Over Trade-School Boy

In some respects the shop apprentice has distinct advantages over the boy attending a trade school connected with a public city school. He has opportunity, during his four years in the shop, to gain a wider experience in factory routine, productive work and mechanical processes than in general it is practical to provide in the public institutions. He has larger opportunity to do with his hands the things the public school instructor theorizes and talks about. (See Fig. 1.)

Whether or not the apprentice must do his night study alone by himself, the training of one or more boys should be a permanent feature of every small shop. The argument that it costs the manufacturer as much, or more, to educate each apprentice than he is worth on completion of his course, in no way alters or diminishes his responsibility to the community. If it were not possible for him to obtain skilled help, which had received apprenticeship training in other localities or had received its equivalent—the experience gained by years of service in other shops—he would, from force of circumstances, be compelled to set about the training of his own employees, in order to maintain a full complement of help. The establishment of vocational schools, either public or private, for the education and training of boys and girls in the specific crafts or professions that will enable them to not only start intelligently and successfully but, also, to continue successfully through life, is destined to become nation-wide, and in process of time world-wide.

In a discussion of the value of training apprentices within an industry it is well to give consideration to some of the important elements essential to a thorough and successful apprenticeship training system.

Essential Elements in a Shop Training System

When entering upon the apprentice course it is necessary, first of all, that the applicant be of the proper legal age to begin work. He should also furnish reference as to character and general habits and should be able to speak, as well as read and write, the officially constituted language of the country in a fair degree commensurate with his age. It is also of little value relatively for a boy to enter upon a course of training until, in conjunction with his parents or guardian, he has carefully considered the definite kind of work or trade he intends making his life study and pursuit. If accepted without condition, being left to choose later on in his course some particular branch of the work, he will in most instances lose spirit and ambition and drift aimlessly from one department to another with no higher object than obtaining his weekly wage. This point should be guarded against at the outset. For this purpose the foreman or person in charge of the apprentice department should talk personally with each applicant, drawing from him as much information as possible concerning his plans or views in regard to the lifework for which he desires to fit himself. He should learn as far as possible his previous preparation, fitness, etc. He will in this way obtain an intelligent idea as to what particular branch of the work the applicant is best adapted by previous tendency or training and can aid him in many instances in making a successful choice. The applicant is then ready to take a formal examination in arithmetic, reading and writing, or such other subjects as may be deemed practical and advisable. If he is entering upon the drafting-room course, his examination will, of necessity,

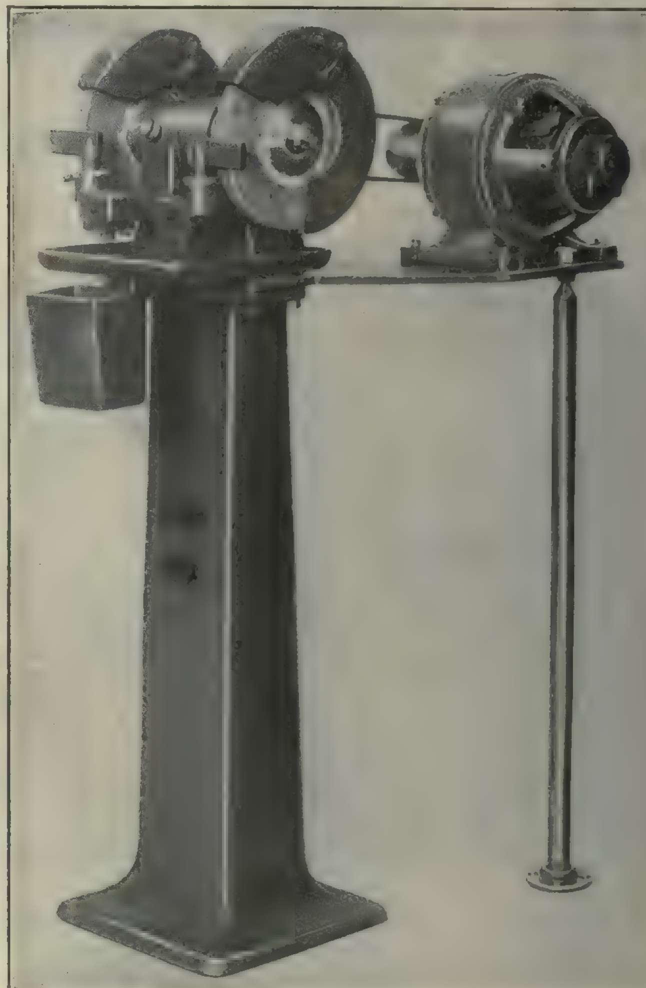


FIG. 2. TOOL GRINDER WITH 9 x ¾-IN. WHEELS
Machine was designed and built in the apprentice department

be of a higher and more advanced grade in mathematics than when entering the shop course. The questions given him will have reference more particularly to the problems which come up in drafting-room work, such as those of mensuration, square and cube root, metrical questions, etc. For the shop course ten or twelve simple problems in arithmetic, in addition to short exercises in reading and writing, should be sufficient to determine previous preparation or fitness.

If the applicant passes his examination successfully, he should be given a trial for not less than one month to determine, as far as possible, whether his choice of trade or work has been correctly made. In frequent instances this period will be found too short to develop the genius or fitness of a boy for a given calling, and

in such cases it will be much better if the time limit of trial is extended to two months, and even longer. During this trial period, boys who are to take the shop course should be retained in the apprentice mechanical training department and not sent into the factory. They should also remain in this department for the first year of their course before being transferred to the various shop departments.

Trial Month and First Year

When started out on their second-year course through the factory, they should spend not less than three or four months in each department except in special cases where, for special reasons, it may be deemed advisable for a boy to continue in one department for a longer period or for the full length of his term.

The training department should contain a good equipment of machine tools, such as lathes, planers, drilling machines, slotters, millers, shapers and any other tools necessary to give a boy a general experience in the rudiments of operating power tools. The department should be presided over by a foreman who is not only well skilled in mechanics, but who also has the capacity to instruct and train the young mind in a clear and practical manner.

A variety of mechanical work not of too complicated a nature may be sent from the various shops to the training department, which will give a good return in productive output. The value of this product helps in a large measure to pay the expense of maintaining an apprenticeship course. Many boys develop a good degree of skill in the early part of their training period, learning the use of machines and tools rapidly, and are able to do good work on small parts, such as collars, nuts, small shafts, thimble-pointed bolts, studs, adjusting screws, pins and keys. They are also able to do a variety of other work, such as repairs to vises and portable tools. This opens up a field of decided advantage to the boy, wherein he may develop his powers of investigation and insight along more general lines than would otherwise be possible.

Not infrequently a boy shows skill and ingenuity on toolwork and the better grades of production work, and will do well making cutters, arbors, mandrels, drill jigs, etc. Crankshafts, which ordinarily are done by experienced lathe hands, have been turned, shaped and finished in first-class workmanlike manner by boys who have not yet completed their first year in the training department. Occasionally a machine tool is built (see Fig. 2).

The pattern apprentice department is a most important feature. (See Fig. 3.) The intelligent boy does good pattern work after a little instruction and practice, and some make rapid progress and display much mechanical ability and skill working in wood. They also show excellent ability in making small cabinets for office use, chests for tools, or similar articles, which require care and exactness in fitting and quality in finish. (See Figs. 4 and 5.)

It is in the training department, also, that a boy will develop and show the trend of his abilities or inclinations, and this gives him an opportunity to change and take up the trade for which he is best fitted, provided such opportunity is within the possibility of the factory. But those in authority, as well as the parents or guardians, should be careful not to encourage a change of mind unless the fact is thoroughly established that the boy has fully determined his final, personal choice. Even with this information a decision should not be reached without the most careful and thorough analysis. This may delay the date of his transfer, but it is likely to alter the whole course of his career for success and increase the value of his services to his employer as he nears the completion of his apprenticeship, and thereafter.

Another feature of the training department is the incentive to excel, which is furnished by a large group of boys working in unison for advancement and self-improvement. A boy will not do poorer work than his fellows if he is in earnest and desires to succeed and has the capacity to do better. The laggard or indifferent boy will be looked upon with ill favor by his fellow apprentices, the same as at school. This factor tends to

FIG. 3. APPRENTICES DOING PATTERN WORK

keep up the standard of workmanship in the training course. It is doubtful if a boy feels the same incentive when put immediately into the shop among men to learn his trade. He feels himself on an unequal footing with the workmen around him, which tends to repress confidence in his own ability to reach out and do new and more difficult tasks. He fears criticism when mistakes are made and does not like to be looked upon as a mere boy. These conditions do not exist in the training department where he is the equal of his fellows, the knowledge of which gives him full confidence in himself and tends to increase his efforts toward progress.

The apprenticeship system should provide classrooms with competent instructors where the boys may attend school a portion of each day, or a portion of stated days each week. Attendance at school should be compulsory, otherwise the boy's training will be incomplete. The course of instruction should comprise such objects as relate directly to shopwork, and in any instance should be of a most practical kind. It should include a proper amount of demonstration work along the lines of the mechanical problems that the boys are given. It is not uncommon to find an otherwise average, skilled machinist who has grown up in the shop, who cannot clearly and logically explain the function of the first-, second-, or third-class lever, and does not fully understand its use. This every apprentice knows before his course in the training school has been completed.

The instruction and education of the apprentice should not be limited to the training department and classrooms alone. He should be given additional work in the shape of drawings and subjects to study during evening hours at home; and the parent or guardian should see to it that some regular, definite time is apportioned to this evening work. Apprentices in the drafting course will necessarily receive additional instruction in higher mathematical subjects, which should be chosen with reference to their work.

Attendance Must Be Compulsory

Attendance upon the classroom work should be made compulsory for all apprentices who have not yet completed their four-year course. Each boy should receive pay for the time spent in classes at the same rate per hour that he receives in the shop. If he falls behind in his classroom work, he should be compelled to make up this deficiency before advancing into his second-year course.

It is evident that all apprentices, according to class, should enter their trial period and the training department at a uniform rate, for reasons of equity and justice to all. The rate after the first year may be arranged on the basis of a sliding scale, increasing from year to year until the course is completed. Where the factory is operated on the piecework system, it may be found advisable to allow boys in the fourth-year class to work by the piece. This will give the foreman of the department a line on their relative efficiency and will tend to increase the daily wage of each apprentice. But it is doubtful if this is desirable for boys who have not reached their fourth year, for the reason that they are not sufficiently experienced or advanced to hurry their operations without danger of producing defective work. When on piecework during the fourth-year course, a satisfactory special piece rate, or a division of the profit between the apprentice's day rate and the piece-price value paid to tradesmen mechanics for the same operations, can easily be made that is equitable to both employer and employee. When the latter practice is pursued, the division of profit paid to the apprentice need not as a rule exceed 25 or 30 per cent.

When working on productive jobs, it is obvious the time of apprentices should be charged to the production orders or requisitions covering the specific class of apparatus for which the parts are being made, and only the time occupied in attending school receiving instruction and doing practice or trial jobs should be charged to expense. Separate time cards should be provided for this, so that proper distribution of the hours may be made in the payroll and accounting departments.

On the completion of his course, the employer may grant each apprentice a bonus of such sum of money as he deems proper and just. If this is made a part of the entering contract, it is an incentive for each boy to do his best and pursue his studies with diligence and good faith. A report showing apprentices by departments should be made out periodically.

Another statement of value is one made in tabular form showing the number of apprentices in the several trades or classes in service at the beginning of the month, the number in service the previous month, the number who have left the service during the month and also the number of each class or trade in the first-, second-, third- and fourth-year courses; also the number who have completed their course or who have left or been discharged during the year. This statement should be a monthly one. A yearly statement made out along similar lines, in addition to giving the information contained in the monthly report, will show, also, the number of each class or trade who have completed the four-year course. It is evident that boys will not be rated in any given year until they have worked the full number of hours and have shown the qualifications and competency in classwork, drawings, etc., required for the previous year.

A card record of all apprentices should be kept in such manner as to show date of engagement, rate, present location (in trial period, training department or shop), classification or trade, state of progress, date of transfer to shops and from one department to another; and any other information that makes it possible to tell at any period the full history of each boy and his degree of progress toward the completion of his four-year course.

Cost of an Apprentice Training Department

The cost of maintaining an apprentice training department and school (exclusive of an apportionment of power, light and heat, rent, taxes, insurance, receiving, shipping, transportation, accounting, etc.) for a total of 400 boys should not exceed \$1.25 to \$1.50 as an average per student per week. This cost will include one head foreman in charge, two assistant foremen and one instructor for the mechanical training department, three instructors for the classrooms, one office clerk and one stenographic clerk, one stockkeeper on tools and materials, one or two laborers to collect, handle and deliver material to the apprentices on benches and machines and to keep the shop floor in a neat, orderly condition, remove chips, turnings, etc., and also the time occupied by the boys in the classrooms while attending school. It also includes the necessary labor and materials for the maintenance of machine tools and small expense tools, as well as all expense-supply material used within the department. The items of

apportionment are excluded for evident reasons. The cost of these items and the amount of apportionment must necessarily vary according to local conditions and the size of the manufacturing plant, hence no uniform basis of calculation of this portion of the operating expense can be properly or accurately assumed. The item of bonuses, being purely an arbitrary matter with the individual manufacturer, is also excluded.

Against this outlay and expense for maintaining an apprenticeship training system and school must be credited a proper proportion of the productive output of the apprentice, which is equivalent to the difference between the labor cost of the work at the apprentice rate and its value when the labor is performed by a regular tradesman machinist. As many boys develop a fair degree of rapidity and skill early in their course, this return to the company in productive output becomes a relatively large and important factor in the economic cost of maintaining the training department and school.

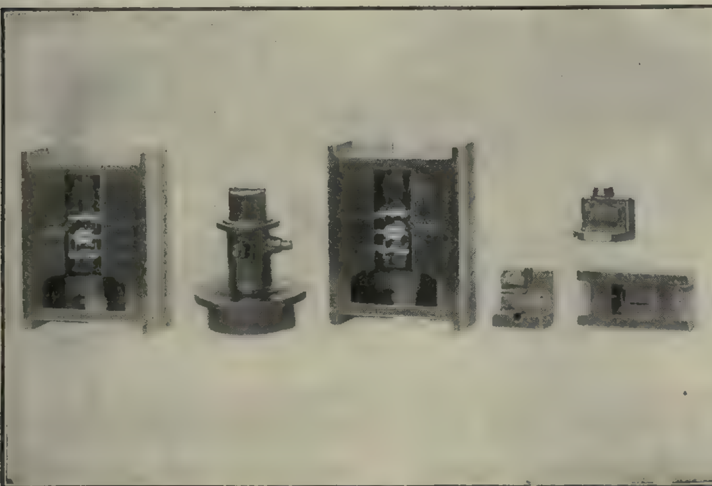


FIG. 4. VALVE AND MAGNET FRAME PATTERNS AND CORE BOXES

Made by an apprentice having had two years of the course in pattern making

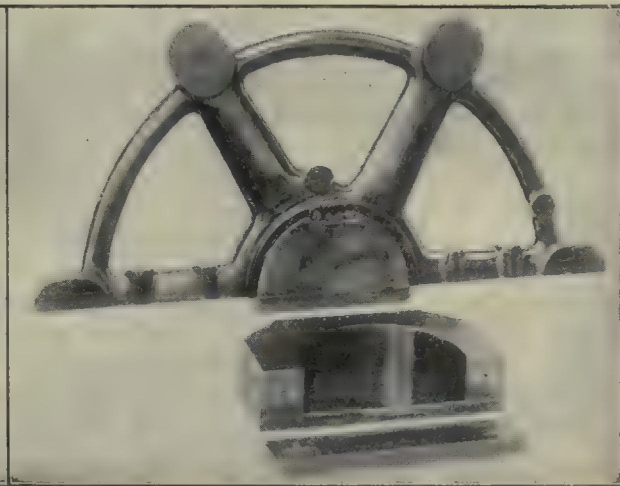


FIG. 5. BRUSH-HOLDER YOKE PATTERN AND CORE BOX

Made by apprentice eight months on the course in pattern-training room

Economic Value of Training Boys

The question may naturally be asked by the busy manufacturer: "Of what special economic value is all this careful adherence to system and detail in the training of boys for factory work, and what are the results obtained for the outlay of money required to maintain the training department and school, with the necessary corps of foremen, assistant foremen, instructors for the class rooms, clerk, stenographer, etc.?" The answer is this: Every manufacturer knows there are times when it is practically impossible to secure enough good journeymen to fill the departments of his factory with competent, skilled help. He is often compelled to take into his shops unskilled labor and break them in on one or two operations in order to turn out the required amount of product. This class of help is frequently unsatisfactory on work where some degree of mechanical knowledge should be possessed at the start. Furthermore, there is a demand at all times in the larger establishments of the country for skilled labor, and this is where the economic value of training boys and young men is plainly demonstrable.

Out of a force of 400 to 500 apprentices, approximately 120 will graduate each year from the four-year course and hold certificates as journeymen. From 60 to 80 per cent. of this number will remain in the factory for a longer period than one year, and it is safe to assume that a reasonable percentage will remain for an indefinite period. Over 80 per cent. of the boys graduated in all trades at the close of the year 1916 from the Schenectady Works apprentice training school of the General Electric Co. have remained in the employment of the company at this plant, and over 60 per cent. of all the students graduated from this school since the beginning are still in the company's employ.

What is the result? There is a constant influx into the factory of young men possessing not only a knowledge of one of the several trades necessary, but trained in the various shop practices and routine of the factory in which they have been schooled. If these young men remain for a term of years, the employer gains the advantage of their services during the most active period of life, when the energies of mind and body are at their best. Furthermore, having, in addition to their training in the school, received the watchful care and all reasonable help and encouragement from the company, the chances of their continuing loyal and faithful to their employer's interest during their term of employment are, on the average, much greater than would be the case with newly engaged employees coming from other and distant localities and having little or no interest either in the city or the factory in which they are employed. It is desirable in most factories, as a rule, to promote men from the ranks to fill the responsible positions of foremen and overseers, and it is of special advantage if these men have received their apprenticeship within the factory itself.

The Cutting Torch on Die Work

An interesting example of cutting with the oxyacetylene torch was recently performed with the Davis-Bournonville apparatus. This was on a steel die block 14 x 18 x 36 in., weighing 2382 lb. The block was cut to make two pieces 14 x 16 x 18 inches.

The torch was style 3000, with a No. 5-8 tip. The time required to make the cut was 9½ min., and the gases consumed were 325 cu.ft. of oxygen at 130 lb. per sq.in. and 12 cu.ft. of acetylene.

Design of Square Broaches*

By Walter G. Groocock

SYNOPSIS—In the design of square broaches there are several methods of arrangement. The usual practice of making the widths of flat the finished size is shown in this article to be bad practice. A method of overcoming this is explained, and the way followed to design a better type of broach is given.

As with other types of broaches, when designing square broaches one is confronted with several different methods of arranging them. In the long broaches it is customary to have the width of the flats practically the finished size from end to end. There is, however, one very good reason why this system is not particularly sound practice; and that is, when the broach loses its size, and it must do so sooner or later, then one has either to put in another short broach just to size the hole or make a complete long one and scrap the one that is under size. Further, if the broaches are designed to pull out the hole to its finished size across the flats from the start, it will be found invariably that there are several nasty scores or marks in each hole. While these drags may not be sufficiently bad to scrap the work, they certainly do not add to its appearance or utility.

Obviously, the best holes, from a wearing point of view, are those that have the smoothest surfaces. This being so, then the endeavor must be to secure this desirable feature. The cleanest holes that can be produced by broaching are obtained by making the set of broaches in two parts, one part of the set pulling the holes out—for square holes—to within, say, 0.005 in. of size across flats for small squares and within 0.01 in. for large squares; the final broach in this system then just takes a scrape all over the hole and leaves it in good condition. Aside from excellent finish by this method of arranging the broaches the useful life of the set is very much prolonged because the finishing broach, having so little to do, will produce many more holes within predetermined limits than it would if it had part of the roughing out to do.

There are other good reasons why the finishing of the hole should be done by the last broach in the set. The time will come when the hole produced will not be to gage. Although a good sharpening across the face of the teeth and a second pull through of the finisher will temporarily overcome this difficulty, another broach must be used to finish with; and it must of necessity take a shave around the flats. Aside from the possibility of replacement by using the last broach to size the flats, one can considerably lessen the cost of a set of square broaches.

Each roughing broach may be made to just clear the hole left by the previous broach, and in a general way they may vary, say, 0.002 in. across the flats below the size that it is intended to make them. This means, of course, that the finish grinding of the flats can be considerably hastened, because less care will be required with such a limit. Consequently, by adopting this system only one broach in the set needs particular care in finishing. Those who know the difference between attempting to work to size and working to a limit of 0.002 in. will appreciate the importance of this point. The set of broaches should be so designed that the finisher has nothing, or at most only a few thousandths of an inch, to take out of the corners, and this work should be spread over the first few teeth, say 0.001 in. per tooth, thus insuring clean finish to the corners.

By giving the finishing broach very little to do on its corners when new, one is enabled to regrind the roughers when required; and whatever reduction takes place on their corners owing to grinding, it can be met by reducing the first few teeth corners of the final broach. Thus, it is assured maximum life, while at the same time the broaches are kept in such condition that they will give good clean results on the very toughest material. To do this they must be kept sharp.

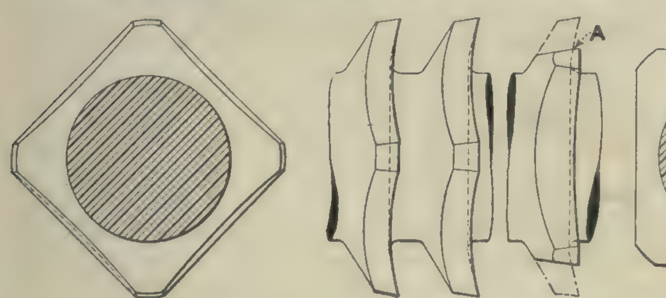


FIG.1

FIG. 1. VIEW TO SHOW LAND ON TEETH

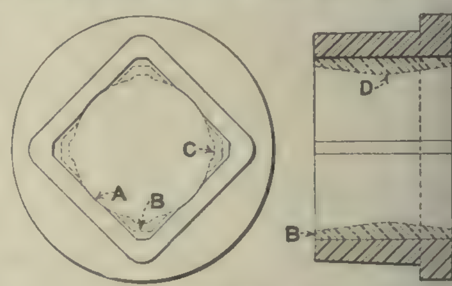


FIG.2

FIG. 2. ARTICLE TO BE BROACHED

Besides just touching the corners of the hole the last broach of the set must take a slight scraping cut along the whole of the flats of the square hole; and to do this, every tooth must be carefully backed off to a cutting edge. The roughing broaches should not be relieved on the flats, but should have a ground land, approximately as shown at *A*, Fig. 1. The curved front is due to the undercutting of the face of the teeth, and it will be referred to again.

In designing square broaches there is no infallible rule by which success may be achieved, except the rule that is common to all design—that is, to base the proportions on the proportions of some successful set, embodying any new data that experience points to as being either necessary or desirable.

The best way undoubtedly is to draw two teeth of each broach very carefully as to size, after one has figured out roughly the load per tooth and the number of broaches to a set. Two longitudinal views should be drawn, one taken

across the flats and one across the corners. In this way one is enabled to see clearly whether there is enough chip room and whether the tooth looks strong enough in the corner view. The root diameter should be checked to see that it is a stronger section than one taken across the pulling slot of the broach. The difference between a corner view and a view of the flats is clearly shown in the illustration.

These broaches were for use on steel forgings of from 3 to 4 in. through the hole. The data for the full square are given at the bottom of the data sheet, and it will be seen that the set consists of six broaches. The first and second broaches appear to have an abnormal load, but in reality their load is small. The articles to be broached, one of which is shown in Fig. 2, are stamped with a square hole; and naturally the forged hole has considerable draft. After it is bored to 3 in. in diameter, the hole looks as it appears at A, the line B representing the square hole on the edge of the forging and the line C being the center of the piece. The portion shown hatched at D is the material to be broached out at the corners. It will be seen that the first and second broach—the first in particular—act on only a short portion of the hole, hence the apparently heavy load.

This set of broaches proved particularly clean in their cutting, and from the easy way in which they did their work it is evident that they might have been loaded still more. But to have put sufficient work on the leading broaches to enable the cutting out of the fifth broach would, without a doubt, have considerably shortened the life of the set. It is a great temptation to the designer, when a set of broaches have been very successful, to increase the load per tooth on the next similar set that he may design; but it is always well to remember that every year the material that we have to broach is getting more and more difficult to deal with. Consequently, the proposition to be considered is not so much "how many pieces per hour" as it is "the cost per piece to be broached."

A set of four broaches may be designed to do a job and work satisfactorily until they have done, say, 1000 pieces. Then they may fall down badly and have to be replaced. Suppose the cost of such a set of broaches is $100. The introduction of another broach into this set would increase the cost of the set by 25 per cent., but it would probably mean that such a set would be in good order after doing 5000 holes. If, now, the labor cost for broaching be considered, in the case of the four-broach set it would be only 20 per cent. less than that for the five-broach set. One can see at once that the small saving in labor cost is very much overbalanced by lower broach cost per piece of the five-broach set. In this, then, as in all good shop practice, the unit cost of production must be considered and not the labor charge alone.

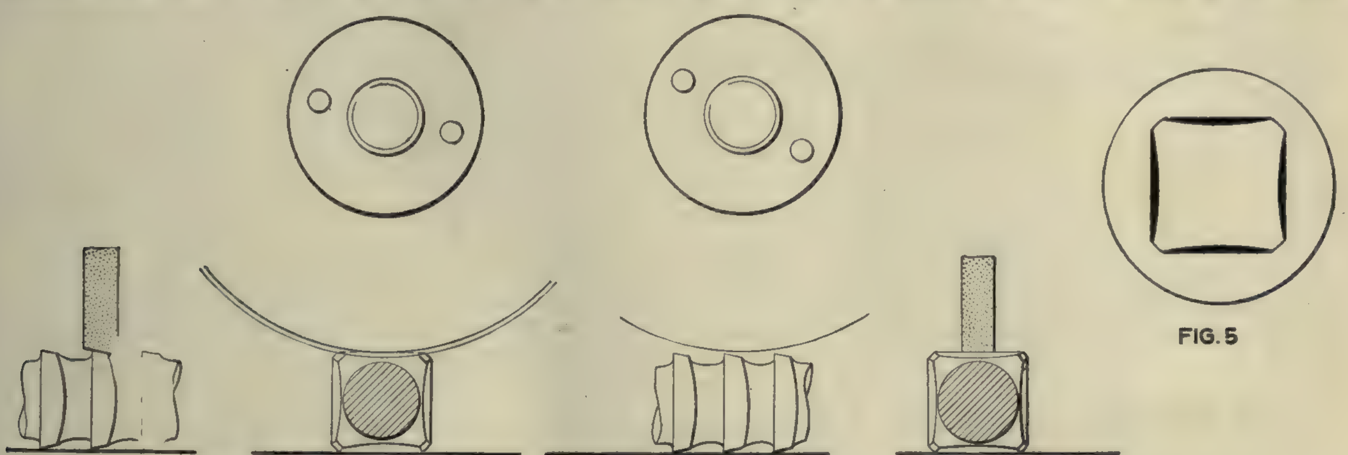


FIG. 3 FIG. 4 FIG. 5

FIGS. 3 TO 5. VARIOUS PROBLEMS IN THE MANUFACTURE OF SQUARE BROACHES

Fig. 3—Grinding broach with edge of wheel. Fig. 4—Grinding large sizes of broaches. Fig. 5—Diagram of error due to undercutting of teeth

Proper Length of Cutting Edge

There is one point in connection with the design of large square broaches that should be mentioned; that is, the length of cutting edge in the first two broaches is such that it is preferable to notch the cutting edges, so as to break up the chips. This notching should be carried out all along the first broach and part of the way along the second. The notching should of course be staggered, so that, as in milling, one tooth takes out what the previous tooth leaves.

An interesting contrast to the large set of square broaches just discussed is provided by considering the second set of data given in the accompanying table. This set of four broaches had to pull out a ¾-in. square hole up to 3 in. long and almost to a sharp corner. The material was a high-grade alloy steel used on automobile gears, and on this material the broaches worked well. This set gave excellent results, and they undoubtedly have sufficient chip room to work in holes up to 4 in. long. They were designed to work from a ¾-in. rough bored hole.

Grinding the Flats on a Broach

The grinding of the flats of square broaches may be accomplished in a variety of ways; but if a Bath spline grinder is available, then with a cup wheel square broaches are a simple proposition. The roughing broaches should be ground parallel the whole length, and afterward the table should be tilted so as to taper the guide portion slightly. When grinding the finishing broach, the finishing end—about six teeth—should be ground parallel and about 0.001 in. over the size of the hole required. Afterward the guide and the remainder of the teeth should be ground taper, the guide being of such size as freely to enter the hole made by the roughing broaches. After this all the teeth along the taper portion of the finisher must be relieved to a cutting edge.

The method adopted to relieve these teeth will of course depend on what machine is available; but as most toolrooms now have a small surface grinder, I will assume that small Brown & Sharpe machines can be used and will discuss two ways of relieving the teeth, which have been found to give good results in minimum time. These two methods are outlined in Figs. 3 and 4.

In the first case the wheel is trued up to a bevel of 3 deg. The work is laid across the table of the surface grinder and is held at right angles to the wheel—that is, parallel to the wheel axis—by means of two parallels clamped to the machine table. The wheel is brought down on each tooth in turn, and the grinder table is moved by the handwheel, thus traversing the broach under the wheel. By this means each tooth is in turn brought up to a cutting edge. When working this way the broach

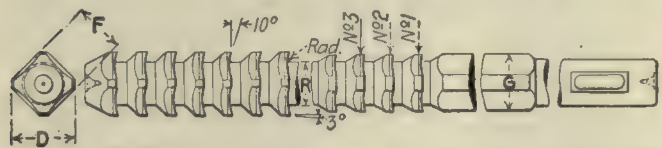


FIG. 6. STANDARD DRAWING FOR SQUARE BROACHES

passes through the standards of the machine and also between the belt. With large-sized broaches there is likely to be interference by the belt. To protect it from accidentally catching on the corners of the broach teeth and thus getting cut, it is advisable to bend a U-shaped piece of sheet steel and lay it across the broach where the belt may foul.

Method To Be Used for Long Broaches

For square broaches over 2 in. this method cannot be used, because the belt rubs badly before the wheel is across the tooth; that is, the travel by this method—on a small Brown & Sharpe—is limited. In such cases we may fall back on the method outlined in Fig. 4. More skill is required in the operator, but the process is perfectly safe for any tool maker who has acquired the "feel" of the machine. The broach to be relieved is laid longitudinally on the table, being held at right angles to the wheel axis by parallels clamped to the table. The wheel is brought down between two teeth to a predetermined depth, which need not be varied, and the table is moved longitudinally so that the wheel just touches the tooth to be relieved. The broach is then traversed by hand underneath the wheel by means of the cross-traverse handwheel; and the platen of the machine, carrying the broach, is moved just far enough to allow the grinding wheel to relieve the tooth to a cutting edge.

This operation, which takes only a fraction of the time required to describe it, is then repeated on all the teeth. The teeth left parallel at the end of the broach should not be brought up to a cutting edge, but should have about $\frac{1}{32}$-in. land. The only drawback to this method is of course the fact that a curved relief is obtained, which is greater at the cutting edge than it need be. However, by using a 7-in. diameter wheel the hollowness of the relief is not very pronounced.

There is another point about the grinding of the finishing broach that must be mentioned here, because it materially affects the design. To get good clean cutting at the corners of square broaches it is advisable to undercut the face of the teeth to the extent of about 10 deg. If this is carried all the way along the finishing broach, one will have difficulty in getting a square hole with perfectly flat sides, because as mentioned before, the undercutting of the teeth gives a curved outline to the cutting edge. Consequently, the cutting edge is relieved by moving a grinding wheel across it in a straight line. It will be found that the center of the flat comes to a cutting edge before the outside. This means that if the whole of the flat be relieved, the broach will be lower in the middle than on the outside of the flats, and naturally the hole produced will be larger measured at the sides than it would if measured in the center. This result is shown exaggerated, in Fig. 5, by the curved lines. The following method gets over this difficulty.

As the finishing broach will never be called upon to cut on the corners, except the first few teeth, the broach need not be undercut the whole of its length. Differential undercutting may be used, as follows: First four teeth, 10 deg.; next four teeth, 7 deg.; and four following teeth, 5 deg. undercut. All the remaining teeth should have flat faces. The result of this is that, when all these teeth are relieved to a cutting edge by a straight-line relief, those that are undercut will cut on the flats near the corners first, while those with less undercut will take more from the center. The teeth with flat faces will take a scrape right across and leave a square hole with a flat side.

The standard drawing recommended for square broaches is given in Fig. 6. Blank dimension sheets should be prepared, which may easily be filled out with the dimensions necessary for any set of broaches. The drawing can also be used for hexagonal broaches by changing the end view. This may be done in the way suggested for spline broaches—by means of an auxiliary print showing the end views of the various shapes.

All that was said with reference to the data sheet shown in a previous article applies with equal force to the data for square broaches, in the accompanying table. This sheet gives the essential particulars of a few successful sets of square broaches and needs no further comment.

DATA FOR SQUARE BROACHES*

Nominal Size of Broach							Effective Teeth, Load per Tooth and Root Diameter																	
							No. 1 Broach			No. 2 Broach			No. 3 Broach			No. 4 Broach			No. 5 Broach			No 6 Broach		
Flats, In.	Corners, In.	Original Diameter of Hole, In.	No. of Broaches per Set	No. of Teeth per Broach	Pitch of Teeth, In.	Total Length of Broach, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.	Effective Teeth	Load per Tooth in 0.001 In.	Root Diameter, In.
5/8	7/8	5/8	3	36	7/16	24½	32	3	7/16	32	4	½	13	2	½									
¾	1 1/32	¾	4	36	½	26½	34	2	9/16	34	3	9/16	33	3	5/8	12	1	5/8	....	...	....	....	...	...
1	1 21/32	1	4	30	5/8	29	27	3	¾	27	3	11/16	27	3	53/64	20	2	[illegible]	....	...	....	....	...	...
1¼	1 23/32	1 5/16	4	34	5/8	31½	30	3	1	30	5	1 1/32	30	4	1 1/16	9	2	1 1/16	....	...	....	....	...	...
1 3/8	1 7/32	1 7/16	6	24	¾	28½	22	2	1	22	3	1 1/16	22	4	1 1/8	22	4	1 1/8	22	4	1 1/8	11	3	1¼
1¾	2 3/16	1¾	6	24	7/8	31½	22	4	1¼	22	5	1 5/16	22	5	1 3/8	22	5	1 3/8	22	4	1 3/8	15	3	1 3/8
2 1/8	2 17/32	2 1/8	5	24	7/8	31½	22	6	1½	22	4	1½	22	4	1 5/8	22	4	1 5/8	6	2	1 5/8	....	...	...
2 3/8	3 3/16	2 7/16	6	24	7/8	31½	22	5	1 7/8	22	7	2	22	5	2 1/16	22	4	2 1/8	19	4	2 1/8	7	1	2 1/8
2 11/16	4	3	6	24	7/8	31½	22	15	2 1/8	22	10	2 3/16	22	8	2¼	22	6	2¼	22	6	2¼	9	2	2¼

* All for use on high-class alloy steels. Work varies from 3 to 5 in. in length.

Business in Prospect and Retrospect

By J. P. Brophy*

SYNOPSIS—Will prices continue to rise, or will they drop? This question is one that affects both the consumer and the manufacturer, although perhaps differently. Here is the opinion of a prominent builder of machine tools who arrives at interesting conclusions regarding the permanence of prosperity. This article was written, of course, before America entered the world war, but is timely.

The past has had its periodically good times and its many years of business struggles. The present is so prosperous that easy money is the fashion, and to ask any old price and obtain it is the merchant's delight.

You are likely to hear a man express himself thus: "Well, I don't think I will purchase just now, your price is too high. I will wait a few months and then I won't have to pay so much. You are charging me 25 per cent. more for this machine than you did before the war. I will be darned if I am going to pay it. I can wait."

This is the kind of talk we hear at present. However, the man or the company that thinks prices are going to drop considerably, now or in the near future, is likely to have another think coming. The time is far distant when prices of machine tools or anything else that is manufactured in this country will be lowered very much; and there are a multitude of reasons for it.

When the demand for machinery and other things became so phenomenal because of the war, the prices were raised to meet the great demand. Labor and material went up in price, a natural consequence in abnormal times. Those who required your product were willing to pay almost any price. They had to have what their needs called for, even if it was necessary to purchase your entire plant; and it nearly reached this condition.

A Forced Increase in Wages

Manufacturers were forced to increase their wages because of the scarcity of help and paid any kind of a workman 20 to 30 per cent. more than the normal wages of the past; in some cases workmen were paid even more. Then, too, materials of all kinds were increased in price from 25 to 100 per cent. In a multitude of cases the selling prices were not raised commensurate with the increase in labor and material, although the net earnings, considering the volume of business, were in most cases satisfactory. It is the volume that generally counts when the profits are figured.

Now how is it possible for the manufacturers whose quotations show less increase than the extra cost of labor and material to make any money? If a manufacturer employed 300 men before the war and because of the large amount of business increased his working force from 300 to 500 or more employees, his fixed expense tumbled immediately. If he had sufficient floor space available, there would be no extra expense for this item; if he did not have enough room, the profit made by the extra 200 or 300 men would warrant an expenditure for it. His office force and the number of his factory supervisors might be slightly increased, but this would not necessi-

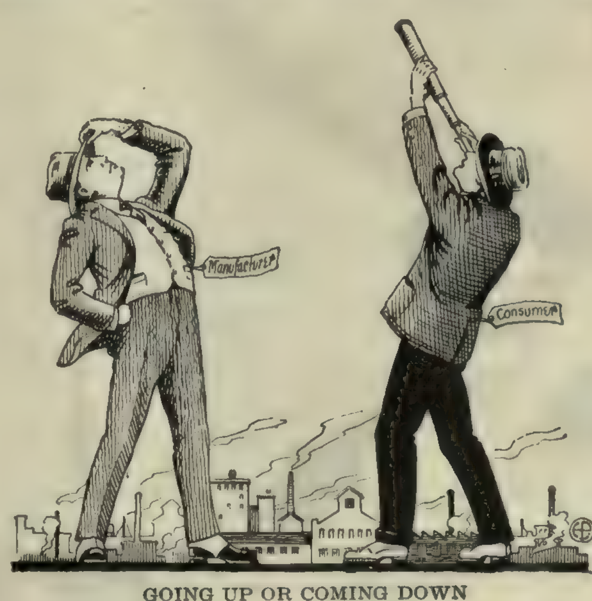
tate much of an increase in his overhead. This explains why it is that when labor and material cost so much the selling price does not necessarily have to be increased proportionately in order to still maintain average profits. But it must be remembered that all the raw material and all the unfinished product in your factory cost you more than they have in the past.

The prices of everything have advanced. What effect will the war have on business? If it means slowing up, how long will it be before the prices of commodities for home consumption become rearranged? If wages remain as they are today, no perceptible change will take place on that which we consume. This is a natural consequence. When things are in an abnormal condition, as they are at present, it will take a long time for price regulation.

Don't be fooled into thinking that the purchase of shells, guns and machinery is what created all this rush of business. If you will spare time enough to investigate, you will be astonished to discover the great diversity of supplies of everything imaginable that have been shipped abroad.

Supposing the high price of material and wages becomes permanent, what occurrs? Just this: We must have protection against foreign competition in the future. When the foreigner gets busy later on looking for American gold, which is perfectly justifiable, he will need money badly. Then look out for serious competition and get ready to meet it. The America-first idea must be implanted in our minds as a safeguard against the foreign dumping of manufactured products. This must be our leading thought.

Some wise men who wish to be quoted as friends of the business men of this nation, claim that the tariff removal, allowing as it does foreign countries to ship their product to this country and compete with us, creates a



GOING UP OR COMING DOWN

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greater effort on the part of our manufacturers to produce cheaply. This is easy to talk about, but these wise ones fail to comprehend that the great effort of 90 per cent. of all the factories at this time is to leave nothing undone that brains and dollars can accomplish to increase the earning power of their investment, and that they have about reached the limit. In the past a vast amount of the manufactured articles imported into this country were produced by cheap foreign labor; and while we successfully competed against this at that time, how about the future?

In thinking of this it will be well to remember that there is nothing so deadening, from a business standpoint, as fear. We must be optimistic. A pessimistic man is a spreader of disastrous views. His arguments always lead to a premonition of approaching calamity and seem to have no weight at the time they are made; but he very often plants the seed of over-caution in the brains of his hearers, and this is the real commencement of the tightening up of the purse strings.

I hope, regardless of what effect the stopping of this war will have on business, that the calamity advocate will do all his talking to himself and not be constantly discouraging others.

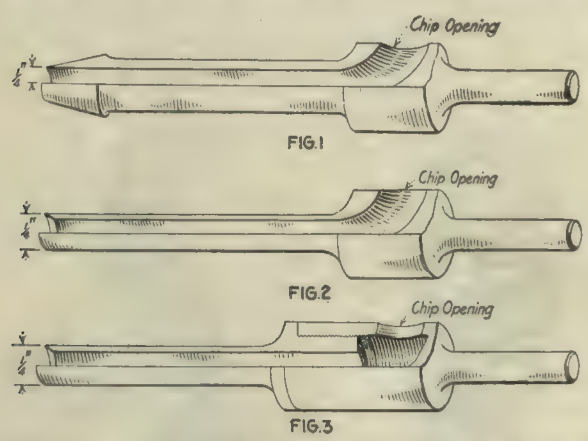
The business men in this great country should join the Onward March Club and encourage rather than destroy the feeling that we in this country, with our good money invested in business, can without very much help from others outside of our own country keep right on prospering.

We, in this great United States, should feel that if the remaining portion of the world disappeared and we were the only human beings left on earth, our great wealth, brains and abundance of virgin soil, would enable us to keep right on doing business as we have in the past and perhaps be more content than we are today.

Drills for Paper

By W. C. Winkelman

Years ago, while working in a jobbing shop in New York City, I was given a job to make some paper drills. These drills were used in a drilling machine run at high speed for drilling $\frac{1}{4}$-in. holes in wall-paper sample books



FIGS. 1 TO 3. DRILLS FOR MAKING HOLES IN PAPER

about 2 in. thick, which were then tied together with a ribbon.

After the order was completed, the drills were tried out as usual; if they did not clog up, they were considered all right and shipped. While trying out the drills, I was surprised to see how they would heat up—in fact, to such an extent that they would turn blue and smoke, which was to be expected, as the design, Fig. 1, will clearly show. Referring to Fig. 1, it will be seen that the drill has a straight hole $\frac{1}{4}$ in. in diameter through the center and therefore does not drill a hole large enough to clear itself. This causes the drill to heat up to such an extent that it will not perform its work in a satisfactory manner.

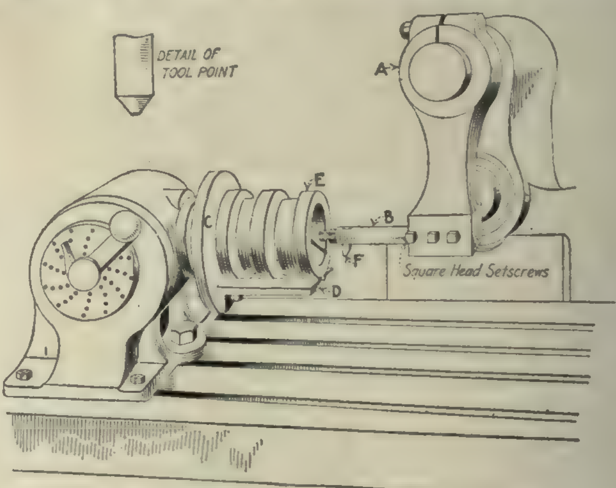
I requested permission to do some experimenting, with the following result: The first drill I made, as shown in Fig. 2, was $\frac{1}{4}$ in. in diameter outside; and there was a straight hole $\frac{3}{16}$ in. in diameter through the center, joining the cutting edge as shown. This prevented the heating up; but the drills would clog up as usual, so I made a drill and holder separate, as shown in Fig. 3. This permitted taper reaming the hole from the back, which overcame all the previous trouble and made a much more satisfactory job; it is only necessary to replace the drills as they wear out.

Using the Miller To Cut Oil Grooves in Bushings

By Fred Stoecklein

A number of bushings had to have oil grooves cut in them. As there was no special machine for cutting them, it was necessary to chip them out until we decided to do the work on the miller as illustrated in the accompanying illustration. The results produced by this method proved to be very satisfactory.

The bracket *A*, made to hold the toolholder *B*, is clamped to the supporting arm of a miller in the position



WORK IN POSITION FOR GROOVING

shown. The tool *F* is held in position by the setscrew and locknut and can be turned to any position desired. The faceplate *C* was made, and a special angle plate *D* with a V-shaped bottom was fastened to it, the entire combination being held on the index head.

A bushing *E* is shown clamped to the faceplate and supported by the angle plate, ready to have the spiral grooves cut into it. The gearing on the index head can be changed to accommodate a bushing of any length or diameter. This method produces a smoothly cut groove and reduces the cost of production considerably below that obtained when the job was done by chipping.

Explanation of the Failures of Materials

By W. Knight*

SYNOPSIS—As the forming and shaping of materials in the shop are done between the elastic limit and the point of failure, there is need of more information as to what actually occurs when materials are stressed between these points. A brief review of the more commonly held theories of stress in materials of machine building, pointing out the confusion in the interpretation of the term "elastic limit," is here presented.

Several theories have been advanced for explaining the failure of materials used in machinery building. Rankine and Lamé ("Mémoire sur l'Equilibre Intérieur des Corps Solides Homogènes," 1833) advocate the maximum-stress theory, which attributes failure to the maximum force acting on a body.

St. Venant ("Historique Abrégé in Leçons de Navier") attributes to Mariotte the well-known maximum-strain theory generally named after him. This theory assumes that failure occurs after the deformation of the material has reached a certain limit.

Coulomb, in 1876 ("Essai sur Une Application des Règles de Maximus et Minimus à Quelques Problèmes de Statique, Relatif à l'Architecture") seems to have been the first to advocate that failure is caused by shear. This theory was later on developed by Guest (*Phil. Mag.*, July, 1900) and is now generally known under his name.

Perry ("Applied Mechanics," 1898) developed a modification of the shear theory by considering the internal friction as being a deciding factor in determining the plane along which fracture occurs.

Mohr (*Zeitschrift des Vereines Deutscher Ingenieure*, 1900) introduced another modification for taking care of the case of materials having different yield points in tension and in compression.

Tresca ("Proceedings," I. M. E., 1878) by his extended researches came to the conclusion that the measure of the tendency to failure is the difference of the greatest and least principal stresses.

Recently, Mallock ("Proceedings," Roy. Soc., 1912) suggested that a limit of volume variation as well as a limit of shear should be considered in the failure of materials and that failure occurs when either of the two limits is reached. This suggestion will probably lead to a better classification of materials that are now considered to be either ductile or brittle and will probably help to explain the reason why some materials do not fail in the same way under different systems of stresses.

All these different theories on the failure of materials are more or less true for a particular group and could not be generalized to all the materials, to all systems of stresses and to all the different conditions under which stresses are applied to materials of construction.

An understanding of the underlying principle of all these theories will probably be of some assistance in applying them, and with this point in view a rapid survey will be made here of their practical interpretation.

The maximum-stress theory assumes that a material subject to forces in one, two or three directions, whether they are tensile or compressive forces, will ultimately fail when the greater stress produced by any one of the forces applied reaches the yield point for uni-directional loading, without being affected in any way by the presence of minor stresses produced by the other forces acting in other planes.

This theory up to a few years ago was generally adopted by American and English engineers and is not based on any extensive experimental data.

The Maximum-Strain Theory

The maximum-strain theory, which is strongly upheld by many elasticians and is generally applied in Europe, assumes that the material yields when the greatest strain reaches a certain limit, which must be (taking a special case) the yield-point strain in simple tension.

Calling s_1, s_2, s_3 three stresses at right angles to each other and taking them with the positive sign, if tensions, and with the negative sign, if compressions; calling E the modulus of elasticity of the material, assumed to be constant in all three directions; calling v the ratio of lateral contraction to axial extension (Poisson's ratio) and d_1, d_2, d_3 the unit strains in the direction of s_1, s_2 and s_3 respectively, the following three equations may be written:

$$\left.\begin{aligned} Ed_1 &= s_1 - v(s_2 + s_3) \\ Ed_2 &= s_2 - v(s_1 + s_3) \\ Ed_3 &= s_3 - v(s_1 + s_2) \end{aligned}\right\} \quad (1)$$

Ed_1, Ed_2 and Ed_3 are called "true stresses," or "reduced stresses."

With the maximum-stress theory we would have

$$\left.\begin{aligned} Ed_1 &= s_1 \\ Ed_2 &= s_2 \\ Ed_3 &= s_3 \end{aligned}\right\} \quad (2)$$

The maximum-strain theory assumes that failure will occur when d_1, d_2 or d_3 reaches the value of the strain at the yield point in simple tension or compression.

From an examination of equations (1) we see that the strain corresponding to a given stress (s_1, for instance) is increased if two stresses (s_2 and s_3) of a sign different from s_1 are added (for instance, s_2 and s_3 both compression and s_1 tension) and is decreased if all stresses are of like sign (all three tensions or compressions). In the first case failure would occur at a value of s_1 lower than in the second case.

Following the maximum-stress theory, the value of s_1 that will determine the failure of the metal is not influenced at all by the values of s_2 and s_3.

If in equations (1) we make one of the two stresses inside the parentheses equal zero, we will have the case of a system of two stresses only at right angles, which is the case most generally met with in engineering practice.

If the two stresses are equal and the Poisson's ratio is taken equal to 0.25, we see that for the case of both stresses being either both compression or both tension the strength of the material is increased 33 per cent.; and if the two stresses are one a tension and the other a compression, the material is weakened 20 per cent. Following the maximum-stress theory, the strength of the material remains unchanged.

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It is easy to see that the percentage variation of strength in either direction depends on the value of v. The value of v, as found by several experimenters, varies between 0.25 and 0.33. Table I is taken from the 1915 "Proceedings" of the American Society of Mechanical Engineers, page 916, and gives several values of Poisson's ratio. However, upholders of the maximum-strain theory maintain that this ratio should be 0.25 in every case and that the variations which experiments exhibit are due to imperfections of the materials.

The higher the value of v the more pronounced is either the strengthening or the weakening effect of one stress on the other acting perpendicularly to it. For instance, if in the previous case we had taken $v = 0.33$ instead of 0.25, we would have had an increase in strength of 51 per cent. when both stresses were of the same sign and a decrease in strength of 25 per cent. when the two stresses were of opposite sign.

TABLE I. VALUES OF POISSON'S RATIO AND YOUNG'S MODULUS

Experimenter	Reference	Material	Poisson's Ratio	Young's Modulus
Wertheim	"Annales de Chimie et de Physique," Ser. 3, Vol. 23, 1848	Brass	0.333	....
Kirchoff	Poggendorff's "Annalen," 1859, Vol. 108	Steel	0.294	....
Bauschinger	"Der Civil Ingenieur," 1879	Steel	0.284	....
Bauschinger	"Der Civil Ingenieur," 1879	Steel (Bessemer) Car Axle	0.261	....
Bauschinger	"Der Civil Ingenieur," 1879	Tin	0.275	....
Bauschinger	"Der Civil Ingenieur," 1879	Sandstone	0.075 to 0.250	....
Amagat	"Journal de Physique," 1889	Steel	0.269	29.6×10^6
Amagat	"Journal de Physique," 1889	Brass	0.327	15.73×10^6
Amagat	"Journal de Physique," 1889	Copper	0.327	17.82×10^6
Amagat	"Journal de Physique," 1889	Lead	0.428	2.28×10^6
Mallock	"Proceedings," Roy. Soc., Vol. 29, 1879	Steel	0.253	....
Mallock	"Proceedings," Roy. Soc., Vol. 29, 1879	Brass	0.325	....
Mallock	"Proceedings," Roy. Soc., Vol. 29, 1879	Copper	0.348	....
Morrow	"Philosophical Magazine," Vol. 6, 1903	Steel (Mild)	0.275	30.64×10^6
Morrow	"Philosophical Magazine," Vol. 6, 1903	Steel (Spindle)	0.275	29.05×10^6
Morrow	"Philosophical Magazine," Vol. 6, 1903	Brass (Drawn)	0.341	13.7×10^6
Morrow	"Philosophical Magazine," Vol. 6, 1903	Copper (Drawn)	0.327	17.73×10^6
Schellens	Thesis, M. I. T., 1911	Steel (Mild)	0.282	29.97×10^6
Schellens	Thesis, M. I. T., 1911	Steel (High Carbon)	0.292	29.43×10^6

The maximum-strain theory assumes that Hooke's law holds right up to the yield point of the material, which is not quite true. For ductile materials, E is approximately the same either in compression or in tension up to the yield point, so that d will have the same value when the material fails in the direction of any one of the three principal stresses shown in equations (1). For brittle materials, E changes; and in this case instead of having the same value of d in all three directions we must have the same value of Ed, or in other words, the unit strain, up to the yield point, varies inversely as the modulus of elasticity of the material.

Both the maximum-stress theory and the maximum-strain theory assume that yielding takes place either in tension or in compression and do not consider at all yielding in shear.

The Maximum-Shear Theory

The fundamental difference between the maximum-shear theory and the ones previously described is to be found in the assumption that failure occurs always in shear, under any system of forces, provided that the yield point in shear of the material is reached before the yield point in tension; and failure occurs always in tension when the yield point in tension is reached before the yield point in shear.

For a test piece of section A, subject to a tensile load P (see Fig. 1), we have that the maximum tensile stress occurs in a section perpendicular to the direction of the load. In any other section A_1 at an angle a with section A we have two secondary stresses P' and Q' into which the principal stress P may be resolved, one tending to break the material in tension and the other one tending to break it in shear. The maximum value of P' is reached when the angle $a = o$; and if the yield point of the material in tension is reached before the yield point in shear (brittle material), the test piece will break through the cross-section A.

The section where Q' has a maximum value is that one making an angle a with A equal to 45 deg.; and this maximum value of Q' is $Q' = \frac{P}{2}$, so that if the yield point in shear of the material is reached before the yield point in tension (ductile materials), the test piece will break through a section at 45 deg. with A.

J. J. Guest conducted by far the most important early researches on this subject. He made the distinction between ductile and brittle materials and came to the conclusion that "the condition for initial yielding of a uniform ductile material is the existence of a specific shearing stress and that the intermediate principal stress is without effect."

Approximately the same conclusions were arrived at by Turner (*Engineering*, Jan. 5, 1909, and July 28, 1911) who tested up to the elastic breakdown steel tubes under simple tension or simple torsion and found the following values for the maximum shear stress: For mild

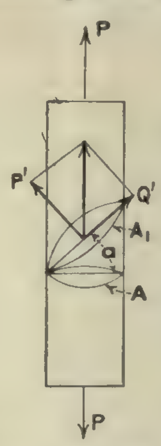


FIG. 1. TENSILE STRESSES

FIG. 2. TEST CURVE FOR PRICE SUBJECTED TO TENSION

steel, 21,200 lb. per sq.in. and 24,000 lb.; for tool steel, 33,900 lb. and 38,400 lb.; and for nickel steel, 40,600 lb. and 40,800 lb. per sq.in. He concluded: "It is clear that the shear theory is no general law which covers all elastic materials. The tool steel shows the greatest inequality of shear in the two distributions of stresses; yet even for it the theory that failure occurs through shear is obviously very much closer than the tension hypothesis."

In engineering practice cases of combined stresses are more frequently met than cases of only one principal

stress, and it will be interesting to note the different results obtained when using one theory or another for designing purposes.

In determining the thickness of a hydraulic cylinder the maximum-stress theory and the maximum-shear theory will both lead to the same thickness of metal needed for withstanding a given pressure with a given factor of safety. The maximum-strain theory would instead suggest a smaller thickness of metal.

In the case of a crankshaft subject to the combined action of a bending moment M and a torsional moment T, the equivalent bending moment M_e obtained by applying the three different theories discussed is given by

$$M_e = \tfrac{1}{2}(M + \sqrt{M^2 + T^2}) \quad \text{maximum-stress theory}$$

$$M_e = \tfrac{3}{8}M + \tfrac{5}{8}\sqrt{M^2 + T^2} \quad \text{maximum-strain theory}$$

$$M_e = \sqrt{M^2 + T^2} \quad \text{maximum-shear theory}$$

The maximum-shear theory leads to the greater value of M_e.

In conclusion we might say that the maximum-shear theory is the one to be used for ductile materials in which the ratio of the yield point in tension to the yield point in shear is equal to two or less than two. Table 2 gives values of $\frac{P}{Q}$ according to Hancock's experiments. However, J. J. Guest in his paper states: "It may also be noted that the specific shearing stress at the yield point is better determined by taking one-half of the tensional yield-point stress than from the results of torsional experiments in which the sharpness of the yield point is masked."

The Internal-Friction Theory

In discussing the maximum-shear theory we have seen that when in a test piece subject to tension, failure occurs in shear, the break must be expected to take place in a plane at 45 deg. with the plane perpendicular to the direction of the principal stress, because in that plane the secondary shear stress reaches a maximum value. Actually, we find that this angle instead of being 45 deg. is less; and in case the principal stress is a compression instead of a tension, the plane where the break occurs is at more than 45 deg. with a plane perpendicular to the direction of the external force. This would seem to point out a modification of the maximum-shear theory, a modification which was first suggested by Navier, who explained this change in the angle of fracture with the existence of an internal friction along the planes where slipping occurs. The tangent of the angle that the plane of break makes with a plane at 45 deg. with the direction of the applied load is the coefficient of friction and is assumed to be independent of the intensity of the force acting perpendicularly to that plane.

TABLE II. VALUES OF $\frac{P}{Q}$ FOR SEVERAL MATERIALS

Material	Elastic Limit in Tension, P	Elastic Limit in Shear, Q	$\frac{P}{Q}$
Steel tubing	21,000	10,500	2
Nickel steel	76,500	38,000	2.013
Mild carbon steel	47,000	30,500	1.546
Steel	64,600	29,170	2.214
Carbon steel	55,500	24,400	1.454
Rivet steel	38,900	23,400	1.662
Nickel steel	56,000	35,000	1.555
Steel tubing	17,000	11,500	1.478
Steel tubing	28,000	16,000	1.750
Steel tubing	20,000	12,000	1.666

Perry found that cast iron, stone, brick and cement fracture in compression at angles greater than 45 deg. with the cross-section. For cast iron the angle is $64\frac{3}{4}$ deg., which corresponds to a coefficient of internal friction equal to 0.35. He also suggested that in wrought iron and mild steel there is not internal friction, and breaking occurs at 45 deg. with the cross-section, showing that the simple law of maximum shear prevails.

Mohr's Theory and Formulas

A further attempt to modify the maximum-shear theory for cases in which the tensile and compressive yield-point stresses have not the same value was made by Mohr (*Zeitschrift des Vereines Deutscher Ingenieure,* 1900), who derived the following formulas:

$$K_4 = \frac{K_1 K_2}{K_1 + K_2}; \quad K_3 = \frac{\sqrt{K_1 K_2}}{2}$$

where

K_1 = Tensile yield-point stress;
K_2 = Compressive yield-point stress;
K_3 = Shearing yield-point stress;
K_4 = Maximum tensile or compressive stress at the point of failure.

It is easy to see that when $K_1 = K_2$ we have nothing else than the maximum-shear theory.

In commercial tests of metals exhibiting a yield point, the stress at which this marked breakdown occurs is often called the "elastic limit" and is generally a little above the true elastic limit, this being particularly true for wrought iron and steel.

The suggestion has been made that elastic failure just below the yield point is due to small portions of the material reaching the breaking-down point before the general mass of the material. This supposition is supported by the fact that ductile materials of very uniform character show the yield point more strikingly than inferior specimens of the same material.

When a sufficiently high stress is applied, yield begins to take place in some weak spots in the mass of the material and spreads through from these spots to the rest of the mass without any increase in the applied load, slipping occurring along the planes of cleavage of the crystals.

Beyond the stage of plastic strain, according to Ewing and Rosenhain ("Phil. Trans.," Roy. Soc., 1899), slips develop into cracks, and fracture takes place through the crystal grains themselves.

In the previous discussion of the different stress theories advanced by several authorities we have always mentioned the yield-point stress as being the limiting value of stress that will determine failure. As a matter of fact elastic failure begins to be noticed at the elastic limit, and probably it would not be out of place to define what we mean by elastic limit.

Interpretation of the Elastic Limit

A good deal of confusion is found in the interpretation of the elastic limit. The elastic limit is sometimes called "proportional limit," "true elastic limit," "apparent elastic limit," "commercial elastic limit," "elastic limit by extensometer," "elastic limit by drop of beam," "elastic limit by dividers," "yield point."

Strictly speaking, the elastic limit is the limit up to which the mechanical energy spent in applying a force to a body (product of force times the corresponding in-

crement in deformation at any moment) can always be restored by removing the force applied, the deformation produced by the applied force entirely disappearing when the force is removed.

Beyond the elastic limit the mechanical energy impressed upon the body is not entirely recovered when removing the force (due to a slight structural change in the material), the body does not return to its primitive condition, and the ultimate deformation is the permanent set.

Below the elastic limit the body absorbs heat, while above the elastic limit heat is generated by the friction of the particles sliding over each other. A number of determinations of the elastic limit by means of a thermocouple have attracted the attention of several investigators (see *Revue de Métallurgie,* January, 1913, pages 174-198); but as far as I know, the investigation is not regarded as complete.

In order to set a definite conventional meaning of the term "elastic limit" J. B. Johnson ("Material of Construction," page 18) suggested the adoption of an "apparent elastic limit" to be referred to when speaking of the elastic limit of a given material.

Having plotted a test curve (see Fig. 2), the line *AB* is drawn tangent to the curve at *A*. From *B* measure *BC* equal to one-half of *FB*. Connect *C* with *A* and draw *CD* parallel to *AC* and tangent to the test curve. The point *E* of tangency is the apparent elastic limit of the material tested.

Dr. T. S. Lynch in a paper presented at the annual meeting, Jan. 22, 1915, of the American Society for Testing Materials shows with a number of tests on copper, iron and steel wires that the values of the apparent elastic limit thus obtained cannot be very far from being correct and for all practical purposes are quite safe.

Elastic Limit Defined

The definition of the "elastic limit" accepted by the American Society for Testing Materials is "the least load per square inch which produces a permanent set as indicated by an extensometer." This point lies right above the "apparent elastic limit" of Johnson. Right below Johnson's point is found the "limit of proportionality" (the point up to which the deformation is proportional to the applied loads, following Hocke's laws).

Johnson's point is some sort of compromise between the elastic limit as defined by the American Society for Testing Materials and the "limit of proportionality," and it would be highly desirable to have it generally adopted and used by engineers, testers and other users.

All the theory of elasticity is based on Hocke's law, which holds to the elastic limit (or more correctly, up to the limit of proportionality); consequently, the elastic limit is the fail point for the elastician and also for the experimenter who calculates his stresses from formulas based on Hocke's law.

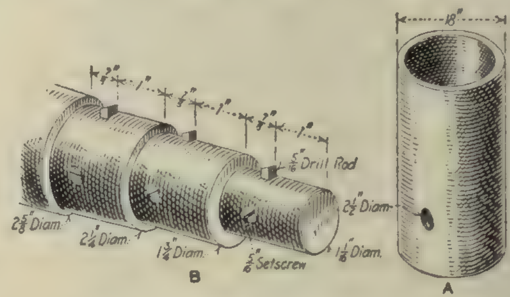
Beyond the elastic limit there is still a very wide field open for investigations; and if we consider that most of the operations for forming and shaping materials for industrial use are performed beyond the elastic limit, the desirability of gaining some knowledge of what occurs in the materials between the elastic limit and the point of failure, under different conditions of temperature and for different periods of application of a given force, will be evident.

Boring a Hole in the Side of a Large Cylinder

By W. Heinzmann

In a factory far from any tool supply house it became necessary to bore and tap the hole in the side of the cylinder shown at *A*.

The biggest drill available was $1\frac{1}{16}$ in. in diameter. The drilling machine was one of the light hand type.



THE WORK AND THE TOOL

The lathe was much too small to swing the job on the carriage.

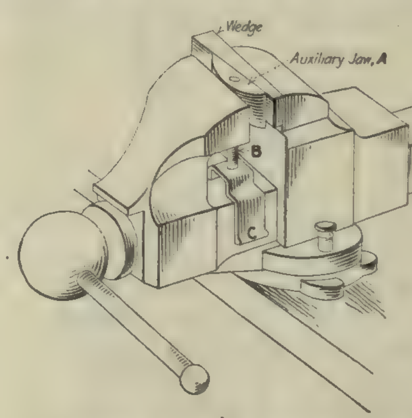
The tool shown at *B* solved the problem. The diameters were so arranged that each cutter removed about the same amount of metal. The dimensions for the length are important, as these made it possible to do the job. It will be seen that the greater diameter guides the tool when this is breaking through; otherwise the tool would break, as it is impossible to provide means for guiding the cylinder sidewise.

The piece was set on the lathe on a board thick enough to bring the centers in line. The $1\frac{1}{16}$-in. drill was run through first, then the tool was used, the feeding being done with the tailstock center. The tapping was started in the lathe and finished by hand. A satisfactory job resulted.

Vise Jaw for Taper Work

By W. C. Betz

The utility of a bench vise that is not equipped with a swiveling jaw for holding taper or wedge-shaped pieces



VISE JAW FOR TAPER WORK

will be greatly enhanced by the addition of the jaw illustrated. It consists of a solid steel jaw *A*, a rod *B*, and a sheet-metal clip *C*, which snaps over the moving jaw.

United States Munitions*

The Springfield Model 1903 Service Rifle

Stacking Swivel, Hand-Guard Clip, Front-Sight Cover, Cleaning Rods

SYNOPSIS—More of the small accessories which go to make up the completed rifle. These are parts which could be readily made in small shops in case of emergency.

OPERATIONS 2 AND 3. DRILLING SCREW HOLE AND REAMING

Transformation—Fig. 1832. Machine Used—Pratt & Whitney four-spindle 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1833; work held by button A, pushed to place by screw B. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, 1/16-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Plugs for hole and surface. Production—120 pieces per hr.

OPERATION AA. REMOVING BURRS FROM OPERATION 3

Number of Operators—One. Description of Operation—Removing burrs from operation 3. Apparatus and Equipment Used—File. Production—Grouped with operations 4 and 5.

OPERATIONS 4 AND 5. MILLING FIRST AND SECOND SIDES OF LUG

Transformation—Fig. 1834. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on pin clamped by vise jaws, Fig. 1835; one cutter mills one side while other handles the reverse. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutters. Number of Cuts—One. Cut Data—70 r.p.m.; 5/8-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Radius from screw hole, and contour. Production—120 pieces per hr.

OPERATION 6. MILLING FRICTION SLOT

Transformation—Fig. 1836. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin clamped by jaws A and B and screw C, Fig. 1837. Tool-Holding Devices—Standard arbor. Cutting Tools—Slitting saws, 2.5625 in. in diameter, 0.04 in. thick, 40 teeth. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, 1/16-in. stream. Average Life of Tool Between Grindings—1500 pieces. Gages—None. Production—125 pieces per hr.

OPERATION CC. REMOVING WITH REAMER THE BURRS LEFT BY OPERATION 6

Number of Operators—One. Description of Operation—Removing burrs from operation 6. Apparatus and Equipment Used—Hand reamer. Production—700 pieces per hr.

OPERATION A-1. ROTARY-FILING CIRCLES INSIDE

Number of Operators—One. Description of Operation—Rotary-filing inside of circle. Apparatus and Equipment Used—Small rotary file. Gages—None. Production—175 pieces per hr.

OPERATION B-2. BUFFING CIRCLE, OUTSIDE

Number of Operators—One. Description of Operation—Buffing outside and ends of band. Apparatus and Equipment Used—Polishing jack and wheel. Production—350 pieces per hr.

OPERATION C-3. TUMBLING

Number of Operators—One. Description of Operation—Tumbling. Apparatus and Equipment Used—Tumbling boxes. Production—500 pieces per hr.

OPERATION 7. FILING BOTH SIDES OF LUG AND MATCHING CIRCLE, OUTSIDE, NEAR LUG

Number of Operators—One. Description of Operation—Filing sides of lug and matching circle. Apparatus and Equipment Used—File. Production—190 pieces per hr.

OPERATION 8. POLISHING LUG AND CIRCLE, OUTSIDE, NEAR LUG

Number of Operators—One. Description of Operation—Polishing circle and lug. Apparatus and Equipment Used—Buffing wheel. Production—175 pieces per hr.

OPERATION 8½. SPREADING LUG FOR TENSION

Number of Operators—One. Description of Operation—Spreading lugs. Apparatus and Equipment Used—Hammer and wedge. Production—500 pieces per hr.

OPERATION 9. TEMPERING AND HARDENING

Number of Operators—One. Description of Operation—Hardened in open fire at 1450 deg. F.; tempered in lead bath at 900 deg. F.

Stacking Swivel

The stacking swivel is a small part that requires many operations. It is made from a drop forging and is finished all over. Its function is to allow the stacking of three rifles, either in camp or during halts on the march.

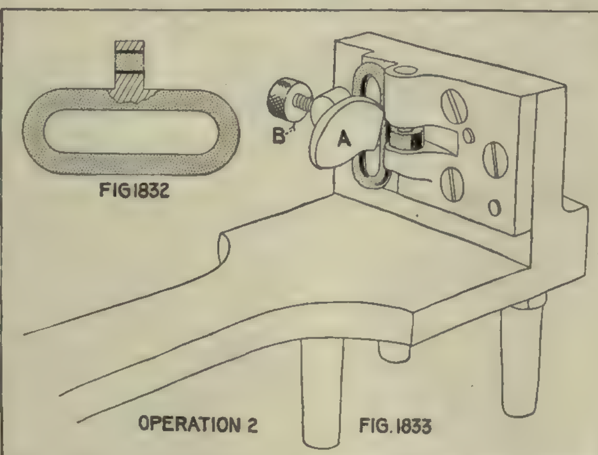


FIG 1832 OPERATION 2 FIG. 1833

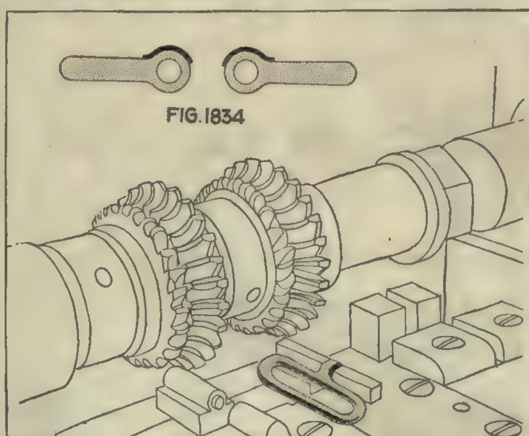


FIG. 1834 FIG. 1835 OPERATION 4&5

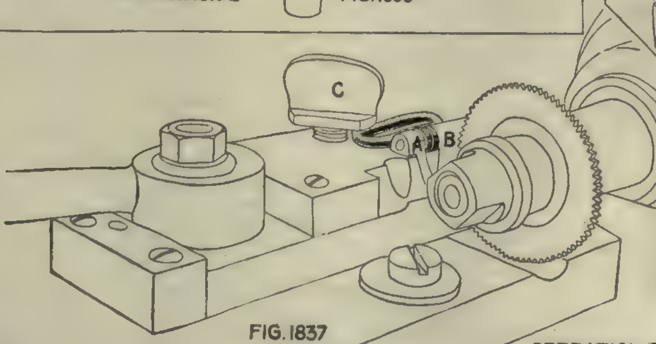


FIG. 1837 OPERATION 6

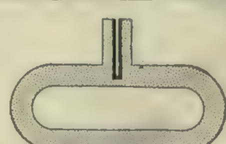


FIG. 1836

OPERATIONS ON THE STACKING SWIVEL

Operation	
A	Blocking from bar
A–1	Pickling
B	First trimming outside
C	Dropping to finish
C–1	Pickling
D	Third trimming, outside
E	Annealing
E–1	Pickling
F	Cold dropping
CC	Swaging to size
1	Hand-milling both sides of lug (straddle)
2	Drilling screw hole
3	Reaming screw hole
AA	Removing burrs left by operation 3
4	Milling first side of lug
5	Milling side of lug
6	Milling stacking slot
BB	Removing burrs left by operations 4 and 5 (reamer)
A–1	Rotary-filing circle, inside
B–2	Buffing circle, outside
C–2	Tumbling
7	Milling, rounding ends of stacking slot (in lathe)
8	Filing both sides of lug and latching circle, outside, near lug
9	Polishing
10	Bluing

OPERATION A. BLOCKING FROM BAR

Transformation—Fig. 1839. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 pieces per hr.

OPERATION A-1. PICKLING

Number of Operators—One. Description of Operation—Put in wire baskets and placed in the pickling solution, which consists of 1 part sulphuric acid and 9 parts water, and left in this for from 10 to 12 min. Apparatus and Equipment Used—Wire baskets, wooden pickling tanks, hand hoist.

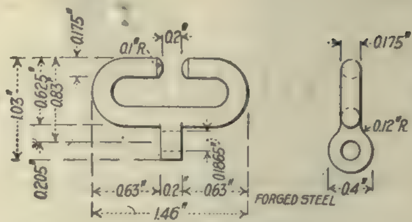


FIG. 1838

FIG. 1839 OPERATION A

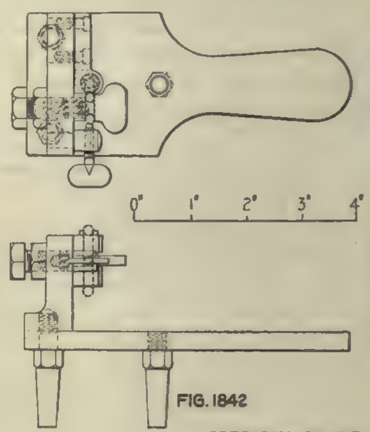
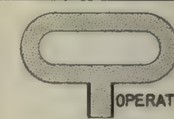


FIG. 1842



OPERATION 1

FIG. 1840

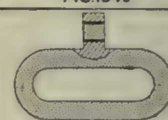
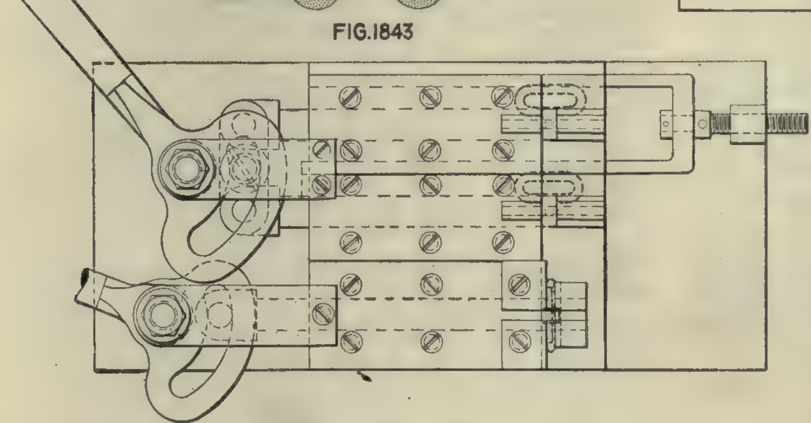
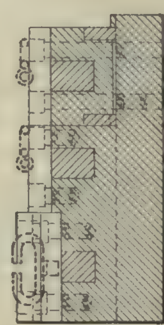


FIG. 1841

OPERATION 2 AND 3

FIG. 1843





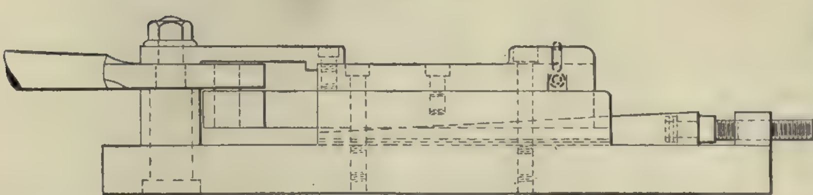


FIG. 1844

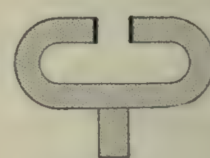


FIG. 1846

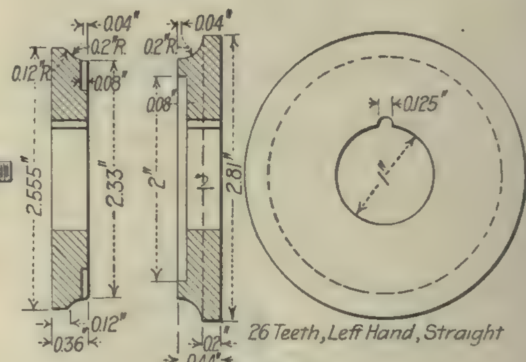


FIG. 1845

FIG. 1843, 1844 & 1845 OPERATION 4 & 5
FIG. 1846 & 1847 OPERATION 6
FIG. 1848 & 1849 OPERATION 7

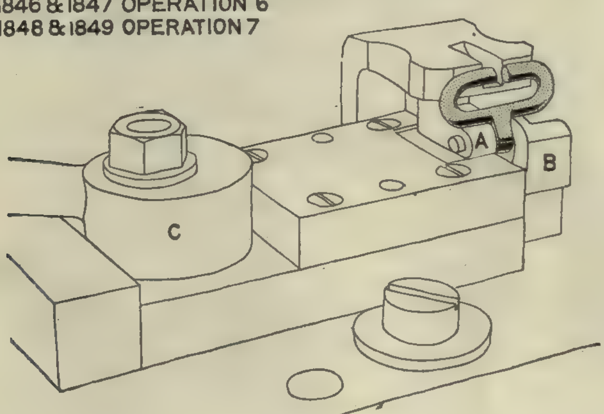
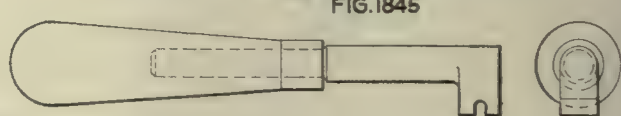
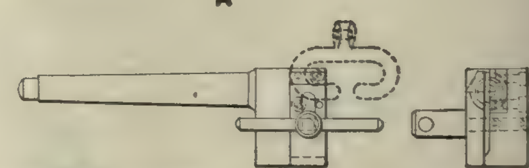


FIG. 1847



A



B

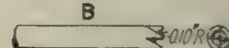


FIG. 1848

FIG. 1849

OPERATION B. FIRST TRIMMING

Machine Used—Perkins No. 40 press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—In shoe, by setscrew. Average Life of Punches and Dies—15,000 pieces. Production—700 pieces per hr.

OPERATION C. DROPPING TO FINISH

Number of Operators—One. Description of Operation—Finish shaping. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—175 pieces per hr.

OPERATION C-1. PICKLING

Description of Operation—Same as previous pickling.

OPERATION D. THIRD TRIMMING, OUTSIDE

Description of Operation—Same as operation B, already described.

OPERATION E. ANNEALING

Number of Operators—One. Description of Operation—Placed in iron pots packed with powdered charcoal and heated to 850 deg. C. (1562 deg. F.) and left over night to cool. Apparatus and Equipment Used—Iron pots, Brown & Sharpe annealing furnace, oil burners, powdered charcoal.

OPERATION E-1. PICKLING

Number of Operators—One. Description of Operation—Same as previous pickling

OPERATION F. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—600 pieces per hr.

OPERATION CC. SWAGING TO SIZE

Machine Used—Old crank draw press. Number of Operators per Machine—One. Punches and Punch Holders—Round-shank swaging punch. Dies and Die Holders—Die screwed to plate; plate bolted to bed of press. Stripping Mechanism—Steel stripper screwed to face of die. Lubricant—A little oil on punch. Production—350 pieces per hr.

OPERATION 1. HAND-MILLING BOTH SIDES OF LUG (STRADDLE)

Transformation—Fig. 1840. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Rotating fixture, similar to those shown previously. Tool-Holding Devices—Standard arbor. Cutting Tools—Cutting mills. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Similar to gage, Fig. 1831. Production—350 pieces per hr.

OPERATIONS 2 AND 3. DRILLING AND REAMING SCREW HOLES

Transformation—Fig. 1841. Machine Used—Pratt & Whitney 16-in. three-spindle upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1842. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill and reamer. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, 1/16-in. stream. Average Life of Tool Between Grindings—200 pieces. Gages—Diameter and clearance for outside of boss. Production—120 pieces per hr. Note—Feed is obtained by means of foot lever; while hole is being drilled, the operator reams by hand on next spindle, holding work in hand.

OPERATION AA. REMOVING BURRS LEFT BY OPERATION 3

Number of Operators—One. Description of Operation—Removing burrs from operation 3. Apparatus and Equipment Used—File. Production—Grouped with operations 4 and 5.

OPERATIONS 4 AND 5. MILLING SIDES OF LUG

Transformation—Fig. 1843. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Held on pin clamped by vise jaws, similar to Fig. 1830; details in Fig. 1844. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutters, Fig. 1845. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Same as for lower-band swivel, Fig. 1831. Production—120 pieces per hr.

OPERATION 6. MILLING STACKING SLOT

Transformation—Fig. 1846. Machine Used—Garvin No. 3 hand miller. Number of Operators per Machine—One. Work-Holding Devices—Held on pin A, clamped by vise jaws B and cam C in upright position with support at rear of swivel, Fig. 1847. Tool-Holding Devices—Standard arbor. Cutting Tools—Slotting cutter, 2.25 in. in diameter, 0.2 in. thick, 20 teeth, left hand. Number of Cuts—One. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—None. Production—350 pieces per hr.

OPERATION BB. REMOVING BURRS LEFT BY OPERATIONS 4 AND 5 (REAMER)

Number of Operators—One. Description of Operation—Removing burrs from operations 4 and 5. Apparatus and Equipment Used—File. Production—Grouped with operation 6.

OPERATION A-1. ROTARY-FILING CIRCLE, INSIDE

Number of Operators—One. Description of Operation—Rotary-filing inside of circle. Apparatus and Equipment Used—Rotary file. Gages—None. Production—125 pieces per hr.

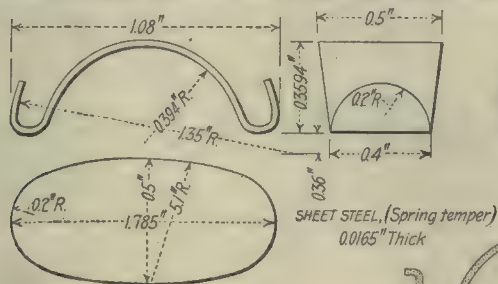


FIG. 1850

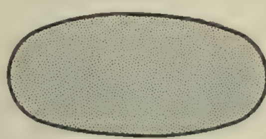


FIG. 1851

FIG. 1852

FIG. 1854

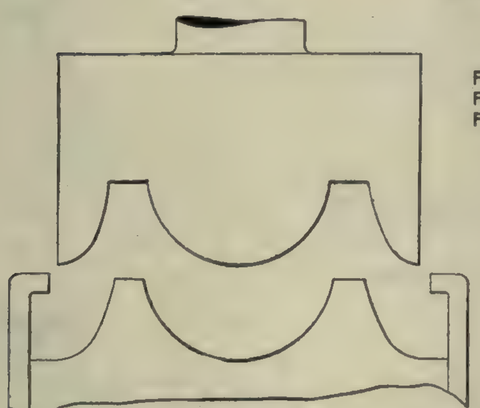


FIG. 1853

FIG. 1851 OPERATION 1
FIG. 1852 & 1853 OPERATION 2
FIG. 1854 & 1855 OPERATION 3

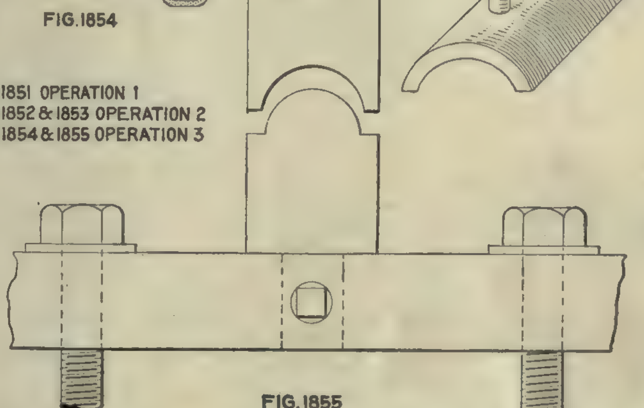



FIG. 1855

OPERATION B-2. BUFFING CIRCLE, OUTSIDE

Number of Operators—One. Description of Operation—Buffing outside of swivel. Apparatus and Equipment Used—Buffing wheel. Gages—None. Production—350 pieces per hr.

OPERATION C-2. TUMBLING

Number of Operators—One. Description of Operation—Brightened by tumbling. Apparatus and Equipment Used—Home-made tumbling machine; tumbled in old screws, washers, then later in sawdust and pieces of belting.

OPERATION 7. MILLING, ROUNDING ENDS OF STACKING SLOT (IN LATHE)

Transformation—Fig. 1848. Machine Used—Prentice speed lathe. Number of Operators per Machine—One. Work-Holding Devices—Held in holder A, Fig. 1849, by thumb-screw in tailstock of lathe. Tool-Holding Devices—Drill chuck. Cutting Tools—Formed hollow mill B, Fig. 2143. Cut Data—450 r.p.m.; hand feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—350 pieces. Gages—None. Production—170 pieces per hr. Note—The end is offset for this operation and bent back after the work is finished.

OPERATION 8. FILING BOTH SIDES OF LUG AND LATCHING CIRCLE, OUTSIDE, NEAR LUG

Number of Operators—One. Description of Operation—Filing lugs at sides and blending circle near lug. Apparatus and Equipment Used—File. Production—125 pieces per hr.

OPERATION 9. POLISHING

Number of Operators—One. Description of Operation—Polishing outside surfaces. Apparatus and Equipment Used—Polishing jack and wheel. Production—125 pieces per hr.

OPERATION 10. BLUING

Number of Operators—One. Description of Operation—Blue in niter at 800 deg. F. Apparatus and Equipment Used—Same as for all other bluing.

Hand-Guard Clips

The hand-guard clips, as shown in detail in Fig. 1850, are made from sheet spring steel so formed as to fit recesses in the hand guard, their object being to prevent the hand guard from splitting or to hold it together in case it should become split in service. These hand guards are quite thin and are made of black walnut or whatever wood is used for the stock. Two of these clips are used on each guard, being fitted into recesses that prevent the interference of the hand guard and the barrel. They are made in a punch press with a simple bending die.

OPERATIONS ON THE HAND-GUARD CLIPS

Operation
1 Blanking
2 First bending
3 Second bending
4 Tempering and hardening
5 Assembling to hand guard

OPERATION 1. BLANKING

Machine Used—Perkins automatic No. 5, roll feed, 1½-in. stroke. Number of Machines per Operator—Two. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Steel stripper screwed to face of die. Lubricant—Stock oiled with cutting oil. Production—1250 per hr.

OPERATION 2. FIRST BENDING

Transformation—Fig. 1852. Machine Used—Niagara No. 36, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank, punch shown in Fig. 1853. Dies and Die Holders—Held on plate by setscrews; plate screwed to bed of press; stops on each side of die. Stripping Mechanism—None. Gages—None. Production—800 pieces per hr.

OPERATION 3. SECOND BENDING

Transformation—Fig. 1854. Machine Used—Same press as operation 2. Number of Operators per Machine—One. Punches and Punch Holders—Square-shank punch, Fig. 1855. Dies and Die Holders—Held on plate by setscrews; plate bolted to bed of press. Stripping Mechanism—None. Lubricant—None. Production—800 pieces per hr. Note—A holder or form A, Fig. 1855, is held in hand and placed over spring, which gives shape to ears.

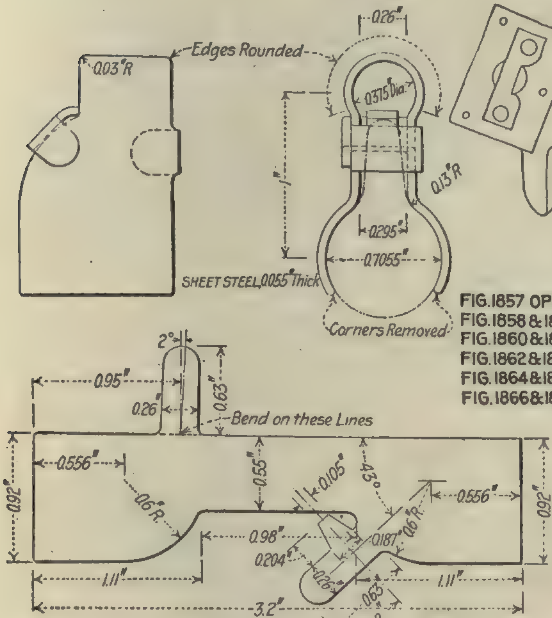


FIG. 1856

FIG. 1857 OPERATION 1
FIG. 1858 & 1859 OPERATION 1½
FIG. 1860 & 1861 OPERATION 2
FIG. 1862 & 1863 OPERATION 3
FIG. 1864 & 1865 OPERATION 4
FIG. 1866 & 1867 OPERATION 5

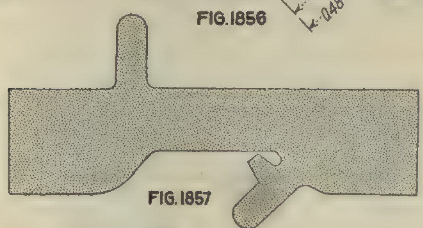


FIG. 1857

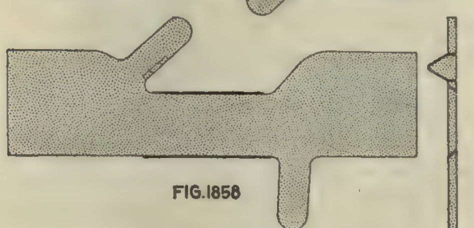


FIG. 1858


FIG. 1867

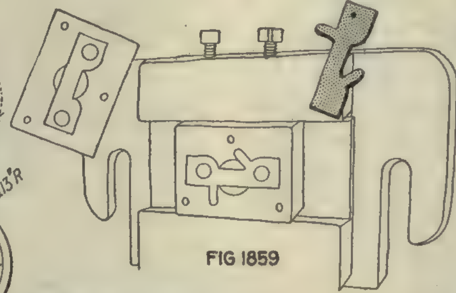


FIG. 1859


FIG. 1860

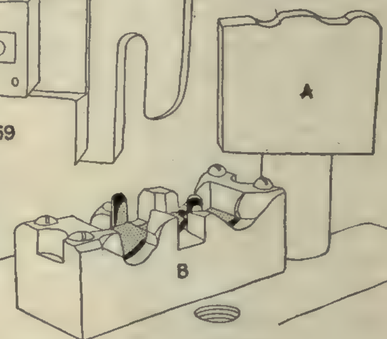


FIG. 1861

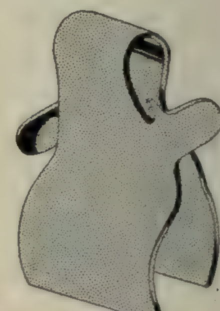


FIG. 1862

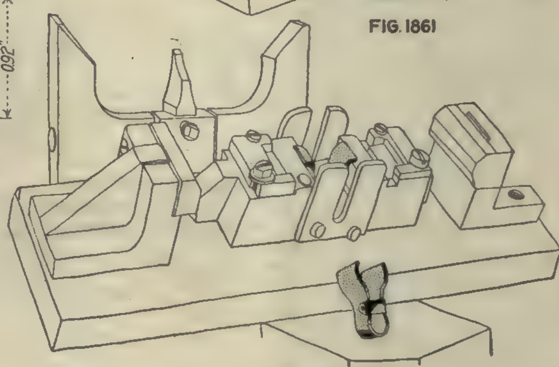


FIG. 1863

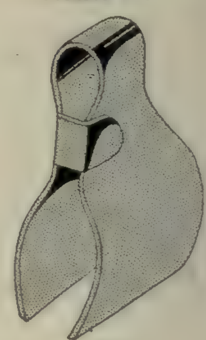


FIG. 1864

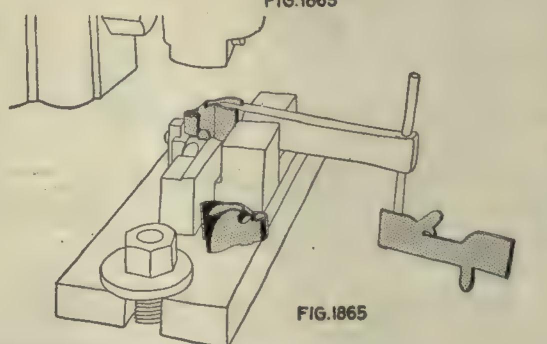


FIG. 1865

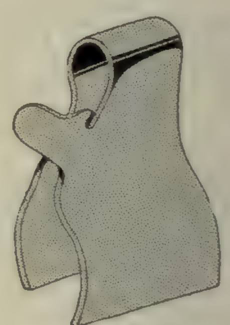


FIG. 1866

OPERATION 4. TEMPERING AND HARDENING

Number of Operators—One. Description of Operation—Hardened in open fire at 1450 deg. F.; tempered in niter at 800 deg. F.

OPERATION 5. ASSEMBLING TO HAND GUARD

The clip is simply put in place by hand, the recess in guard being coated with cosmoline.

Front-Sight Cover

The front-sight cover, Fig. 1856, is used to protect the front sight in field and other service. This was formerly made of sheet brass but is now of sheet steel pressed into place and has the lower ends bent so as to spring round

the front-sight stud. It is made from a sheet-steel stamping and pressed into shape with suitable forming dies.

OPERATIONS ON THE FRONT-SIGHT COVER

Operations	
1	Blanking from low sheet steel
1½	Pressing radii on edges, rounding corner of top and bend sight prong
2	Bending flanks to fit barrel and bending prongs
3	Bending flanks together to fit barrel
4	Bending down front prongs
5	Bending down rear prongs
7-A	Correcting
9	Caseharden

OPERATION 1. BLANKING FROM LOW SHEET STEEL

Transformation—Fig. 1856. Machine Used—Perkins No. 19 press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe between screws; pierce and blank, using finger stop. Stripping Mechanism—Steel strippers screwed to face of die. Average Life of Punches and Dies—20,000 pieces. Lubricant—Stock oiled with cutting oil. Production—1500 pieces per hr.

OPERATION 1½. PRESSING RADII ON EDGES, ROUNDING CORNER OF TOP AND BEND SIGHT PRONG

Transformation—Fig. 1858. Machine Used—Niagara No. 36, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held in shoe by setscrew; shoe bolted to bed of press, Fig. 1859. Stripping Mechanism—Two spring pins in punch to strip work from punch. Lubricant—None. Production—600 pieces per hr.

OPERATION 2. BENDING FLANKS TO FIT BARREL AND BENDING PRONGS

Transformation—Fig. 1860. Machine Used—Niagara No. 36, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank A, Fig. 1861. Dies and Die Holders—Dies screwed to plate which is bolted to bed B, Fig. 1861. Stripping Mechanism—None. Production—650 pieces per hr.

OPERATION 3. BENDING FLANKS TOGETHER TO FIT BARREL

Transformation—Fig. 1862. Machine Used—Niagara No. 36, 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—In shoe by setscrews; die shown in Fig. 1863. Stripping Mechanism—None. Gages—None. Production—650 pieces per hr. Note—A mandrel is placed at center point which gives top circle and shapes ends. Pieces on side of die close in, bending prongs together.

OPERATION 4. BENDING DOWN FRONT PRONGS

Transformation—Fig. 1864. Machine Used—Old draw press, maker not known. Number of Operators per Machine—One. Punches and Punch Holders—Round shank, Fig. 1865. Dies and Die Holders—Screwed to plate which is bolted to bed of press; a holder is placed inside of cover to keep it from closing together; punch forces end over and down. Stripping Mechanism—None. Gages—None. Production—800 pieces per hr.

OPERATION 5. BENDING DOWN REAR PRONGS

Transformation—Fig. 1866. Machine Used—Old draw press, maker not known. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Screwed to plate which is bolted to bed of press; holder in this operation is similar to but of a different size from that used in operation 4. Gages—None. Production—800 pieces per hr.

OPERATION 7-A. CORRECTING

Number of Operators—One. Description of Operation—Testing springiness. Apparatus and Equipment Used—Piece of stock size of barrel and pair of hands. Gages—Fig. 1867. Production—1200 pieces per hr.

OPERATION 9. CASEHARDEN

Number of Operators—One. Description of Operation—Pack in bone and leather and caseharden in usual way. Apparatus and Equipment Used—Usual equipment.

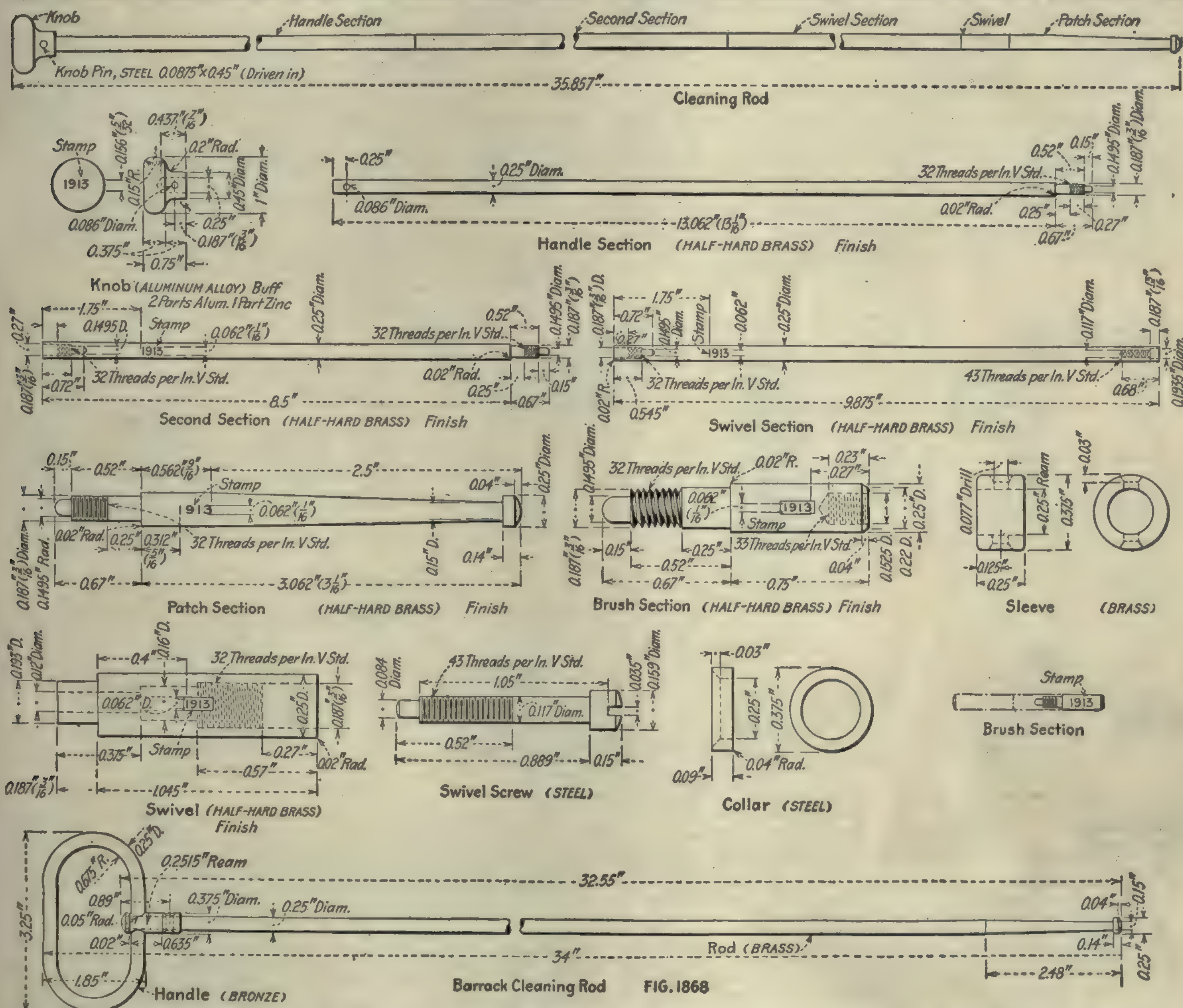


FIG. 1868

Operations on Barrel-Cleaning Rods

There are two types of cleaning rods, the solid rod for use in barracks, the jointed rod and the thong cleaner. These are all shown in detail in Fig. 1868, the greater part of the work being done on a screw machine. The operations are shown in connection with the transformation drawings and so require no explanation whatever.

OPERATIONS ON THE CLEANING ROD, KNOB

Operation
1 Forming, drilling, reaming and cutting off
2 Stamping 1903

OPERATION 1. FORMING, DRILLING, REAMING AND CUTTING OFF

Transformation—Fig. 1869. Machine Used—Hartford No. 2 automatic. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret and crossforming tool drill. Cutting Tools—Drill, reamer, forming tool and cutoff. Number of Cuts—Three. Cut Data—900 r.p.m.; $\frac{1}{16}$-in. feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—1000 pieces. Production—315 pieces per hr. Note—This is made from an aluminum alloy; bids for die casting have been asked for, which will eliminate machinery.

OPERATION 2. STAMPING 1903

Description of Operation—Stamping 1903 on end of knob. Apparatus and Equipment Used—Hammer and stamp. Production—500 pieces per hr. Note—This would also be eliminated by the use of die castings.

OPERATIONS ON THE BARRACK CLEANING-ROD HANDLE

Operation
1 Drill, ream and face both sides

OPERATION 1. BARRACK CLEANING ROD, HANDLE

Transformation—Fig. 1871. Machine Used—Pratt & Whitney No. 1 hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Work held in fixture, screwed to spindle in head, clamped by chuck jaws, Fig. 1872; counterweight is shown. Tool-Holding Devices—Turret of machine. Cutting Tools—Spot drill, drill, reamer, facing and back-facing tools; back-facing tool is held in same way as cutter for facing cutoff slot in receiver, Fig. 410. Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—800 pieces. Gages—Plug and length. Production—150 pieces per hr.

Life of Tool Between Grindings—500 pieces. Gages—Plug. Production—90 pieces per hr. Note—Held in hand to ream.

OPERATION 5. ASSEMBLING WITH PIN

Description of Operation—Assembling knob with pin. Apparatus and Equipment Used—Bench and hand hammer. Gages—None. Production—125 pieces per hr.

OPERATION 6. POLISHING

Number of Operators—One. Description of Operation—Polishing ends of rivet in knob. Apparatus and Equipment Used—Buffing and polishing wheels. Production—600 pieces per hr.

OPERATION 7. ASSEMBLING ROD AND STAMPING ALL PARTS EXCEPT KNOB

Number of Operators—One. Description of Operation—Assembling and stamping 1903. Apparatus and Equipment Used—Hand stamp and hammer. Production—55 pieces per hr.

OPERATIONS ON THE CLEANING ROD, SECOND SECTION

Operation
1 Cutting to length
2 Threading male end
3 Drilling, tapping and counterboring

OPERATION 1. CUTTING TO LENGTH

Transformation—Fig. 1875. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in. chuck, hollow-spindle lathe. Tool-Holding Devices—Crossfeed. Cutting Tools—Cutting-off tool, hand forged. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Length. Production—350 pieces per hr.

OPERATION 2. THREADING MALE END

Transformation—Fig. 1875. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Threading die.

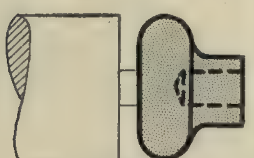


FIG. 1869 OPERATION 1 Knob

FIG. 1870

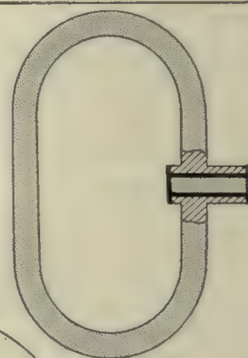


FIG. 1871

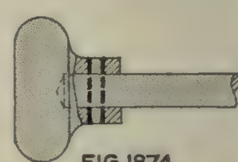
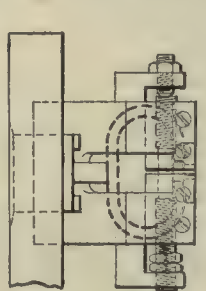


FIG. 1874 OPERATION 4



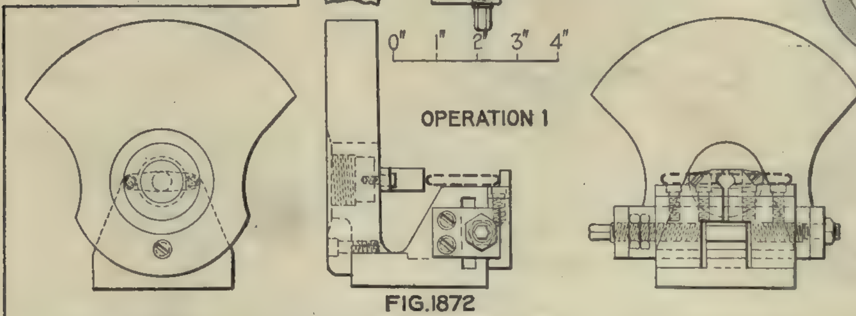


FIG. 1872

FIG. 1873 OPERATION 2

OPERATIONS ON THE CLEANING ROD, HANDLE SECTION

Operation
1 Cutting to length
2 Threading one end
3 Assembling knob
4 Drilling and reaming pin hole
5 Assembling with pin
6 Polishing
7 Assembling rod and stamping all parts except knob

OPERATION 1. CUTTING TO LENGTH

Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Crossfeed. Cutting Tools—Cutting-off tool. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Length. Production—350 pieces per hr.

OPERATION 2. THREADING ONE END

Transformation—Fig. 1873. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Held in turret of machine. Cutting Tools—Hollow mill, threading die, forming tool (rounding end). Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Ring, thread and length. Production—70 pieces per hr.

OPERATION 3. ASSEMBLING KNOB FOR DRILLING

Number of Operators—One. Description of Operation—Assembling knob to rod. Apparatus and Equipment Used—Hammer and bench block. Production—125 pieces per hr.

OPERATION 4. DRILLING AND REAMING PIN HOLE

Transformation—Fig. 1874. Machine Used—Any drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Held in V-block. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill and reamer. Number of Cuts—Two. Cut Data—900 r.p.m.; hand feed. Average

Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Thread and length. Production—75 pieces per hr.

OPERATION 3. DRILLING, TAPPING AND COUNTERBORING

Transformation—Fig. 1875. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Drill, tap and counterbore. Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Plug, thread and depth. Production—50 pieces per hr.

OPERATIONS ON THE SWIVEL SECTION, CLEANING ROD, 1903

Operation
1 Drilling, counterboring, tapping first end and cutting off
2 Drilling, counterboring, tapping second end

OPERATION 1. TAPPING FIRST END

Transformation—Fig. 1876. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret. Cutting Tools—Drill, counterbore and tap. Number of Cuts—Three. Cut Data—950 r.p.m. Gages—Plug, thread and depth. Production—150 per hr.

OPERATION 2. TAPPING SECOND END

Transformation—Fig. 1876. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Similar to operation 1. Number of Cuts—Three. Cut Data—950 r.p.m. Gages—Same as operation 1. Production 150 per hr.

OPERATIONS ON THE SWIVEL, CLEANING ROD, 1903

Operation
1 Drilling, reaming, threading one end and cutting to working length
3 Polishing joint corners
4 Stamping 1903

OPERATION 1. DRILLING, REAMING, THREADING ONE END AND CUTTING TO WORKING LENGTH

Transformation—Fig. 1877. Machine Used—Pratt & Whitney No. 1 hand screw machine. Number of Operators per Machine — One. Work-Holding Devices — Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Drill, reamer, threader and cutoff. Number of Cuts—Four. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Diameter, thread, length and depth of recess. Production—150 pieces per hr.

OPERATION 3. POLISHING JOINT CORNERS

Number of Operators—One. Description of Operation—Rounding corners. Apparatus and Equipment Used—Polishing stand and wheel. Production—650 pieces per hr.

OPERATION 4. STAMPING 1903

Number of Operators—One. Description of Operation—Stamping 1903. Apparatus and Equipment Used—Hammer and stamp. Production—700 pieces per hr.

OPERATIONS ON THE CLEANING ROD, SWIVEL SCREW

Operation
1 Trimming, threading and cutting off
2 Slotting
3 Polishing

OPERATION 1. TRIMMING, THREADING AND CUTTING OFF

Transformation—Fig. 1878. Machine Used—Hartford No. 2 automatic. Number of Machines per Operator—Four. Work-Holding Devices—Work held in draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Trimming, box tool, threading die and cutoff. Number of Cuts—Three. Cut Data—1200 r.p.m.; $\frac{1}{16}$-in. feed. Coolant—Cutting oil, ¼-in. stream. Average Life of Tool Between Grindings—400 pieces. Gages—Ring, thread and length. Production—50 pieces per hr.

OPERATION 2. SLOTTING

Number of Operators—One. Description of Operation—Slotting head of screw. Apparatus and Equipment Used—Hand slotting or Manville automatic slotter and saw. Production—700 pieces per hr.

OPERATION 3. POLISHING

Number of Operators—One. Description of Operation—Polishing and burring. Apparatus and Equipment Used—Wheel and polishing stand. Production—1000 pieces per hr.

OPERATIONS ON THE CLEANING ROD, PATCH SECTION

Operation
1 Cutting to length
2 Clamp-milling bottom end
3 Trimming, threading and rounding ends

OPERATION 1. CUTTING TO LENGTH

Transformation—Fig. 1879-A. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret and cross-slide. Cutting Tools—Cutting-off tool. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Length. Production—350 pieces per hr.

OPERATION 2. CLAMP-MILLING BOTTOM END

Transformation—Fig. 1879-B. Machine Used—Machine built at the Hill shops. Number of Operators per Machine—One. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—Crossfeed. Cutting Tools—Clamp-milling cutters, Fig. 1880. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Coolant—None. Average Life of Tool Between Grindings—1500 pieces. Gages—Form. Production—150 pieces per hr.

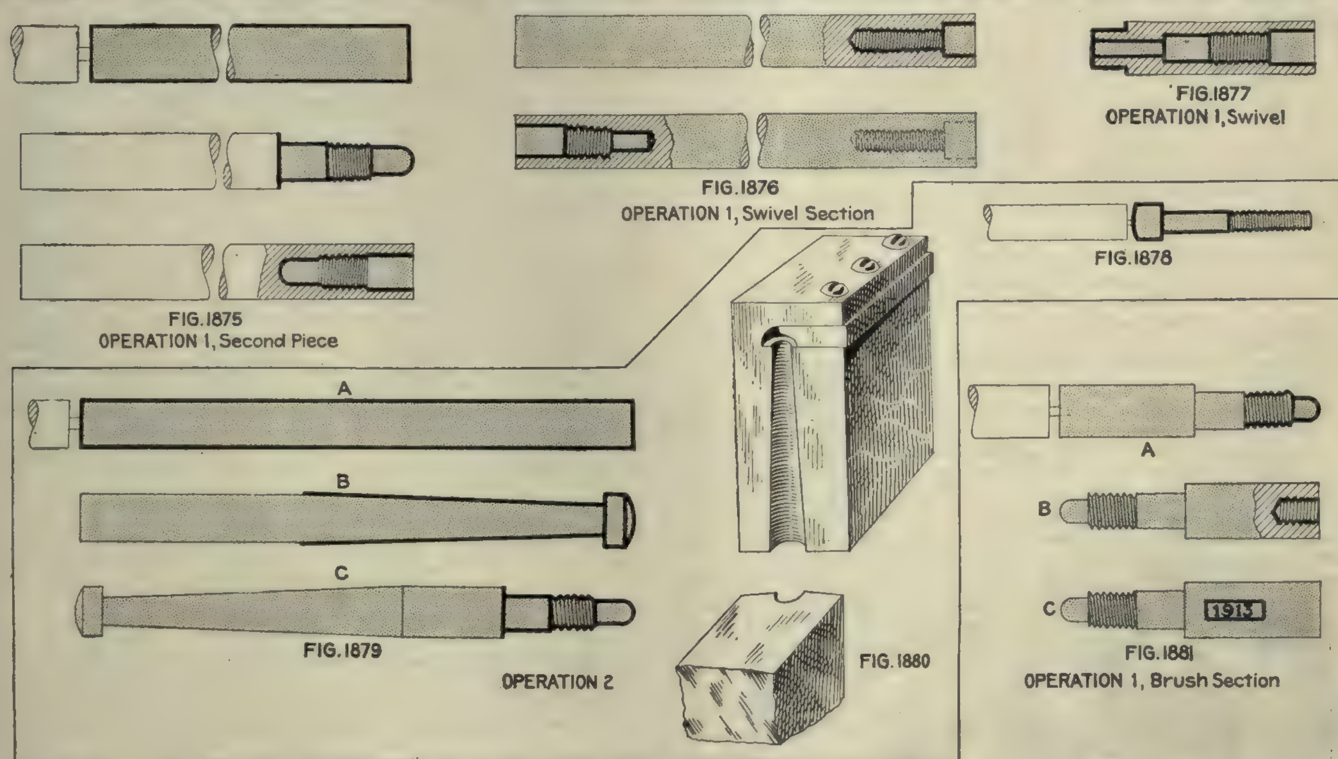


FIG. 1875 OPERATION 1, Second Piece

FIG. 1876 OPERATION 1, Swivel Section

FIG. 1877 OPERATION 1, Swivel

FIG. 1878

FIG. 1879 OPERATION 2

FIG. 1880

FIG. 1881 OPERATION 1, Brush Section

OPERATION 3. TRIMMING, THREADING AND ROUNDING ENDS

Transformation—Fig. 1879-C. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Hollow mill, threading die and forming tool. Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Length, diameter and thread. Production—70 pieces per hr.

OPERATIONS ON THE CLEANING ROD, BRUSH SECTION

Operation
1 Forming, threading and cutting to length
2 Drilling and tapping
4 Stamping 1903

OPERATION 1. FORMING, THREADING AND CUTTING TO LENGTH

Transformation—Fig. 1881-A. Machine Used—Acme No. 2 automatic screw machine. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Hollow mill, die, end-forming tool, cutoff. Number of Cuts—Three. Cut Data—1200 r.p.m.; $\frac{1}{16}$-in. feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Diameter and length of thread. Production—160 pieces per hr.

OPERATION 2. DRILLING AND TAPPING

Transformation—Fig. 1881-B. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Drill and tap. Number of Cuts—Two. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Diameter and depth. Production—75 pieces per hr.

OPERATION 4. STAMPING 1903

Transformation—Fig. 1881-C. Number of Operators—One. Description of Operation—Stamping 1903 on rod. Apparatus and Equipment Used—Hammer and stamp. Production—650 pieces per hr.

Some Ways That Engineers May Serve Their Country

Successful prosecution of the war depends in a large measure upon proper organization wherein each man will be assigned to the work in which he is best fitted to serve the country. With this in view the National Defense Act was approved last June, authorizing the creation of an Officers' Reserve Corps in the United States Army. There are many engineers anxious to render service in some such capacity, but who do not know the necessary procedure or just where they will fit in. To aid these the five national engineering societies[1] have compiled jointly, for distribution among the membership, information covering the various branches of the service to which this corps will be assigned. The following outline is taken from this source:

[1]The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining Engineers and the American Institute of Consulting Engineers.

The branches of the service for which the engineers are best fitted are the Coast Artillery, the Engineer Corps, the Signal Corps, Quartermaster's Department and Ordnance Department.

THE COAST ARTILLERY covers the transporting and mounting of both heavy and light guns, installing and operating power plants in connection with fortifications, moving and installing searchlights, planting submarine mines, placing submarine nets, installing range-finder apparatus, telephone systems, etc.

THE ENGINEER CORPS in time of war attends to military demolitions, the construction and repair of wharves, roads, ferries, bridges and other structures, operation and repair of military railways, the construction of defensive and offensive work, sanitation of camps, etc. The work covers the following special branches of engineering: Bridge engineers, constructional engineers, electrical engineers, highway engineers, hydraulic engineers, irrigation engineers, mining engineers, railroad engineers, sanitary engineers and surveyors.

THE SIGNAL CORPS is divided into two branches, the first covering the transmission of information by means of the telephone, telegraph, wireless and signals, and the second, or Aviation Section, covering airplanes, internal-combustion engines for airplanes, wireless equipment on aircraft and expert work in pyrotechnics and automatic cameras.

THE QUARTERMASTER'S DEPARTMENT is charged with the duty of providing means of transportation of every character, supplies for the troops, and other materials needed for the army. Textile and chemical engineers are required for the supply and subsistence branches; civil, mechanical, electrical, hydraulic, railroad and marine engineers for the transportation work; and structural engineers for work in connection with buildings, barracks, wharves, water supplies, etc.

THE ORDNANCE DEPARTMENT offers one of the best fields in which mechanical engineers can serve, as it requires men especially trained for the production of munitions. The duties of the ordnance officers are those connected with the direction, management, control and supervision of the work of manufacture, test and repair of ordnance and ordnance stores at arsenals and depots and the inspection and test of such materials when purchased by contract.

Candidates for appointment in the Reserve Corps of Engineers will be examined either for duty with combatant engineer troops and other duties in the service at the front, or for special service on the lines of communication or other points in the rear, including work in connection with the coast defenses. However, officers appointed for the latter work will be subject to assignment whenever needed for the first, or more active, service.

In the time of actual hostilities the President may order members of the Officers Reserve Corps, subject to physical examination, to temporary duty with the regular army or as officers in the volunteer or other organizations. While reserve officers on such duty, they shall be entitled to the pay and allowances of the corresponding grades in the regular army. The pay of a major is $3000 a year, that of captain $2400, that of first lieutenant $2000, and second lieutenant $1700. An officer has to purchase his uniform and personal equipment and pay for his food.

After having decided in which department he is best fitted to enroll, one should apply for application blanks to the secretary of the engineering society to which he belongs, or to the Adjutant General, War Department, Washington, D. C. The application blanks for the Coast Artillery, when filled out, should be sent to Chief of Coast Artillery; for the Corps of Engineers to the Chief of Engineers; for the Signal Corps to the Chief Signal Officer; for the Quartermaster's Department to the Quartermaster General, and for the Ordnance to the Chief of Ordnance; all at the War Department, Washington, D. C. The examinations are both physical and mental, the subjects covered differing with each branch of the service.

The following publications relate to subjects covered by the examinations: "Infantry Drill Regulation," issued by the Superintendent of Documents, 35c.; "Field Service Regulation," issued by the Superintendent of Documents, 60c.; "Engineers' Field Manual," issued by the Superintendent of Documents, $1; "Bulletin No. 4, Vol. 1, Chief of Staff," issued by Adjutant General; "Army Regulations, 1913," issued by the Superintendent of Documents, 60c.; "Manual of Court Martial," issued by the Superintendent of Documents, 65c.; "Army Transport Regulations," issued by the Superintendent of Documents, 35c.; "Rules of Land Warfare," issued by Adjutant General, 50c.; "Coast Artillery Drill Regulation," issued by Superintendent of Documents, 60c.

The books issued by the Superintendent of Documents may be obtained by addressing that official at the Government Printing Office, Washington, D. C. Those issued by the Adjutant General may be obtained by addressing that official in care of the War Department, Washington, D. C.

SERVICE IN THE NAVY

Service in the navy is possible by enlistment in the navy, in the Naval Militia, and by enrolling as an officer or man in the Naval Reserve. Civilians are being employed as mechanics, draftsmen, etc., in the navy yards. The Departments of Yards and Docks, Construction and Repair, and Steam Engineering are not enrolling officers; hence engineers competent to enroll as officers can do so only by joining some branch of the Naval Reserve, where, after proper examination, they will be taken on trial by giving them provisional rank. After a period of three months' training, such provisional officers will again be examined, and if the result is satisfactory, they will be confirmed in this provisional appointment and given actual rank. To be given a provisional rating in the navy a man must have the technical knowledge of the corresponding rating in the navy, and to be confirmed in a provisional rating a man must, in addition, have a fair knowledge of naval discipline and customs. To be advanced in rating a man must have the technical knowledge of the corresponding rating in the navy and a good knowledge of naval customs and methods.

CLASSES OF THE NAVAL RESERVE

The Naval Reserve force is divided into six classes, covering Fleet Naval Reserve, Naval Reserve, Naval Auxiliary Reserve, Naval Coast Defense Reserve, Volunteer Naval Reserve, Naval Reserve Flying Corps. The first of these requires previous service in the navy, the second experience in the merchant marine, the third service on American vessels listed by the Navy Department as desirable for auxiliary use in time of war. The Volunteer Naval Reserve is composed of those members of the Naval Reserve force who obligate themselves to serve in the navy in any one of the classes without pay in time of peace. Citizens skilled in flying, or in the design and building of aircraft are eligible to the Naval Reserve Flying Corps.

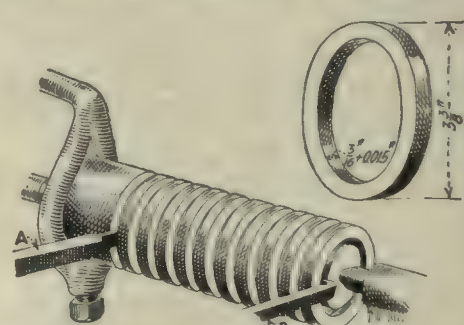
The Naval Coast Defense Reserve is the branch in which engineers will probably find greatest service at the present time. However, enlistment in this branch of the service must be for a period of four years. A patrol-boat unit consists of an ensign, a quartermaster, an engineer and four seamen. The ensign and the engineer must be experienced, the former with coastwise navigation, and the latter with the handling of the engine.—"Power."

Making Hardened Tool-Steel Thrust Washers

By E. R. Wolcott

I had to make ten tool-steel thrust washers, 3⅝ in. in diameter, and 2⅜ in. in the hole. They were to be hardened and surface-ground on both sides to a thickness of $\frac{3}{16}$ in.

A piece of steel was selected large enough so that one cut finished the outside diameter. With the tool *A* I cut



MAKING TOOL-STEEL THRUST WASHERS

ten grooves with the calipers set at 2¼ in.; then, using the tool *B* and inside calipers set at 2⅜ in., I carefully cut rings off the bar, leaving the stock in the center for use on some other job. The job was finished in five hours, which included the time spent in all turning, hardening and grinding operations, and the steel wasted was less than would have been the case with flat stock.

Auxiliary Plate in Toolmaking

By William C. Betz

It is sometimes desirable to machine a piece of work of such odd shape or section that it is impossible to hold it with the devices furnished with the machine. Examples of this nature are shown by Figs. 1, 2 and 3. It would be almost impossible to bore the two holes in perfect alignment in the gage frame shown at *A*, Fig. 1, with regular toolroom equipment, but by the auxiliary-plate method it becomes a very simple operation. The ends are faced and the holes bored on the miller, the holes being located on a surface plate as follows: A solid rectangular or square plate, with perfectly square corners and of heavy cross-section about as large as the piece to be machined, should be used. The casting or forging is fastened to this plate without any machining, making up for the irregularities of the surface with cardboard shims.

A parallel is fastened to the miller table parallel to the center line of the spindle, and edge *C* or *B* of the auxiliary plate is placed against the parallel and the plate securely fastened to the miller table. An end mill is used to machine the end. The opposite side of the auxiliary plate is next placed against the parallel strip and the other end is milled; this leaves the ends of the gage parallel with each other.

The plate and gage assembly is taken to a surface plate where the centers are laid out; from there to a sensitive drill, where it is drilled for the button screws. The buttons are then located and the plate assembly again placed on the miller platen, one edge against the parallel as before, and securely clamped. The button is located central with the machine spindle by means of an indicator held in the spindle; the button is then removed and the hole drilled and bored to size, the same operation being repeated on the other end of the gage. The assembly is then taken to a sensitive drill and the clamp screw holes

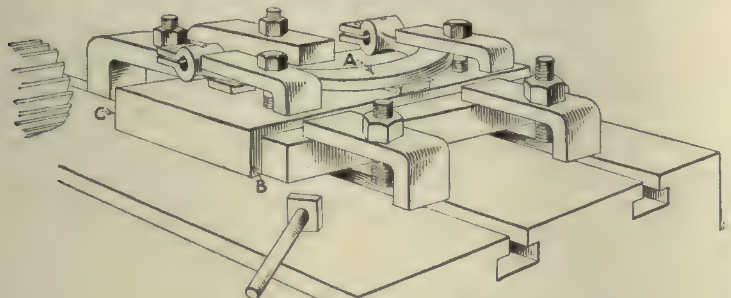
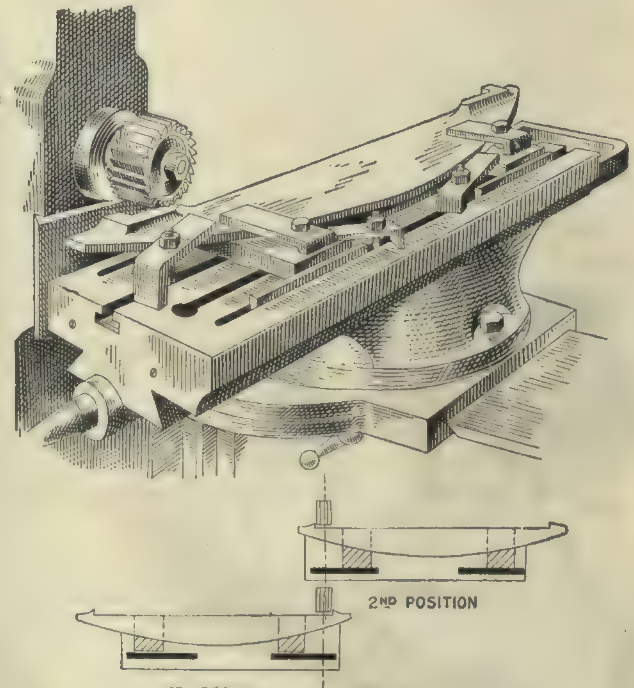


FIG. 1



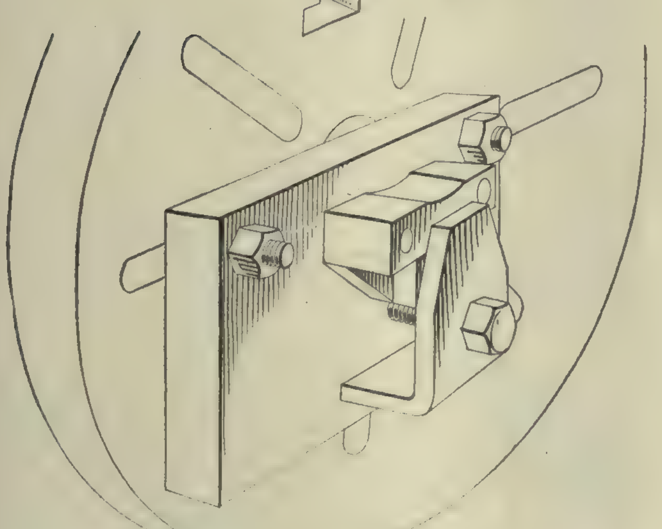


FIG. 3

FIGS. 1 TO 3. VARIOUS TOOLROOM PROBLEMS SOLVED BY MEANS OF AN AUXILIARY PLATE

are drilled, reamed and counterbored. This particular gage has adjustable rectangular pads, the shanks of which are ground and lapped to a push fit in the frame ends. The faces of the pads are ground and lapped and must be perfectly parallel with each other. The gage is set with Johansson standards. Another example of auxiliary-plate work is shown in Fig. 2. In this instance two plates are used, and in the case of a miller a span equal to about twice the table travel is available. This is accomplished as follows:

We will assume that we have a casting with two seats 36 in. apart between shoulders; they must be parallel with each other and the pads must be in line; a miller is available with a table travel of 20 in.; the planer has only a 24-in. span and is the largest tool in the shop. How could the part be machined to the desired degree of accuracy with such equipment?

The plate method is as follows: A parallel strip is machined to a snug fit in the outer T-slot of the table; the table is brought to the extreme left, or right, as desired, and the casting is fastened to the plate as in Fig. 2; the assembly in turn is clamped to the miller table in the position shown; the plates are held snugly against the parallel strip and one pad is milled. The miller table is now brought to the other extreme of its travel and the plate slid along the locating strip to the other end of the table; here it is fastened and the other pad milled. This scheme is also applicable to the planer or horizontal boring mill. On the lathe the auxiliary-plate method also comes in handy at times, as for instance in the case of the piece shown in Fig. 3. This piece of work presents too small a surface to be strapped directly to the faceplate, especially on a 14-in. or larger lathe, where the spindle hole would prevent fastening it at all. The plate method comes into its own in such an emergency. The piece is strapped to the auxiliary plate with the special strap shown at Fig. 3; this is not removed until both the holes are bored, as these holes must be perfectly parallel with each other. A large surface must be available for clamping purposes on the faceplate, to eliminate the possibility of distortion in clamping, which would of course cause the holes to be thrown considerably out of parallel.

The Design of Tumbler Reverse Gears

By Sherwood C. Bliss

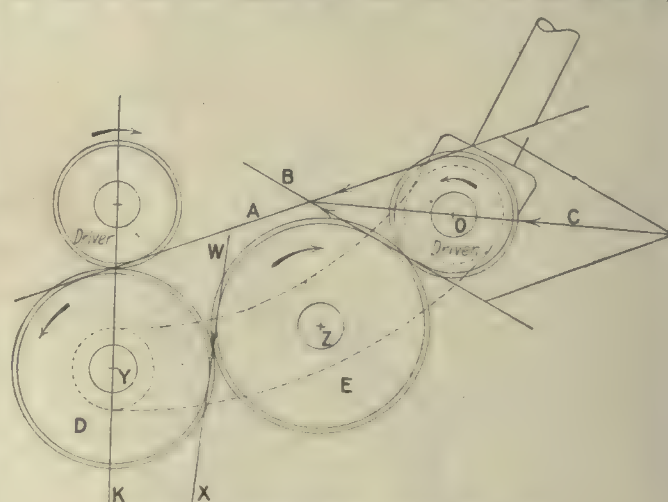
Mr. Clegg's article on page 297, criticizing my article on tumbler reverse gears, would indicate that there are several points which he has apparently overlooked. The illustration shows part of a tumbler arm similar to that in Mr. Clegg's article. To avoid confusion of lines, only the pitch and base circles of the gears have been drawn. In this discussion the gear tooth and bearing friction have been disregarded. The problem is to locate the idler *D* so that when it meshes with the driven gear, there will be no unbalanced force tending to rotate the tumbler arm about its center of swing, designated as *O* in the illustration.

In order to satisfy this condition the extreme forces acting on the tumbler arm must be in equilibrium. The extreme forces are, first, the action of the driver at its point of mesh with the idler *D*; second, the reaction of the driven at its point of mesh with the idler *E*; and third, the reaction of the tumbler-arm pivot shown in the illustration at *O*.

If we disregard friction, the line of force of the reaction of the driven gear on the idler *E* will be tangent to the base line of the driven gear. This line is marked *B* in the accompanying figure. The line *A* is then drawn tangent to the base circles of the driver and driven gears. The line *K* is drawn through the center of the driver and also through the intersection of the line *A* with the pitch circle of the driver. The line *K* is the line of centers of the driven gear and the idler *D*. The idlers *D* and *E* are made of any convenient size, the larger the better.

By construction the reaction of the driver on the idler *D* is along the line *A*. Disregarding friction, the forces acting along the lines *A* and *B* are equal. By construction they are both tangent to the base circle of the driven gear. Therefore, their resultant must pass through the center *O* of the driven gear. This resultant is marked *C*. As it passes through the center *O*, about which the tumbler arm swings, there can be no tendency to rotate the tumbler arm.

If Mr. Clegg wishes to determine the forces acting through the centers *Y* and *Z* of the idlers *D* and *E*, he will find that the moments of these forces about the point *O* are equal and opposite and thus balance each other. The reason that the size of the idler *E* does not affect our problem is as follows: The force acting through the center *Y* of the idler *D* is the resultant of the force acting along the line *A* and the reaction of the idler *E* on the idler *D*,



FORCES ACTING ON TUMBLER ARM

which acts along the line *W*. The force acting through *Z* is the resultant of the force acting along the line *B* and the action of the idler *D* on the idler *E* along the line shown at *X*.

By construction the forces along the lines *A* and *B* produce no moment tendency to rotate the tumbler arm. The forces acting along the lines *W* and *X* are equal, opposite, and pass through the same point. They thus balance each other and produce no turning moment on the tumbler arm and can be disregarded. Now if the center of the idler *D* is located on the line *K*, none of the above conditions are changed by a variation in size of the idler *E*, which therefore need not be considered. In using this method due regard must be paid to directions of rotation in drawing the lines *A* and *K* or the results obtained will not be correct.

Precision Gage-Making Work

By J. B. Murphy

On page 1047, Vol. 45, Mr. Johnson states that my way of grinding a snap gage—by setting it vertically—would be improved if I were to set it horizontally, in line with the grinder spindle, as by my method any error in the line-up of the grinder spindle would tend to "bell" the gaging surfaces.

Now, it is a very simple matter to show that any error in the machine will be reproduced in the gage, no matter how the gage is placed for grinding. In support of this opinion I submit the diagrams, Figs. 1, 2 and 3.

Mr. Johnson's idea of placing the gage in the same plane, horizontally, as the center of the grinder spindle is, of course, theoretically correct; but in practice a gage so placed could be of but two dimensions—length and breadth—for if the gage possessed any thickness at all, part of it must be below the center of the spindle and part above.

It is not to be expected that the part of the gage above the center of the spindle would correct any error in the part of the gage below the center of the spindle; for, as can be seen by the diagrams (exaggerated for clearness), any error in the lower part of the gage would merely be continued in the upper part.

Certainly, if the gage is placed in the horizontal position specified by Mr. Johnson, the grinding wheel cannot pass entirely through the gage, though it will if the gage is set in a vertical position; but the error cannot be less because of the method of setting.

As between the two methods, in case of error in the alignment of the machine you would simply have your choice of a straight taper, as shown in Fig. 3, when the gage is placed in a horizontal position, or the "belled" surfaces, shown in Fig. 2, when the gage is placed in a vertical position.

There is a simple method of testing the spindle, as I will presently show.

Suppose we refer to Fig. 1: this shows the grinder spindle out of alignment in a vertical plane: the gage is set vertical. Now, if the head were to be moved straight down into the gage, without any table movement, the result would be true surfaces, provided there were no horizontal error. If the wheel should be set for depth at the start, and the cut obtained through the table traverse, the result would be as shown at B—undercut on one side in an amount corresponding to the error in the machine and "back-raked" on the opposite side in a similar amount.

Such a cut could not be "belled," but be a straight taper only, for in the dished wheel shown the periphery only does the cutting. In Fig. 1 the cut is produced by the lowest part of the wheel's periphery.

In Fig. 2 a change in the direction of the error from the vertical to the horizontal plane produces an entirely different result. As in the first case, the gage is set in a vertical position; and also as in the first case, the grinding wheel passes clear through the gage.

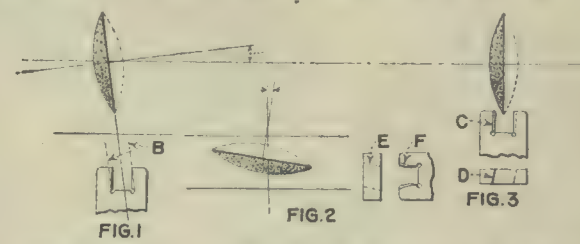
It will be observed that as the work is passed to the wheel, half of the wheel nearest the gage, shown in Fig. 2, fails to cut.

Now, as the center of the wheel is reached, the lowest point on its periphery begins the cut: and as the wheel is passed through the gage the distance between the bottom of the slot in the gage and the periphery of the wheel constantly increases, while the periphery of the wheel steadily approaches the surface of the work. Hence, while the cut at the bottom of the slot diminishes, it is increased at the top, producing the "bell-mouthed" surfaces shown at F in Fig. 2.

If this wheel were fed straight down into the work, and no table movement employed, the result would be as at E.

Fig. 3 shows a plan of Fig. 1; in this case the gage is placed horizontally. We may assume, for the present, that no error exists in the horizontal adjustment of the spindle, but vertical only, as shown. Plainly, then, if this gage is moved direct to the wheel the error will be reproduced in the gage, as shown at C and D, the last being an end view of the first. In this case, should the table be stationary and the head moved, "belling" would be the logical result.

Of course, a combination of these two evils—"belling" and tapering—is the result where the spindle is out in



FIGS. 1 TO 3. INACCURATE GRINDING RESULTS

both directions, as is frequently the case in old machines or in new machines that have been abused.

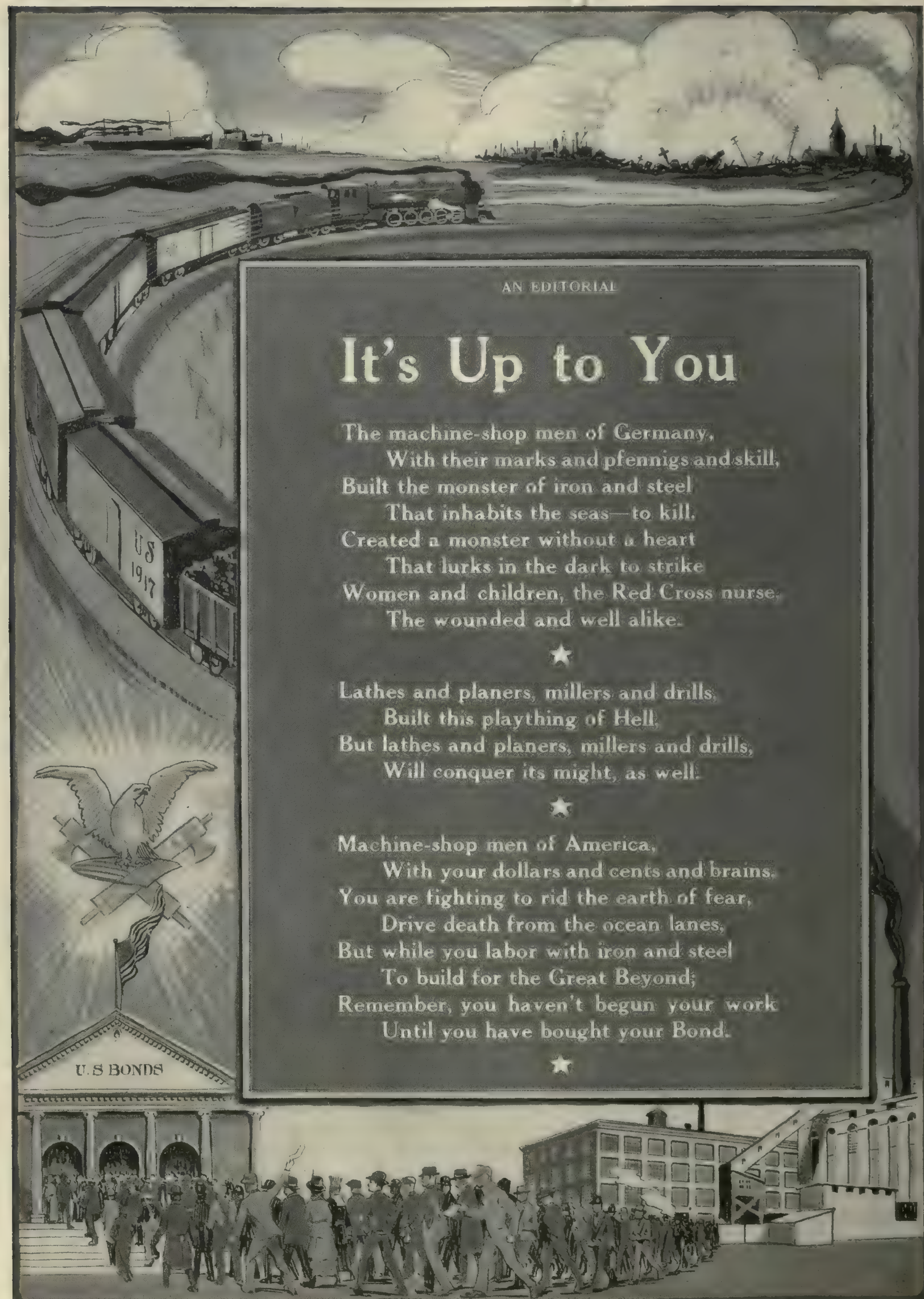
This, then, is the sum and substance of all the trouble due to tapered or "bell-mouthed" work. In summing up it would appear that the best method of all is to get the best machine and to employ the most competent operator that can be obtained, if the object is really high-grade work; for, as we see, the most accurate methods may be "jimmed" by an operator lacking, even a little, in skill and experience.

An easy way to test the spindle for accuracy in both directions at one and the same time is as follows: Set upon the table the best angle plate to be had, say a 12-in. plate, and clamp an indicator to the grinder spindle; then move the table traverse by hand and take a reading from one side of the plate to the other side; then move the head up and down and see what the indicator says; lastly, pull the belt by hand, very carefully, and allow the indicator to travel in a circle over the face of the plate, observing the reading of the indicator. These three tests will give reliable information as to the accuracy of the grinder. The first is to test the truth of the table travel, the second is to test the head and the third is to test the alignment of the spindle.

The angle plate may be set true by indicating from the spindle or from the headways or from a slot in the table, using indicator and surface gages.

All this brings to mind another little suggestion. Why not keep a card record of the general condition of all the machines in the toolroom, together with a record, as far as possible, of the efficiency of the operator? Then when a job is to be ground, the foreman is enabled to send it directly to the man and the machine best fitted to bring it through with the required accuracy and dispatch.

I understand, of course, that foremen are supposed to know all about their machines—but do they?



AN EDITORIAL

It's Up to You

The machine-shop men of Germany,
With their marks and pfennigs and skill,
Built the monster of iron and steel
That inhabits the seas—to kill.
Created a monster without a heart
That lurks in the dark to strike
Women and children, the Red Cross nurse,
The wounded and well alike.

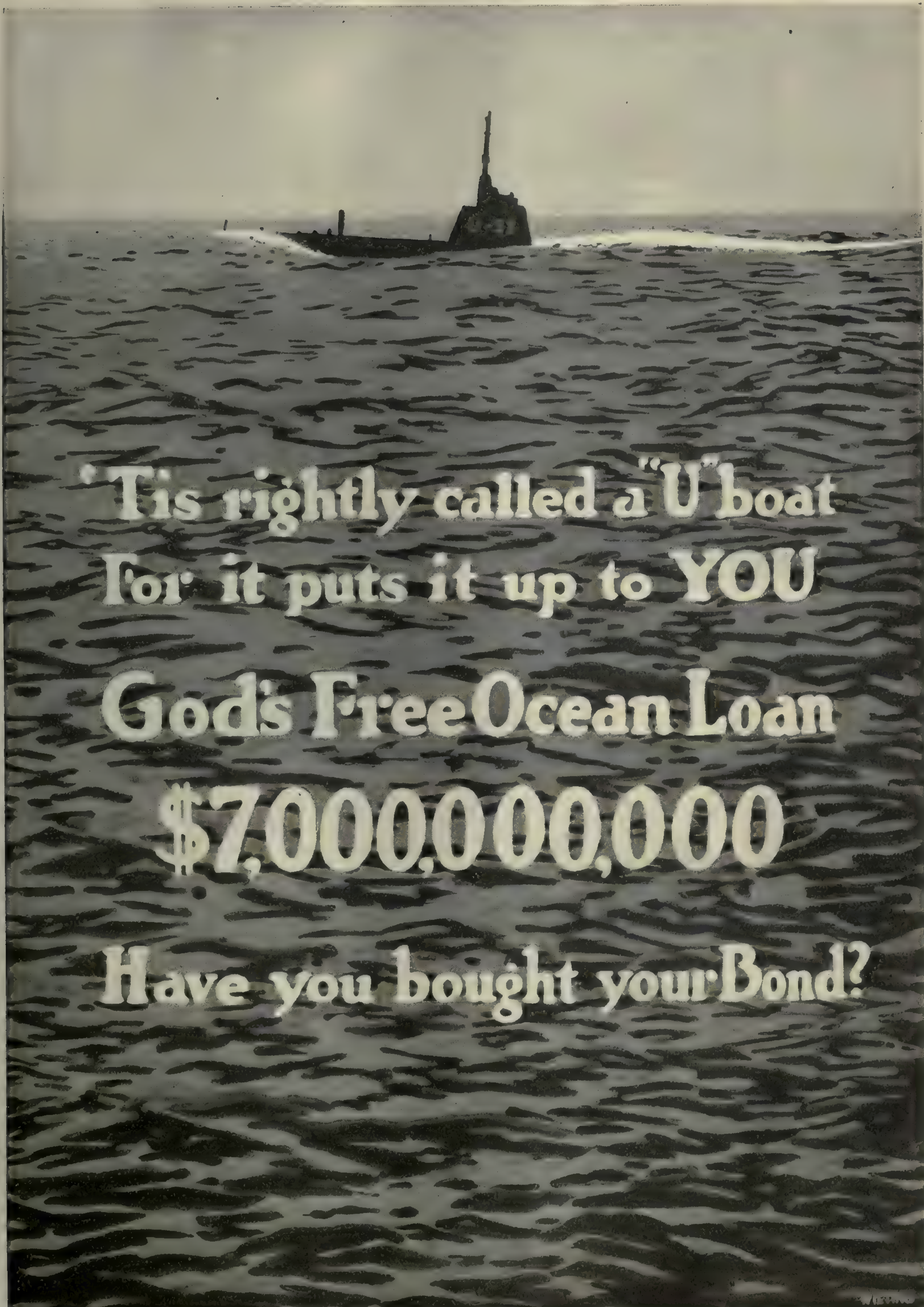
★

Lathes and planers, millers and drills,
Built this plaything of Hell,
But lathes and planers, millers and drills,
Will conquer its might, as well.

★

Machine-shop men of America,
With your dollars and cents and brains,
You are fighting to rid the earth of fear,
Drive death from the ocean lanes,
But while you labor with iron and steel
To build for the Great Beyond;
Remember, you haven't begun your work
Until you have bought your Bond.

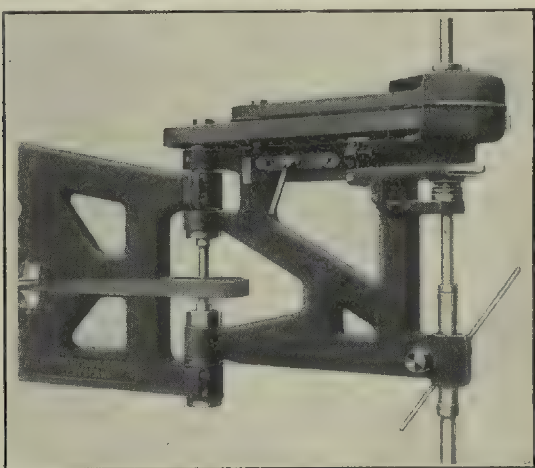
★


'Tis rightly called a "U" boat
For it puts it up to YOU
God's Free Ocean Loan
$7,000,000,000
Have you bought your Bond?

Shop Equipment News

Tapping Attachment for Sensitive Radial Drilling Machine

The Hammond Manufacturing Co., Cleveland, Ohio, has placed on the market a tapping attachment for use with its ball-bearing high-speed sensitive radial drills. The device has a capacity up to ½ in. taps in cast iron. The

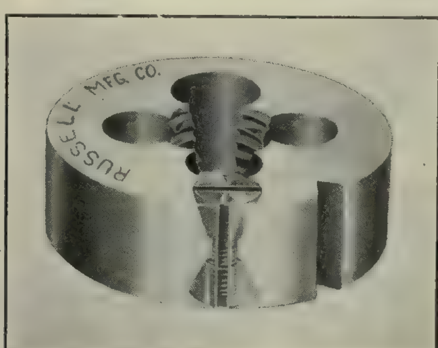


TAPPING ATTACHMENT FOR SENSITIVE DRILLING MACHINE

drive is through a double cone friction from two pulleys on the head driven by open belts provided with a means for adjusting tension. The friction is nominally held in contact with the lower pulley by three springs, the reverse being engaged by a downward movement of the horizontal lever seen just below the head. The reverse speed is 50 per cent. greater than that of the forward movement. All rotating parts are on annular ball bearings.

Adjustable Round Dies

The Russell Manufacturing Co., Greenfield, Mass., is now marketing a line of round adjustable dies similar to the one shown in the illustration. The adjustment is



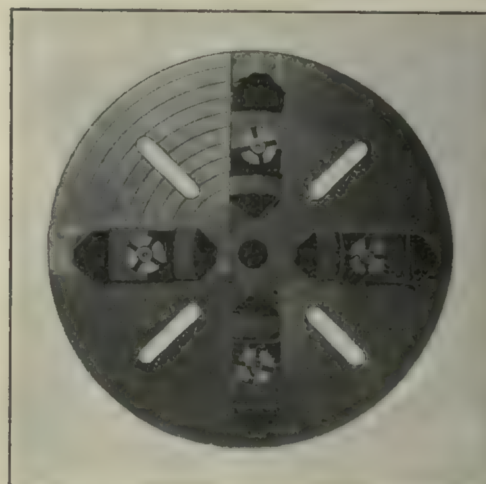
ADJUSTABLE ROUND DIE

secured by a screw having a cone-shaped head and nut, bearing in cone-shaped recesses in the front and back faces of the die.

It is claimed that the double-cone construction causes the die to open or close evenly and prevents any twisting. The spot for the setscrew runs across the entire edge of the die, thus permitting it to be used with any of the various makes of die holders.

Independent Four-Jawed Chuck

The independent four-jawed chuck shown has been built by the Simplex Tool Co., Woonsocket, R. I. The body is of crucible cast iron, the jaw ways being planed deeply into the face in order to give large bearing surfaces on the jaw sides. Forgings, machined all over, and hardened and tempered, are used for the screws. The screw bushings are of high-carbon steel, to provide a dur-



INDEPENDENT FOUR-JAWED CHUCK

able radial and thrust bearing. The jaws are of the separably reversible type and are so constructed that backlash is automatically taken care of. It is claimed that this type of jaw construction permits the jaws to be reversed very quickly.

Emery-Wheel Dresser

Lubrication of the "Brandenburg" emery-wheel dresser, shown in the illustration, is provided by flake graphite instead of oil, as is generally the custom. The construction used consists of a hardened-steel spindle running in

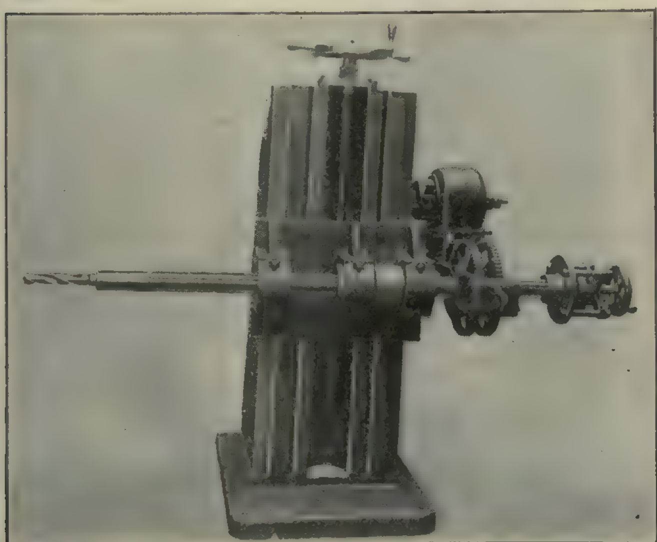
SELF-LUBRICATING EMERY-WHEEL DRESSER

cast-iron bearings, to which the flake graphite is fed through small holes connecting with the storage space inside the handle.

It is claimed that, as no oil is used, the abrasive dust does not stick on the bearings or cutters and their life is therefore greatly lengthened. The dresser, it is asserted, will never become so hot as to draw the temper of the cutters. In order to prevent sparks or pieces of abrasive from flying into the eyes of the workman, the head of the dresser is formed in the shape of a safety hood. The device is the product of the Hetherington-McCabe Co., Piqua, Ohio.

Column-Type Boring Machine

The illustration shows one form of a boring machine of the column type that has recently made its appearance on the market. The machine shown is for use on a floor-plate, but it may also be had with an outer support for the



COLUMN-TYPE BORING MACHINE

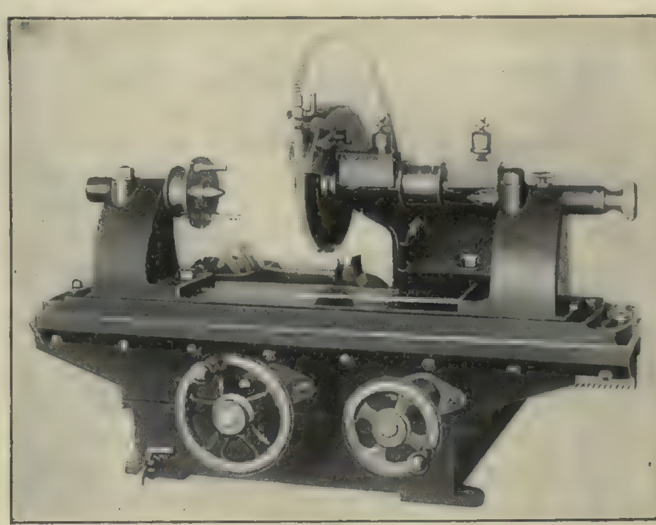
Maximum distance center of bar to floor-plate, $56\frac{1}{2}$ in.; minimum, $14\frac{1}{2}$ in.; size of base, 48 x 29 in.; size of saddle, 25 x 18 in.; travel of saddle, 42 in.; weight, 4200 pounds

bar and mounted with a long bed at right angles to the bar. The bar is held in a saddle moving vertically on the column and is driven from an electric motor through a compound gear train, various speeds being provided for. The feed has three forward and three reverse speeds. The feed screw is contained in a groove in the side of the bar, is supported by bronze thrust bearings and has a square thread. The bar may be used as a traveling bar or as a fixed bar with traveling head. A Morse taper is used in the end of the bar for inserting drills, reamers, etc. The machine is intended for large, heavy work, one of its features being the possibility of boring holes of such size that the boring bar itself will not pass through them. The Pedrick Tool and Machine Co., Philadelphia, Penn., is the manufacturer.

Cutter and Tool Grinder

For the purpose of grinding cutters, small tools, fixtures, gages, etc., the Factory and Mill Supply Co., Boston, Mass., is now selling the universal cutter and tool grinder illustrated.

The spindle runs in phosphor-bronze bearings that may be adjusted to compensate for wear. All feeds are by handwheels provided with indicating dials. The tailstock slides on the base, the center also being adjustable. The machine as shown is set up for external grinding; but an internal-grinding attachment is supplied, which is mounted in ball bearings clamped to the wheel head.



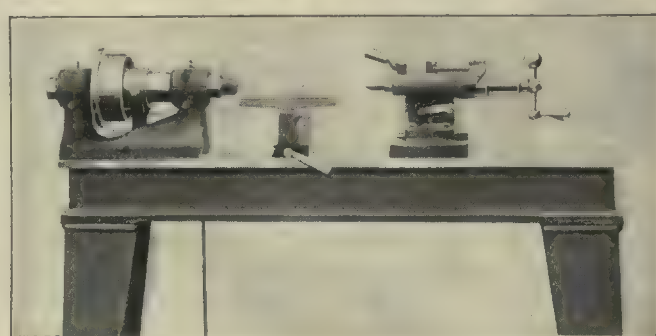
UNIVERSAL CUTTER AND TOOL GRINDER

Capacity, up to 10 in. in diameter and 15 in. between centers; crossfeed, 6 in.; longitudinal feed, 15 in.; table travel, 30 in.; diameter of spindle, 1 in.; driving pulley, 3 in. in diameter for $1\frac{3}{4}$-in. belt; takes wheels with $\frac{7}{8}$-in. spindle hole up to 8-in. diameter and $\frac{3}{4}$-in. face; spindle, hollow, with No. 2 Morse taper

The speed of the spindle for internal grinding is 3000 r.p.m. The machine is equipped with a lubricant reservoir, pump and piping and is furnished either with or without floor stand.

Lathe with Draw-In Friction Headstock

The accompanying illustration shows a lathe, with a draw-in friction headstock, that has just been placed on the market. It is intended especially for rapidly producing or finishing small parts, the spindle being driven



LATHE WITH DRAW-IN HEADSTOCK

by a friction controlled by a foot treadle. The operation of the treadle not only stops the spindle, but opens the collet as well. On releasing the treadle a spring closes the collet automatically.

The spindle runs in self-oiling bronze bearings, the nose being fitted with a hardened bushing to prevent undue wear by the collet. The nose is also threaded to receive a chuck or faceplate. Collets up to $\frac{5}{8}$-in. inside diameter may be used. The headstock is also arranged in a manner suitable for mounting on a bench. The machine is the product of the J. G. Blount Co., Everett, Massachusetts.

Latest Advices from Our Washington Editor

By Fred H. Colvin

Washington, D. C., May 5, 1917

As pointed out in a previous letter, the question of apportioning raw material is serious and must be handled from a broad viewpoint that considers the relative importance of the various industries. Just as the farmer's hoe is necessary to raise the vegetables to be preserved for future use, so is the machine tool necessary to make guns, shells, fuses and all the other implements of warfare. Without iron, steel and the other raw material necessary, the builders of lathes, millers and the like are helpless to produce the machines that are at the foundation of all industry. And so, in diverting these raw materials to Government use, the builder of machine tools must be considered as a very necessary part of the program, or we shall find shell and gun makers with plenty of material for shells and guns, but with no machines on which to make them.

So far as the shell proposition goes, there need be no uneasiness whatever, this being simply used as an example. There is ample shell-making capacity now in the country and already equipped for the work. In fact, shells are now being made for our own guns as well as for our allies. When it comes to guns, gun mounts and other implements of war, much remains to be done, and this work requires the most careful organizing; for the needs of each branch of the service must be carefully balanced against all the others in order to secure the things we need most in advance, and at the same time not to delay the products that must come later. If those who complain at apparent delays will figure out a few problems of this kind as applied to their own work they will get some idea as to what it means. Then they must multiply the difficulties a hundred-fold to realize what those who are giving all their time and energies in trying to solve these problems for the general good are up against.

When this balancing of the needs of one industry against the other begins, we must be prepared to have our own toes stepped on occasionally. Whoever has the regulation of supplies in charge is sure to see things differently than we do at times. As he will be in position to see over a larger field than we can, let us try to assume as long as possible that his judgment is best. None of us like to be "regulated" in any way; but we are learning that it is a part of the complexity and interwoven relations of modern industry and civilization, and we have come to accept the regulation of guards on machinery, compensation for accidents and similar regulation as a matter of course in times of peace.

Now that we are at war, without realizing much what it really means as yet, let us remember that to secure maximum output at minimum expense (and this means less burdensome taxes in the future) we must sink personal preferences as to men and methods, that we must coöperate with all other industries and only think of so doing our part as to end the war as quickly as possible.

Another problem of conserving the supply of raw materials, and one that is troubling the scientists, particularly the chemists, is that of platinum. The fad for platinum jewelry among those who wish to advertise the fact that they can afford to buy the most expensive materials has sadly affected the supply for scientific purposes. Platinum dishes and weights are a necessity with the chemist, and steps are being taken to restrict the use of this material, at least during the war. Manufacturing jewelers have agreed, it is understood, to refrain from using it, but are opposing any mandatory rulings in the matter. This may suffice to give the chemists and others all that they need; if not, other means are sure to be undertaken, for platinum must be had.

One very drastic proposal, but one which would surely prove most effective, is to impose a holding or possession tax of 25 per cent. on all platinum not in commercial or scientific use. This would tax the owner of a platinum ring 25 per cent. of the value of the ring every year; and while some would enjoy such a mark of distinction, it would in all probability release a large amount of platinum for useful purposes.

The Springfield Rifle Not To Be Abandoned

There seems to be much confusion and some apprehension as to the use or abandonment of the Springfield rifle. So far as can be learned, there is no intention to abandon the Springfield, which is a wonderfully hard-shooting rifle and has many advantages. But it is absolutely impossible to make these rifles fast enough to arm an expeditionary force, owing to the lack of capacity of our only two arsenals that are equipped for this sort of manufacturing. After the establishment of a rifle plant at Rock Island it was shut down and has been idle most of the time since, while Springfield has been running at only a small fraction of its capacity—all because Congress, which now passes the stupendous bond issue of $7,000,000,000, has persistently refused to appropriate a few hundred thousand a year to keep these arsenals running so as to be accumulating a supply of rifles for just such an emergency.

Springfield rifles can be made in any good rifle shop, but it requires special tools, fixtures and gages, and these take time to make. They are now being manufactured in accordance with the recent appropriation for this purpose; but even had the appropriation been large enough, the time that it will take effectually prevents the use of the Springfield in large quantities such as will be required for the arming of a million men, and that may be only the beginning.

The Lee-Enfield rifle has been selected for the expeditionary forces, because we have factory capacity for its production, owing to the fact that we have equipped for this work in order to fill foreign contracts. The three plants so equipped are said to have a capacity of 40,000 Enfield rifles a week with a little crowding, which means that the rifles can be made much faster than we will have men to use them, so that the supply to the British armies will not suffer in the meantime. Reports do not agree as to whether the British ammunition is to be used or whether the barrels are to be chambered out to take the United States cartridge, which is a little larger and which

carries a heavier propelling charge. This is a detail that can well be settled later, as either kind of ammunition can be made in large quantities. There are some advantages in having uniform ammunition that is readily interchangeable, but whether these features outweigh the good points of using the harder-shooting cartridge is yet to be determined. Those who recall the Civil War days remember the different kinds of rifles that it was necessary to use at that time. The lack of uniformity was greater then and had many more disadvantages than in the present case. Considering our unpreparedness, we are extremely fortunate in having an adequate supply of a similar arm available at such short notice.

Lack of Appropriation Delays Contracts

Now that the bond issue has been authorized, many seem to think that there is nothing to do but to go ahead and place orders. As a matter of fact, the real appropriation bills, the measures that actually release the various sums of money for use by the army or navy, have not yet come out of Congress. When they do, things will begin to move faster; but even then it will take time really to get the huge machinery of production in operation in all its branches. Every effort is being made to gather in the loose ends, so that things will move smoothly when they once get started; and there is every indication that an excellent foundation is being laid.

Some Problems of the Commercial Economy Board

As an indication of this it is interesting to mention the formation of a Commercial Economy Board, whose function it is to study the relative value of the various industries to the country in wartime. Eliminating the industries which are directly or indirectly engaged in producing munitions and direct army products and which must have a full quota of men, this board is studying the industries that can be curtailed without affecting the necessaries of life or the supply of needed materials for the army or other Government work. Such industries as jewelry, lace, fancy underwear and the like are likely to be seriously curtailed, but wherever possible they will be transformed into making the more useful products. Where this is not possible, the employees will be transferred to the more necessary industries.

Small groceries and other distributors are also being considered as possible fields for economies in labor by combining the fields covered and releasing men for other purposes. This is an entirely new proposition for this country and will require not only a large amount of study, but also great coöperation and concessions in the interest of the general efficiency of the country. This board will also consider cases of overlapping and duplication in various plants and industries as a further means of preventing waste of effort.

The personnel of the board shows the character of the men who are serving in this emergency. The chairman is A. W. Shaw, of Chicago; other members are Dean Edwin F. Gray, of Cambridge; W. D. Simmons, of St. Louis; George Rublee, of New York; Henry S. Dennison, of Framingham, Mass.; and Dr. Godfrey, of the Drexel Institute, representing the Advisory Council of National Defense. In addition to the board itself, Dr. Melvin T. Copeland, of Harvard University, is also working with it and is making a study of data that have already been published or are otherwise available, to show what the European countries have done along this line. It is of course too early to attempt to predict what will be accomplished, but it is very encouraging to know that such details are being considered, and by such competent men.

Question of Handling Stores

Another encouraging sign of far-sighted preparation is the formation of what is known as the Storage Committee, headed by Morris L. Cooke. This committee is preparing to handle the problem of storing and distributing the various army supplies that are to be accumulated at different points of the country. While this may seem like a minor problem to those who are not familiar with the necessity of the rapid and economical handling of large stores of widely varying material, it is in reality a man-size job, as more trouble and delay can be caused by a lack of system at this point than seems possible on the surface. While it is essential to have materials made rapidly and economically, much time can be lost and much expense added by not being able to locate promptly and ship when wanted.

Anticipating the need for this kind of service, J. A. Bursley, of the University of Michigan, has already started a school for storekeepers with 80 men, so that a number of men will have had the necessary training to begin the work and to teach others if necessary. A similar school is being started in the University of Pennsylvania, and other colleges are expected to fall in line shortly. Work of this kind is particularly gratifying, as it shows the desire to find a place to serve, even if it be not in the limelight and is lacking the opportunity to secure the medals given for military honors. Then, too, the initiative to start work or training before its need is pointed out by dire necessity is commendable.

Problem of Munition Gages Again

The question of gages for shells and other munitions is still unsettled, although careful consideration is being given to it. There are two points of view at present, one of which advocates that the gages be furnished the manufacturers by the Government, and the other that the manufacturers be supplied with blueprints of the gages to be used, with the tolerances clearly marked, from which the required gages could be secured at the nearest available source. All inspectors' gages and gages used to check these inspection gages will be made by (or for) the Government and be tested by the Bureau of Standards, according to this latter plan. All shells must conform to these inspection gages, no matter where the shop gages have been made; and this should not be difficult, as the gage sizes would be clearly indicated on the blueprints furnished. These or any other gages would of course be tested at the Bureau of Standards when desired, but it would have to be clearly understood that this in nowise affects the necessity of the shells passing the inspection gages. The bureau could only certify to the correctness of the gage when returned, and it could not be in any way responsible for the condition of the gage on arrival at its destination or after being used a few times; for gage wear is too often overlooked and leads to all kinds of trouble when it is not appreciated.

Advocates of this plan believe it will have many advantages and secure production much more quickly than to have the Government supply the gages. It would enable each manufacturer to use all his own toolmakers or those of any local organization and would probably distribute the work much more thoroughly over the manufacturing districts. Then, too, it puts the responsibility for the accuracy of the gages up to the manufacturer rather than to the Government, making the Bureau of Standards responsible only for master or checking gages.

This whole problem of gages is very apt to be underestimated by those who do not appreciate, first, the difficulty of securing accurate gages in large quantities and, secondly, the amount of wear that takes place in gaging a thousand pieces. This wear varies of course with the kind of gage and the nature of the piece measured. The long-armed calipers used to measure the thickness of a shell wall wear very rapidly, while some other gages will last ten times as long before requiring replacement.

The experience of others is always worth considering; and when it has proved successful, it is a good guide or basis, even if we do not follow it entirely. From this standpoint the practice of the Canadian Munitions Board can well be studied with profit. When an order for shells is placed, the Gaging Department at Ottawa is notified as to quantity, time of delivery, and location of the makers. These facts show when the inspection gages must be ready, how many gages will be needed to take care of wear during the order, and where the inspectors will have to go. They plan their work accordingly; and this of itself makes a check on production at different plants, as if any plant falls down, it throws out the inspection schedule.

This Gaging Department has grown into an organization of over 150 men. It includes those buying gages from various makers, those who test the gages, both when new and from time to time to check wear, and the clerical force who keep all records, which are nearly as important as the gages themselves. This department has gaged over \$500,000,000 worth of shells and is supplied with all the funds needed to carry on its work, its importance being fully recognized by those in authority on the governing board. Can we do better than to pattern after this plan, so far as it fits our requirements, placing this work in the hands of the Bureau of Standards with a sufficient force to carry it on properly?

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There is one thing to be borne in mind at this time, which has a direct bearing on the conduct of preparations of all kinds—that is, whatever is done must be supplementary to the existing bureaus and organizations rather than as a substitute for them. The more that existing machinery can be utilized, even though it only serves as a basis for future work, the better. So instead of criticizing destructively, let us try wherever possible to build up these organizations by supplementary means rather than by tearing down, at least until it has been proved to be necessary. There are so many problems that the regular bureaus will be glad to hand over engineering matter to engineers and keep their own men busy along lines in which they have been specially trained.

As an example of the exaggerations we have been hearing as to airplane performances, it is interesting to note what Maj. L. W. B. Rees, the aviator who accompanies the British war commission, has to say in regard to the matter of speed. He places the speed of airplanes at the front as about 125 miles an hour as a maximum, an increase of only 7 miles during the past year. This is decidedly different from the tales we have been hearing of speeds of 150 to 160 miles an hour and makes the performances of our own fast machines nothing at all to be ashamed of, when we consider how very little actual experience we have had with them.

It is of course quite possible that even 200 miles an hour has been attained by some aviators in their thrilling nose dives from a great height, but this cannot be counted as the speed of a machine, as a stone attains a terrific velocity in dropping a few thousand feet. What we need is reliability, the assurance that a motor will keep on the job as long as may be necessary and continue to deliver its rated power over long periods.

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The Experience Needed To Promote American Aircraft

While our aircraft has not been the complete failure some would have us believe, it is far from perfect, and with good reason. The only way to learn to do a thing well is to do it often and to keep on doing it until experience shows us the weaknesses as well as the strong points. This was the case with the automobile, and it is the case with every form of machine development. We developed the airplane, but we built very few with which to experiment and from which to learn defects as a basis for future improvement.

The French and the Germans immediately began to experiment and to build airplanes on a large scale. Faults and weaknesses were detected as they developed and corrected as experience dictated. This course was repeated thousands of times, while we built airplane by dozens. Motors and planes were both improved far beyond the point our limited knowledge made possible. We are learning, and we will learn more and faster when we can utilize their experience and add it to our own, as we are beginning to do.

There are other circumstances, too, which we often overlook. The flying conditions in France vary no more than they do in one small section of the United States, say a state like New Jersey. But a machine developed to a high degree of efficiency in that section would meet very different conditions in Colorado and might be almost a failure in New Mexico, where climate, wind and air have totally different characteristics.

These are some of the reasons why it is necessary for us to get actual experience of our own under these varying conditions, why the experience abroad cannot be taken as a positive guide unless we are careful to compare all the factors involved. The airplanes now in use will help us to attain the described efficiency, but it will take ten times the number of machines and ten times the experience to give us the mastery of the air that should belong to the pioneers in air navigation.

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The care of airplanes and motors is also being discussed; and there seems to be much misunderstanding as to the arrangements for such maintenance, even among those who should be in a position to know. The statement has been made on the authority of an officer in the flying corps that few mechanics were provided for, but that any enlisted man might be assigned to this duty

whether he was an experienced mechanic or not. This, I am informed, is not in exact accord with the provisions of the case, which do allow for a corps of mechanics. The difficulty is in securing them, as skilled workers in this line are all too few and the builders of airplanes can offer higher wages. Here, as in many other lines, we have not the number of trained mechanics needed, and it affords a good opportunity for those who wish a new line of endeavor.

Airplane Repairs as Handled by the French Army

The French army method, adopted under stress of military necessity, is to secure as many of the best mechanics as can be spared from the airplane factories and to enlist them in the aviation corps. Repairs are in charge of a skilled man with the title of sergeant, who is responsible for the work turned out by the men placed under him.

When a machine comes down from a flight, it is gone over, or groomed, nuts tightened, carbon scraped if necessary and such other work done as may be needed, a record of all repairs being carefully kept. Each worker is assigned to a particular job and becomes a specialist in it, being directly responsible to the sergeant and signing a repair slip for everything he does. This must be O.K.'d by the sergeant before the machine goes into service again.

Should it be found that any man had not done his work properly, either through ignorance or carelessness, he is liable to military punishment to such a degree as may seem to fit the case. This naturally makes every man careful to do his job right; or if he does not understand it fully, to consult the sergeant in regard to it before signing his name to the repair slip.

When perfect performance of airplanes may mean the winning or losing of an important battle, too much care cannot be taken in repair work.

William Lodge, Pioneer Tool Builder, Dies Suddenly

News of the death of William Lodge, or Uncle Billy, as his hosts of friends affectionately called him, comes as a shock to all who knew him. And particularly to those who have known him best, in the earlier days when the outlook was not always bright, as well as in his more prosperous years; for no amount of adversity ever dimmed his unfailing good nature and his human sympathy.

Born in Leeds, England, in 1848, he came to this country in 1869 after serving his apprenticeship in his native town. Landing in Philadelphia, he did not find what he desired in the way of employment and wandered as far as St. Louis, often in close quarters financially, until 1872, when he finally went to Cincinnati. The way in which he raised the necessary funds for the trip by selling his watch was one of his favorite stories in later years; and when told as only Uncle Billy could tell it, no one ever forgot it.

He began work as a journeyman machinist in Cincinnati in 1872 and soon became foreman. Eight years later, in 1880, he started a little business of his own in a partnership known as Lodge & Barker, which afterward became Lodge, Davis & Co.; and here began his devotion to the building of the engine lathe. At that time Cincinnati was almost unknown as a machine-tool building center, and there is little doubt that the perseverance and the success of William Lodge formed a large factor in placing that city in its present position on the machine-tool building map.

The present company, the Lodge & Shipley Machine Tool Co., was founded by William Lodge and Murray

WILLIAM LODGE

Shipley, in 1892, with Mr. Lodge as president. It has grown to its present enormous proportions under their guidance. Specializing on the engine lathe, making it in fact his chief interest in life, as he often told his friends, naturally led to many changes and improvements in its construction.

Mr. Lodge was largely responsible for the formation of the Machine Tool Builders' Association and was its second president. He was treasurer of the National Metal Trades' Association for two years and president of the Ohio Manufacturers' Association for a like term. Those who have attended the annual meetings of the National Metal Trades' Association or the Machine Tool Builders' Association can never forget the active part almost invariably taken by Mr. Lodge, or his unfailing good humor, both in personal contact with the members and in his annual rendition of his well-known "smoke song," which typified both his whole-hearted good nature and the hold his personality had in the hearts of his friends. What better tribute can we pay any man than to say that he was loved for his personal characteristics as well as for his achievements in his work-a-day world? And this is especially true of William Lodge among the men in the machine-building field.

Mr. Lodge was a member of the Cincinnati Chamber of Commerce, the Business Men's Club, the Merchants' and Manufacturers' Association, and was a thirty-second degree Mason. His widow and two daughters, Mrs. Louis B. Weber and Mrs. Louis Dolle, survive.

Another Metric Danger

The Springfield rifle is a Government weapon made only at the Springfield and Rock Island arsenals, while commercial factories are equipped for the production of Lee-Enfield guns. Consideration of the subject by our War Department has shown that to furnish commercial factories with gages, jigs and special tools for the production of the Springfield rifle would involve a delay of 18 months to two years. As private factories are already equipped for the production of the Lee-Enfield gun, this delay will be saved by the adoption of that gun; and this rifle has been decided upon for foreign use, although the Springfield is considered the superior weapon.

And now comes Dr. George F. Kunz, who, as president of the American Metric Association, advises the head of the War Department to have our "new guns and other weapons of war made in accordance with the metric system."

If a delay of from 18 months to two years would be involved in fitting commercial factories for making the Springfield rifle, which is already manufactured upon a large scale in the two Government arsenals, how much time would be required to prepare factories for the production of all military equipment to the metric system, for which equipment the drawings have not even been begun? Equally to the point, when will Dr. Kunz and his supporters learn that there are several things about machine-shop measurements that they do not know?

The simple-minded folly of this suggestion should not blind us to the situation, but on the contrary it should illuminate the situation. We have, in this recommendation of Dr. Kunz, a measure of the extent to which the metric party is prepared to go. We have a measure of the intelligence behind the metric movement and a measure of the wall of ignorance and fanaticism with which we have to deal. More to the point, *the manufacturers of this country have here a measure of the consideration which their interests will get when their turn comes.* Let there be no mistake; their turn will come unless they organize to fight the stupid, ignorant, fanatical metric propaganda. The means for fighting it are now complete in the organization of the American Institute of Weights and Measures, of 20 Vesey St., New York City. Every reader, and still more every advertiser in these columns, should lose no time in enrolling his name at that office. The *American Machinist* has joined the American Institute of Weights and Measures as a corporation member. Have you?

Advising Employees How To Act Under Present Conditions

The poster advising employees how to act under present conditions, which was reproduced in miniature on page 701, Vol. 46, has met with such a demand that the first printing is exhausted. This need not, however, deter shop owners and managers who wish these posters from asking us for all they need to hang in the various departments of their works. We are running more through the press and are glad to be of service to American shops.

Personals

Dr. John A. Brashear has returned to Pittsburgh after a four months' trip through the Orient.

F. T. Weaver has been appointed superintendent of the Pennsylvania Saw Works, Frackville, Pennsylvania.

C. C. Bradley has been nominated for the presidency of the Manufacturers Association of Syracuse, New York.

J. H. Mariotte has become connected with the J. R. Stone Tool and Supply Co., Detroit, Mich., and is to have charge of the machine-tool department.

G. E. Thomas has been transferred and will become sales representative of the Gisholt Machine Co., Medina, Wis., in the New England district.

W. T. Clark has resigned as manager of the Traylor Engineering and Manufacturing Co., Allentown, Penn., to become manager of the Moline Plow Works, Moline, Illinois.

James McNaughton, formerly vice president of the American Locomotive Co., has been appointed assistant to the president of the Eddystone Ammunition Co., Eddystone, Pennnsylvania.

A. L. Barrett, formerly with the Union Iron Works, San Francisco and Alameda, Calif., has resigned and joined the Vulcan Iron Works, San Francisco, in the capacity of general foreman.

W. C. Hammond, formerly assistant manager of the Standard Cast Iron Pipe and Foundry Co., Bristol, Penn., has been appointed general manager of the William E. Hill Co., Kalamazoo, Michigan.

W. S. Quinlan, formerly with the National Screw and Tack Co., Cleveland, Ohio, has become associated with the Maynard H. Murch Co., of the same city, in the capacity of industrial counsel.

Robert H. Patchin has resigned as secretary of the National Foreign Trade Council to become manager of the foreign-trade department of W. R. Grace & Co. **O. K. Davis** will succeed Mr. Patchin.

H. A. Coffin has severed his connection with the Firestone Tire and Rubber Co. and has become associated with the Detroit Pressed Steel Co. in the capacity of manager of the wheel department.

Alexander Engblom, formerly mechanical superintendent of Sidney Blumenthal & Co., Shelton, Conn., expects to go to Sweden very shortly and will be glad to place agencies in that country for American machine-tool builders.

J. N. Kelly has resigned as superintendent of the Ross Gear and Tool Co., Lafayette, Ind. **E. L. Usner** has been made assistant manager, **J. P. McParland**, superintendent of machine shops, and **M. C. Griswold**, superintendent of assembly.

T. F. Webster, formerly of the Link-Belt Co., has resigned to take the position of vice president of the R. H. Beaumont Co., Philadelphia, which specializes in hoisting and conveying machinery. Mr. Webster will be connected with the sales department.

J. F. McCloskey has resigned as tool-division superintendent of the Remington Arms and Ammunition Co., Bridgeport, Conn., to become partner and manager of the Dover-McDevitt Co., Pawtucket, R. I. Mr. McCloskey was formerly connected with the Taft-Pierce Manufacturing Co. and the United Shoe Machinery Company.

P. E. Thomas, formerly general manager, has been elected president of the Kempsmith Manufacturing Co., Milwaukee, Wis. The additional officers elected are as follows: **John Goetz**, vice president and works manager; **F. Wollaeger, Jr.**, secretary; **E. E. Leason**, assistant treasurer and purchasing agent; **Peter Lowe**, assistant secretary and manager of sales and advertising.

Business Items

The Railway Car Manufacturers Association has established an office at 61 Broadway, New York City, Room 2216.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice-president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeteing at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio, on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

The American Society of Mechanical Engineers will hold its annual spring meeting at Cincinnati, Ohio, May 21 to 25. There will be a joint session with the National Machine Tool Builders Association on May 21. The headquarters will be at Hotel Sinton.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

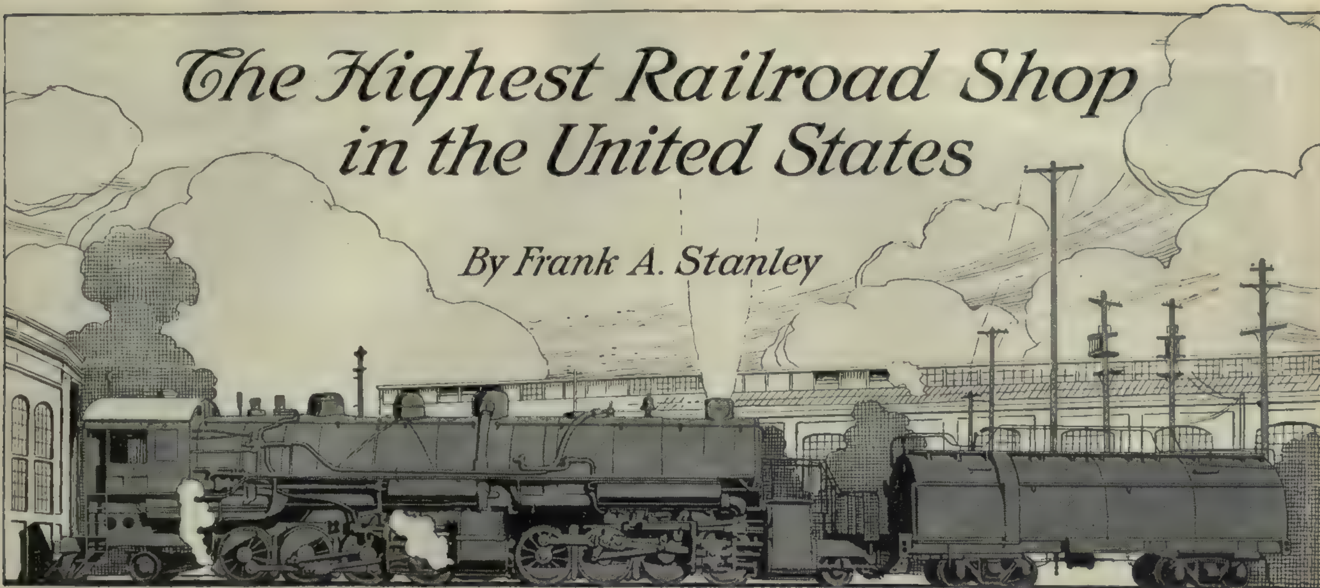
Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1735 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The Highest Railroad Shop in the United States

By Frank A. Stanley



SYNOPSIS—Not only is the shop at Sparks, Nev., of unusual interest because of its high altitude, but also because of the mechanical equipment provided and the Mallet-Consolidation, Mallet-Mogul and Mikado engines that are overhauled there. In this article, the first of a series on railroad-shop operations, a number of interesting pieces of equipment are described. The work handled includes all types from small details to heavy engine repairs.

The Southern Pacific Co's. division shops at Sparks, Nev., are situated on a plateau in the Sierra Nevada Range at an elevation of nearly 5000 ft. above sea level and about 250 miles distant from San Francisco. Some 50 miles to the westward is Summit, the highest point reached by the Ogden route from California east, where at an altitude of over 7000 ft. and under the protection of 40 miles of snowsheds the tracks of the Southern Pacific system are carried over the ridge of the Sierras. The community of Sparks is a typical railroad town of approximately 3000 inhabitants, a large percentage of whom are directly employed by the railway company. Four hundred enginemen and trainmen run out of this town every day, and under ordinary conditions in the transportation business fully 600 more are kept busy in the repair shops and roundhouse. An attractive clubhouse is maintained here for the local employees and for the hundreds of others, living elsewhere on the system, who lie over at this point waiting for their runs back home. The mayor of Sparks is a Southern Pacific man, Foreman Cheney of the blacksmith shops. The roundhouse is a 40-stall building, and here may be seen at any time numerous examples of heavy locomotive equipment including Mikado, Pacific, Consolidation and Mallet types of engines. Running west from Sparks there are some 45 Mallet-Consolidation, a dozen Mallet-Mogul and 65 Mikado locomotives, while for handling traffic east from this point there are over 40 Pacific and 50 or more Consolidation types of engines. This equipment, together with rotary snowplows and other apparatus, provides a varied line of work for the shops, from heavy repairs down to small details.

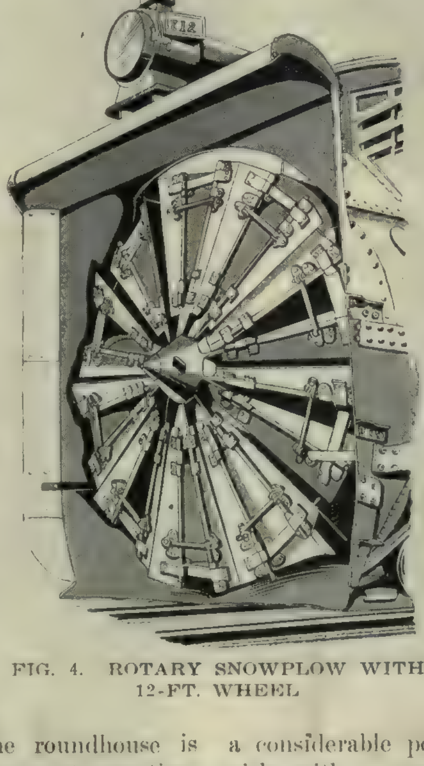


FIG. 4. ROTARY SNOWPLOW WITH 12-FT. WHEEL

The Unique Location

The Sparks shops may be said to occupy a unique situation, located as they are at what I believe to be the highest altitude of any railroad plant of importance or any general machine shop of any size in the United States. Situated on the eastern slope of the Sierras in a section where fair skies and clear sunshine prevail through practically the entire year, where at the extreme only a few days of stormy weather may be expected in the course of many months, these shops have the advantage of a real asset in the way of sunlight and healthful atmosphere that might best be appreciated perhaps by plant managers operating in climates where discouraging weather conditions go far toward affecting adversely the activities and effectiveness of shop employees. The clear illumination by sunlight in the Sparks shops and the neat and orderly appearance of the interior of the plant reflect at once to the visitor the invigorating and stimulating influences of the natural conditions surrounding the entire community. These conditions are well brought out by the general views, Figs. 1 and 2, the one representing the main bay of the machine shop with its double line of heavy planers, wheel lathes and so on, the other showing a considerable portion of the overhauling and erecting aisle with a number of locomotives of various classes over the pits. These two engravings illustrate clearly the characteristic features of shop construction, the steel col-

FIGS. 1, 2 AND 3. VARIOUS DEPARTMENTS IN THE HIGH-ALTITUDE RAILROAD SHOPS AT SPARKS, NEV.

umn, girder, monitor and gallery arrangement, the locations of windows, skylights, crane runways, etc. The crane in the far end of the view presented in Fig. 2 is of 100 tons' capacity, with double hoists for picking up bodily locomotive boilers and frames for wheeling. The other traveling crane, shown in the first photograph, is of lesser capacity, but of ample size for handling the heaviest planer and lathe work in and out of the machines.

As will be noticed from Fig. 2, the pits are located crosswise of the length of the shop building, and the tracks from these lead out to a transfer table by means of which the engines are shifted from the yard tracks to the shop and vice versa.

The machine-department view, Fig. 1, shows in the foreground two planing operations that will be referred to in detail in another article. The planer at the left is illustrated in operation on a crosshead attached to its piston rod and supported on the platen of the machine by a pair of angle irons provided at the top with suitable V-seats and clamps by which the piston rod is located parallel with the platen and held securely while the guide bearing surfaces are planed out in the crosshead. The planer at the right of the aisle is shown with a pair of driver boxes in position for the planing of the bearing surfaces along their edges. Fig. 3 is included in this article to illustrate the arrangement of some of the medium-sized tools and the method of lighting, etc. A variety of work attended to in this department will be illustrated in later articles.


FIG. 10. TANK AND CAR USED FOR CLEANING GREASY PARTS IN SODA BATH

Very few examples of big Mallet articulated locomotives are seen in the East, although such engines are common enough in the mountain districts of the West. For this reason it is believed that the title-piece illustration may be of interest to most readers, showing as it does one of the Mallet-Consolidation locomotives—that is, a 2-8-8-2 type—just outside the Sparks roundhouse. Like the other Southern Pacific engines, this locomotive is an oil burner and is one of many similar machines used on the heavy grades west of this division point.

Another interesting example of important equipment taken care of at this point is the rotary snowplow illustrated by Fig. 4. Despite the many miles of snowsheds over the Sierras, blockades do occur now and then in the midwinter season. While the heavy snowfalls add to the entertainment of the thousands of Californians who travel up over the mountains for a few days of pleasure during the winter carnival at Truckee, which lies just west of Sparks, the clearing of the tracks after each storm constitutes a serious problem in the work of handling traffic over the division and imposes more or less severe service upon the equipment.

The rotary plows used, of the type illustrated in Fig. 4, have a 12-ft. wheel with 10 sets of blades that measure at the outer ends about 18 in. in width and have a length of about 5 ft. These blades, or vanes, are adjusted at the shops to uniform lead or pitch and normally are set for a lead of approximately 2 in.

The foregoing reference to weather conditions in this locality during certain of the winter months will suggest to the reader the possibility of extreme cold at intervals through the season. While periods of temperatures considerably below zero are not extended over any great length of time, nevertheless they are of sufficient duration to make necessary adequate provision for keeping the shops and roundhouse in comfortable condition for the workmen. In this connection an important feature is the system of rolling steel doors, Figs. 5 and 6, for closing the entire length of the roundhouse. The views referred to illustrate the doors opened and closed and show the method of operating with hand chain and gearing, so that any door may be rolled up to clear the corresponding track for an engine passing in or out and then as readily dropped to close the passageway completely. As is the case with other of the shops on the Southern Pacific system, an apprentice school is maintained at Sparks. Here, systematic instruction in drawing, mathematics and other branches is given the shop apprentice boys. At the present time some 40 or more are availing themselves of the opportunity thus afforded them for supplementing their shop training with the school branches essential to their advancement in mechanical pursuits. Moreover, the system of instruction is not limited to boys and youths attending the regular apprentice classes mentioned; in addition, mature mechanics, enginemen and trainmen are given lectures and instruction in various departments of work such as the construction, upkeep and operation of air apparatus of various kinds. For the latter purpose there is a special building in the Sparks yards, where a lecture room has been fitted up with complete outfits of air-brake equipment and similar apparatus. In this department the men who have the handling of such equipment in the shops and on the road are taught every important feature of its construction and operation. Figs. 7, 8 and 9 show certain parts of the equipment for the demonstration and test of air-brake equipment as installed in this lecture room.

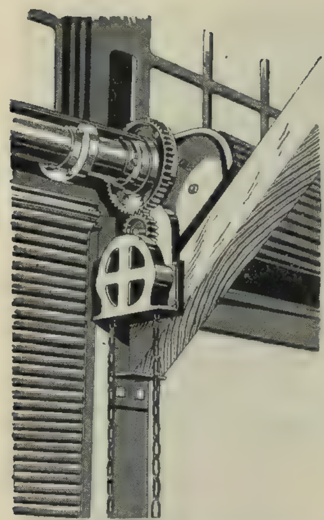


FIG. 5. THE ROLLING DOORS OPEN

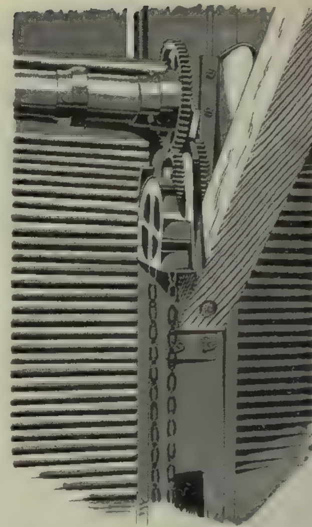
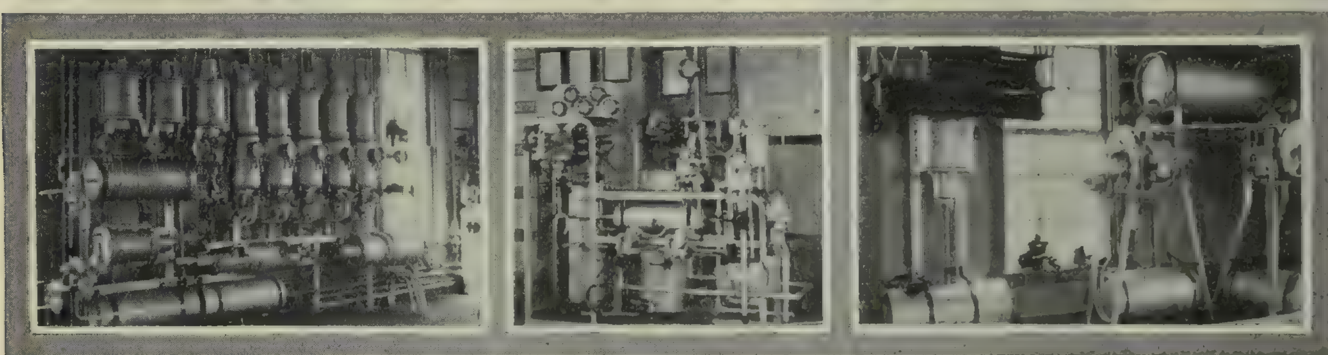


FIG. 6. THE ROLLING DOORS CLOSED

The final view in this first article on the Sparks shops and methods illustrates a very convenient arrangement for cleaning locomotive parts preliminary to sending them into the shops for overhauling. In many cases these engine members are heavily coated with grease, grit and dirt, and it is oftentimes an awkward task to handle them at all until after they are put through the cleansing process. For this operation a tank has been constructed in the shop yard, as shown in Fig. 10. Here, all such parts are soaked and thoroughly cleaned of slush and dirt in a bath of hot sal soda or potash. The tank is of such proportions as to admit a good-sized steel car, which is run down into the pit upon a pair of inclined rails. The car is formed, sides and bottom, with perforated plates, so that the cleansing medium flows freely through the container and over the material to be cleaned.

The entire outfit, car and contents, is ordinarily submerged completely and is left under the hot liquid until all the metal parts in the perforated body are freed of their accumulation of grease and dirt. One of these dipping cars will be noticed on the cross-track at the right. The tank, or pit, as will be seen, is surrounded by a heavy guard rail. The track for carrying the dipping car is located at the farther end of the pit. The fogged appearance of the center of the illustration is not due to halation of the negative, but to the dense cloud of white vapor rising from the steaming tank of soda water.



FIGS. 7, 8 AND 9. DEPARTMENT FOR DEMONSTRATION AND TEST OF AIR EQUIPMENT USED ON THE VARIOUS TYPES OF ROLLING STOCK

Central Selling Organization of British Machine-Tool Builders

A coöperative plan for exporting machine tools of British manufacture has been developed and is consummated in the formation of the Associated British Machine Tool Makers, Ltd., as noted on page 660. This company has a capital of $500,000 and was registered on Feb. 14, of this year, with offices at 34 Victoria St., S. W.

A central selling organization has been inaugurated in London, and subsidiary companies will, as soon as possible, be formed in certain continental countries, particularly Italy, France and Belgium. In some other cases, China for example, the association will work with an established house. It will not confine itself to its own tools exclusively, but will take up agencies for others outside of its own products, the only requirement being that all articles, for which the agency is taken, must be the product of British manufacturers.

The overlapping of products is to be prevented as far as possible, and the following list will indicate the arrangements that have been made in this direction as well as the members of the association: J. Archdale & Co., Ltd., Birmingham, light radial drills and also certain sizes of millers; W. Asquith, Ltd., Halifax, heavy radial and vertical drills; J. Butler & Co., Halifax, light slotters, light planers and shapers; Churchill Machine Tool Co., Ltd., Manchester, grinding machinery; Kendall & Gent, Ltd., Manchester, plano-millers; J. Lang & Sons, Ltd., Johnstone, lathes of the lighter patterns; G. Richards & Co., Ltd., Manchester, boring mills; T. Shanks & Co., Johnstone, heavy lathes, planers and slotters; Smith & Coventry, Ltd., Manchester, plain and universal millers, high-speed planers and certain gear cutters; H. W. Ward & Co., Ltd., Birmingham, capstan lathes.

A. S. M. E. Convention

The Cincinnati Planer Co., Cincinnati, Ohio, is issuing to anyone interested an attractive little booklet, "Organization and System," which outlines the shop system used in its plant. Placed on the outside of the booklet is a sticker calling attention to the A. S. M. E. convention in Cincinnati, May 21 to 24.

Since both the A. S. M. E. and the National Machine Tool Builders conventions are to be held in Cincinnati at the same time an unusual effort is being made to obtain a record-breaking crowd that will be amply entertained.

Some Problems in Selecting Help

By E. F. Henry

SYNOPSIS—Help is too often selected in a perfunctory and hurried manner, and by persons who are ill-fitted for the work. While no one is infallible when it comes to selecting the right man for the job, the cost of changing help is frequently great enough to warrant paying a man whose knowledge of human nature and sympathy with the problem fit him for the task.

When I was a small boy I conceived the idea that if a youth was named George, he was necessarily fat, and that if his name was Fred, he was slim. My ideals were all named Harry. Today, our ideas of the suitable kind of men to work in our shops are based on similar reasoning, with the difference that we see many Georges and more Freds, but not enough Harrys. We have had bad luck with several red-headed men, therefore we hire no more until they have their hair dyed. We had excellent success with a man whose ears stuck out like sign boards, consequently we watch out for men possessing this characteristic. Being predisposed to see these men successful, we go out of our way to make them so, or we fool ourselves into thinking that they are all right, even though our friends know that we are doing all their work ourselves.

On the other hand, we do not give quite so good a chance to the man whom we think destined to fail, because we once knew a failure who looked like him. Even though we get up in a conference and tell other people that every man is entitled to an opportunity, and that there is good in every one and it is our duty to bring it out, we do not live up to our speeches.

The Value of Tests

It is the reaction from this selection by bias that has made otherwise sensible and level-headed business men look to psychological tests to provide a means of selecting the right man for the right job. It is the same thing that leads the college professor to substitute percentage marks, based on examinations, for personal judgment. He knows his judgment is not much good, and he does not expect the pupil or his parent to have any better opinion of it than he has himself. The result is that he resorts to records to which he can point and say: "See, on Friday the thirteenth your son took an examination on which I could not possibly give him more than 10 per cent. Averaging this with my very high personal opinion, which I have set down here at 90 per cent., he failed to pass by 15 points." In like manner we are looking for some scheme of examination by which we will be able to say to an applicant for a position, "You see, my dear sir, your mark based on the psychological test is only 49 per cent., while we have a very rigid rule that requires at least 50 per cent."

I have no doubt that we will yet arrive at that stage, because I have unlimited faith in the foolishness of this little old world. It seems to be necessary for us to hide behind unintelligible excuses and unintelligent methods of making up our minds about abstract things. We have made fun of women for so many years for settling all weighty matters offhand, and giving as the reason the simple word "Because, that we are ashamed to acknowledge we have no better excuse for the various hunches and other obsessions that really determine our course of action. So I expect to see the time when every one of us that wants a job will get it by a sort of civil-service examination that will have even less apparent connection with the things we are to do than the Government examinations have now. When this time comes those few who have a faculty of remembering disconnected and inconsequential information will get the jobs, and the poor devil whose only qualification is his ability to do the work will have to take the leavings.

Testing Mental Alacrity Instead of Skill

This is really what the psychological test means, for it can only test the mental alacrity of the victim. A man who likes to play solitaire, or who is given to speculating on the number of stars in the heavens, can interest himself in counting the o's and i's in the Declaration of Independence, while the man who can inspect armature shafts to a fraction of a thousandth can hardly bring himself to take up seriously the task of sorting cards to determine his ability to do what he may have done for years.

In the meantime, we have to go on hiring men by some sort of hit-or-miss scheme, and we like to make hits as often as possible. Like most of the faults of business men, we have no method of tersely stating our opinion of other men, and we have made no analysis of our opinions of them. What follows is simply an attempt to express in words what we have really done for years in sizing up men by the common, or horse-sense, method.

The first thing we all desire to learn is the attitude of the applicant toward work. We have a holy horror of the man who only comes out after a job when his wife gets after him with the broom. We might like to hire his wife, but not him. Then there are the men who are certain that the world owes them a living and who do not want to even pay the cost of collecting the bill. On the other hand, there are many men who find themselves happiest when they are working hardest, and we hire them even though we know that they will work up out of the job we put them on a little sooner than we might like.

How can we discover which class the applicant is in? Ask him; not the direct question, but get him to tell you all about the jobs he has been on and why he got through in each place. A man who has only left one job to go to a better one, or because of failure or reorganization of the company, is likely to keep his habit. If he has floated about aimlessly, however, he cannot always be condemned. If he is a young fellow, he may be traveling to see the country, and the influence of some one shop may be the means of making him settle down into a much more contented state than many who have never been outside the town they work in. Then, too, a man who thinks the world owes him a living is likely to give it away in conversation.

We may say to ourselves that all we require is a man who can do the work we want done, but if we stop to think we know we have often failed to get full value from men of unquestionable ability. A divided interest or

lack of any interest at all is worse for our pocketbooks than lack of knowledge or experience. That leaves the second thing on our list, knowledge of the work and training for it.

Modern organization is rapidly getting us away from the trade idea. We will always need a few men who possess knowledge of a complete trade, but they will be in the shops where our special machinery is developed or our repair work done rather than in manufacturing departments. Competition will not allow us to manufacture with men who can turn from one machine to another and who can build a machine all the way through from start to finish. The natural outcome of this is that the semi-skilled operative is coming into his own. We require men who can learn to do some one thing quickly. The fact that he has worked on similar work for one of our competitors does not weigh so heavily in our minds as it did, because we are pretty sure that our way of doing the job is better, and we know it is usually harder to teach an old dog new tricks than a young one.

Test of Mental Ability Valuable

Some little test of mental ability is often valuable because it indicates whether he can comprehend instructions or not. The average foreigner, recently arrived in this country, will say "Yes, yes," to everything that is said to him unless he thinks he is in wrong, when he will shut up like a clam. But if he is told to go somewhere and sit down, or if in the physical examination he is told to take off part of his clothing, or to stand on the scales, or to cover one eye and look at a card, the person who gives the instructions gets a pretty clear index of the man's mental activity if he makes due allowance for his lack of acquaintance with the language.

When we have determined whether or not he will work if we hire him, and whether he is able to do the work we have in mind, or is capable of being taught, we want to know what the chances are of his being loyal to the company. Of course, we intend to treat him so well that he ought never to have a thought of leaving us, but we know that the average man leaves whatever job he has oftener than once a year no matter whose shop he is in. We also know that a man who damns the last shop he worked in will very like do the same to our shop when he leaves us. We would like to have men who do not condemn every shop out of hand, because they will not be so likely to make hasty judgment as to our intentions. Consequently, we sometimes lead a man on by a few questions to unburden himself as to his previous relations and give him a chance to tell us what rotten shops he has worked in in the past. We ought to make a little allowance, however, because men often think that we like to hear our competitors run down, as possibly some of us do.

In many places initiative is worth money. In others we know that men of good initiative will not stay. We all have jobs that we wish we did not, and that we are ashamed to ask people to take, and we know that no matter how monotonous they may be there are always men who want them and will take them in preference to anything that calls for responsibility or thought, or initiative. They do not want to be promoted. They expect a little increase in pay from year to year, and they are worth it, because they give the employment manager nothing to worry about.

It is more difficult to pick out the man who will go ahead on his own responsibility than to discover his capacity for work, but a little inquiry as to what he does in his own time will uncover any disposition to venture into a new field and to stick to it. Almost any man will admit having started a garden, but the proportion who have carried it through and have actually harvested more than they put in the ground is small. Men who build furniture at home in the evening or who take correspondence courses and stick through them are likely to be willing and anxious to start something for the firm. Initiative also shows in the way a man makes out an application blank or answers questions. The man who goes ahead and fills in a blank as he thinks the author intended or who anticipates questions by stating his case completely is pretty sure to be a man of some pep in other things as well.

Then there is courtesy. To be sure we do not care to have our shops operated on a five-o'clock-tea basis, but we all hate to have a grouch around. That is really all that discourtesy means. One man can say almost anything that comes into his mind in a shop and get away with it, provided everyone knows that he is square and does not carry ill feeling over night. Even the man who flies in a rage because someone breaks a belt pole can get away with it if he is impartial in his tirades, and if he does not do more than blow off steam. The kind of discourtesy that cuts is the kind that nurses imaginary grievances, talks behind the boss' back and sneers at everything and everybody.

This is the one thing that seldom shows when a man is looking for a job. If he is ever on good behavior that is the time. Whether one is justified in making some slurring remark that will bring fire to the surface or not is questionable. For a time I thought that if a man could see a joke he could not be discourteous enough to do any harm, but I am not so sure of that now. However, the combination of a joke and a look at his eyes gives one a pretty good chance to guess correctly. The eyes tell more than most people think. A man with a quick, active eye that seems to drink in what you say is almost certain to have something worth while in him. I say "almost" advisedly, for I have been badly fooled at times by not distinguishing between a quick eye and a roving one. When a man cannot direct his gaze, but keeps looking all about, he may be nervous or he may be suspicious. Suspicion does not make for loyalty, because the suspicious man cannot drop his suspicions long enough to consider the point of view of the firm he is working for.

Abstinence, Moderation or Souse

Another thing that we all want to know about is sobriety. It appears that this should be determined by the examining physician if there is one, but the doctors tell us that we are just as well able to discover anything less than a case of delirium tremens as they are. Of course, the man who is so thoughtless as to come in with a breath that you can hang a hat on is out of the question, but there are many men who have periodic souses who show no ill effect between drinks. If it were not for the loss of profit on their work while they were keeping up their reputations we might like to have them. Even then I recall one planer hand that managed to come in every day and turn out more work than any other man I ever had, though he was not out of the influence of liquor for

a minute during three months. Fortunately, that was in the days previous to workmen's compensation. Now we would not dare let him come in to work. Most men, when they are asked if they drink, will say no without compunction. But if they are asked in a matter-of-fact way, "You take a glass of beer occasionally, don't you?" they will cheerfully admit that they do unless they are total abstainers.

Another matter of interest is the man's willingness to improve. A man who has been in this country for two or three years and has never made any effort to learn to read English is not likely to make a serious effort to do more than be around on pay day. If he has read or studied anything, no matter what, it indicates an attempt to make more of himself. If his efforts were wrongly directed, it should be possible for us to redirect them so that he and ourselves will be the gainer. As a matter of fact few men who show no signs of self-improvement ever get the maximum wage in the job for which they were hired, and almost none secure promotion to better jobs.

It takes some little time to write this analysis, but as a matter of fact these are the things that flash across the employer's mind while he is looking a man over. No set list of questions will bring them all out, nor will the answers show in a man's physiognomy. The same man questioned on two different days will not respond in the same way, which is right, for he is not alike on any two days. Nothing serves better than to sit down and talk with the applicant until his mind is at rest, his fears and suspicions lulled, and he is ready to do his part to sell you his services. Questions which appear to him to be personal can be asked in such an impersonal way that if he is possessed of any initiative at all he will answer. This takes time, but is it not worth a little time to find men who will stay longer than the six, eight or ten months that the average worker now remains on any one job?

Making a Six-Throw Model Crankshaft

BY HERBERT M. DARLING

SYNOPSIS—In building the experimental model of any new machine the machine methods used generally vary considerably from those used when production is started. This article tells how a six-throw crankshaft for an automobile motor was machined from the solid.

One of the most interesting departments of an automobile factory is the experimental, or model, room. A good many problems that call for considerable mechanical skill and judgment in their solution arise there. Many intricate parts of an automobile, which will later be manufactured in large quantities with special equipment, must be made up in a hurry, using standard machine tools. Many steel parts that will later be forged in dies must be cut out of solid stock or else forged to shape from the bar.

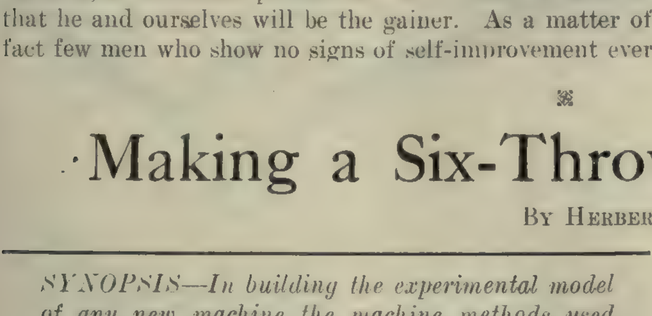


FIG. 1. THE COMPLETED CRANKSHAFT

The largest and at the same time the most important steel part in the automobile is the crankshaft. Most manufacturers use a hammer forging for an experimental crank with four throws, but it is a different proposition when it comes to a six-throw crankshaft. It is extremely difficult to get a forging, without excessive stock, which will "clean up" at all points. Consequently, an experimental six-throw crankshaft is made from solid stock.

Some time ago I made a six-throw crankshaft for the first light-six model built by one of the large automobile manufacturers in the Middle West, and I will attempt to give an idea of the different operations involved. In Fig. 1 is shown the completed crankshaft. It will be noticed that there are four bearings, *A*, *B*, *C* and *D*. The total length is 38⅝ in., and the throw is 2¼ in. with a plus or minus limit of 0.005 in. All bearings have a diameter limit of 0.001 in. and a length limit of 0.002 in. The bearing *C* has flanges of large diameter and is designed to take the end thrust. In Fig. 2 is shown the bar of stock used. Its dimensions are 7¼ in. in diameter by 38½ in. long; weight, 450 lb.

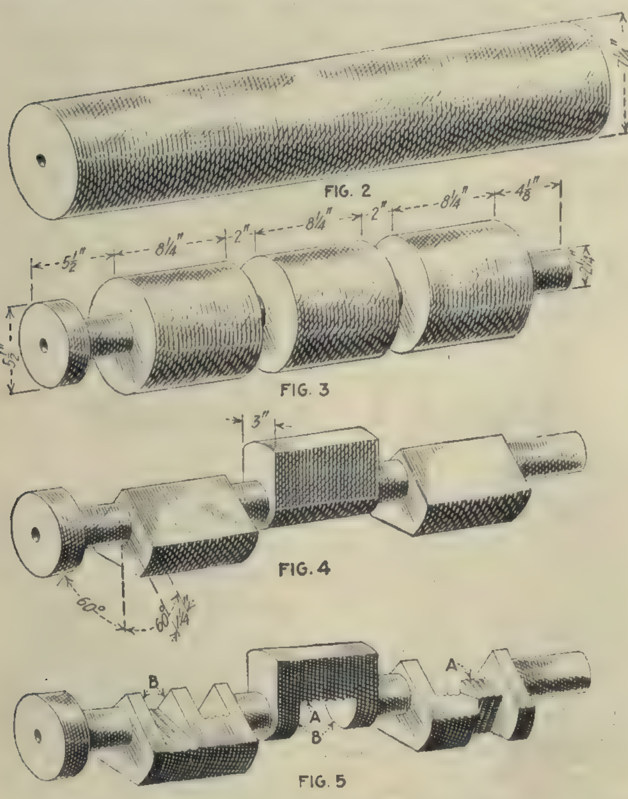
A pair of good-sized center holes were drilled in the ends and countersunk with an electric hand drill. The bar was then mounted in a 20-in. lathe, a light chip taken off the outside and the bearings roughed down to 2¼ in. in diameter as shown in Fig. 3. The outside was turned fairly smooth and coppered with blue vitriol, after which it was laid out and planed between centers to the dimensions shown in Fig. 4.

The position of the crankpins and the arms was then laid out, and holes were drilled at *A*, Fig. 5. Sawing into these rows of holes was found to be impossible on the miller, so I was obliged to use a large cold saw. It took much makeshift blocking to hold the piece in the various positions necessary, especially when making the angular cuts, but this method seemed to be about the only way to handle the work. At this point it will be noticed that the bar of stock has begun to assume the rough outlines of its finished shape.

The next operation was to turn the flywheel flange and the bearing *A*, Fig. 1, to fit the triple center throw-blocks, Figs. 6A and 6B. The work was mounted on V-block angles, Fig. 7, on a large surface plate, and the throw-blocks were fitted to them. It will be noticed that the three centers in each block are hardened and ground plugs with 1-in. heads. These heads projected so that a height gage could be used to line them all up properly, after which the screws were securely tightened and the crankshaft was placed between centers of the 20-in. lathe. The crankpins were then roughed to ⅛ in. oversize, the work being successively swung between the three

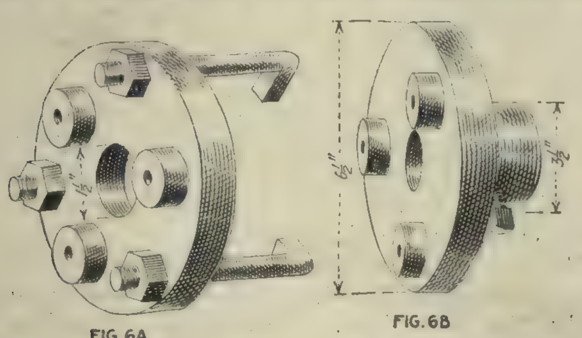
different pairs of centers. The bearings *B*, *C* and *D* were then rough-turned and the throw-blocks removed. The arms, or cheeks, were roughed to $\frac{1}{8}$ in. oversize, the shaper being found the most adaptable for this work.

The next operation was to anneal the crankshaft to remove strains before finishing. The work was placed in an oil-fired furnace. Care was taken to pack up under each pin and bearing, to prevent sagging. The piece was heated to a dull red and allowed to cool overnight in the furnace.



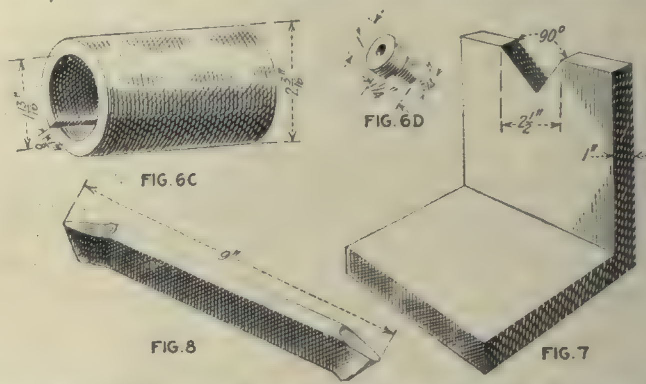
FIGS. 2 TO 5. VARIOUS STEPS IN THE MACHINING OPERATIONS

In the morning it was prepared for the finishing operations. The flywheel flange was turned to fit the smaller bore of the throw-block, Fig. 6A, $5\frac{1}{16}$ in. The bearing *A*, Fig. 1, was turned to $1\frac{13}{16}$ in. This diameter was fitted to the throw-block, Fig. 6B, by means of the bushing, Fig. 6C. The bearing *D* was turned to the same diameter as *A*—that is, $1\frac{13}{16}$ in. The crank was then mounted in the V-irons, Fig. 7, and the throw-blocks were properly adjusted, so that the $\frac{1}{8}$ in. of stock on the crankpins was evenly divided. It was then mounted in the lathe, and the flanges at both ends of each crankpin and bearing were finished to size. This gave me something definite to work to in the next operation, which was to plane and mill the webs to finished size. As it now stood, the crankshaft was of the same dimensions on the webs and bearings as its drop-forged duplicates would be when manufactured in quantities later.



FIGS. 6A AND 6B. THE THROW-BLOCKS

The crankpins were finish-turned to size. This operation was the one that caused the most trouble. Although the lathe was carefully counterbalanced and was run on the slowest speed, it was found nearly impossible to turn the crankpins round. The ones in the middle did not cause so much trouble, but the ones on the ends of the crankshaft were oval to the extent of about 0.0015 in. This was corrected by "whipping" off the two opposite high sides with emery cloth. I used a 20-in. Hendey lathe and ran on slowest speed, but found it advisable to have a feed that was not too fine, as an extremely fine feed caused chattering.



FIGS. 6C TO 8. SOME OF THE DEVICES MADE USE OF
Fig. 6C—The bushing. Fig. 6D—The bearing. Fig. 7—The V-irons. Fig. 8—The turning tool

Every pin had to be polished dead smooth, as even a small file mark might tear the babbitt bearing in the connecting-rod. This may seem like mighty slow work to the reader, but it was impossible to finish a crankpin complete in less than four hours. It must be remembered, however, that I had to go at the work very carefully, especially while forming the $\frac{1}{8}$-in. radius in the corners. Moreover, in filing and polishing and from the shape of the crank it was impossible to get the steadyrest close enough to the turning tool to be of much service.

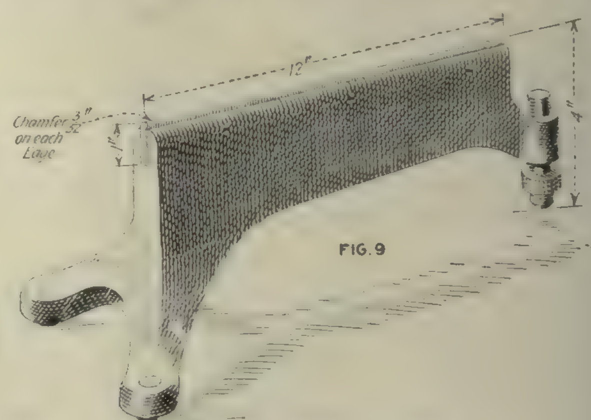


FIG. 9. ONE OF THE BALANCING WAYS

The turning tool is shown in Fig. 8. It is double ended and by reversal may be used for finishing both ends of a crankpin. For roughing I chose a high-speed turning tool, but a smoother cut was obtained with a

carbon-steel tool. As each pin was finished, I covered it with friction tape, to prevent injury to it. I turned the bearings B and C, Fig. 1, and was then ready to balance the crankshaft, using balancing ways, Fig. 9, which I had made for the purpose. The crank was balanced by turning down the counterweight, Fig. 1, until it was in balance. The bearings A and D, the flywheel flange and the oil collar were then turned to size, the thread and keyway cut in the end A, Fig. 1, and bolt holes drilled in the flange for attaching the flywheel. This completed the crankshaft. The weight, when finished, was about 42½ lb.. and the time required was 300 hours. After the manufacture of these cranks had been put on a production basis, the actual working time required to finish one was less than 3 hours, all crankpins and bearings being both roughed and finished on a grinding machine built for this specific purpose.

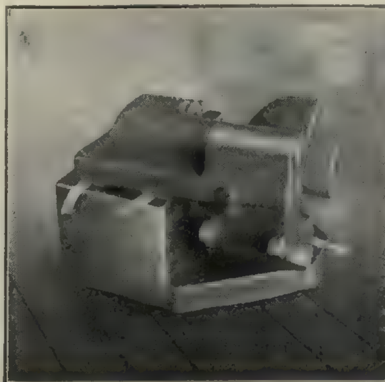


FIG. 3. SURFACE TESTING

FIG. 4. TESTING ALIGNMENT

Machining a Gear-Shaper Bracket

By H. C. Miller

The machining of the bracket that carries the depth and rotary feed mechanism of the No. 6 Fellows gear shaper presents several features of interest. The first operation on this piece is on a No. 2 Cincinnati vertical miller, milling the surfaces A, B, C, D and E, Fig. 1, which clamp to the bed, also the small boss F on the opposite end of the casting, which serves as a locating surface for the subsequent operations. The accuracy of the surfaces milled is tested on a surface plate, shown in Fig. 3. It is essential to have all surfaces milled flat and in correct relation to the spot F, to avoid warping the casting when clamping in the second milling operation or in the boring jig.

After it has passed inspection, the bracket is milled for the cap on a No. 2 Cincinnati horizontal miller. It is clamped on the milled surfaces. It is then drilled and tapped for the cap. With the cap assembled to the bracket, as shown in Fig. 2, it is placed in the drilling and boring jig, Fig. 1, clamped down on its milled surfaces, which are used for clamping to the bed, and on the locating spot on the end. It is located sidewise by the side surfaces of the spots F and A.

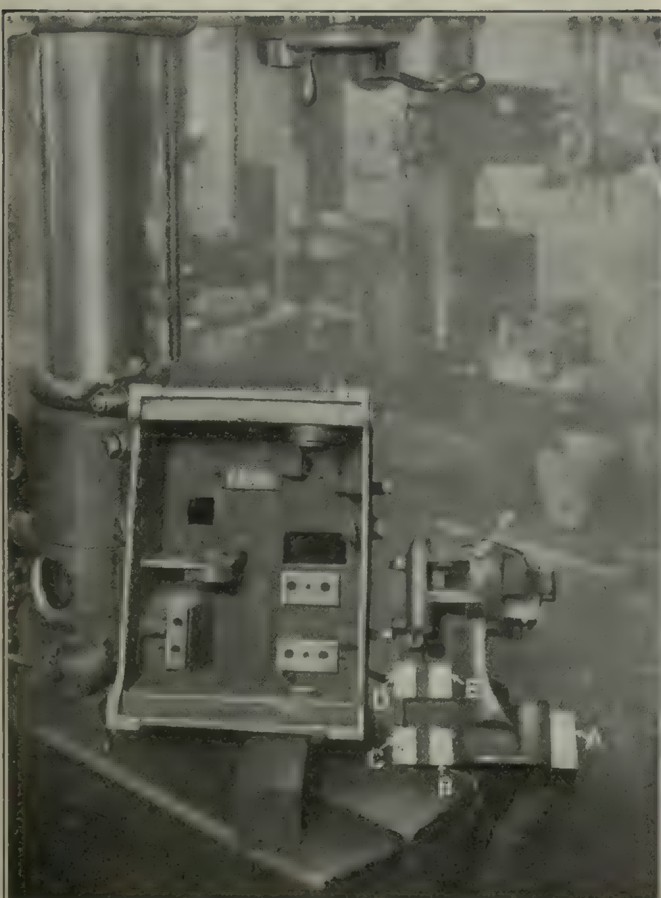


FIG. 1. THE FIRST MILLING OPERATION

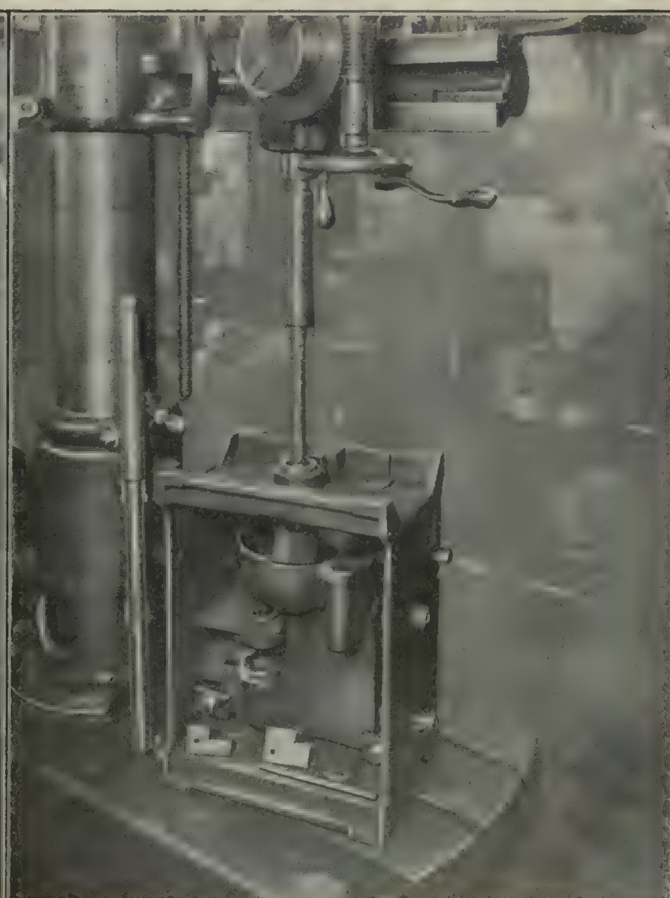


FIG. 2. THE CAP AND BRACKET ASSEMBLED

The shorter of the two $1\frac{1}{8}$-in. holes carries the rock-shaft, which by oscillating operates the cutter slide in the saddle, while the longer $1\frac{1}{8}$-in. hole is for the lead screw and dial. These holes are first drilled on a 3-ft. American radial with a core drill, followed by bars supported on each end, the boring bar carrying two cutters and the reaming bar carrying two Kelley reamers, thus finishing the top and bottom holes simultaneously.

The facing to length of the bearing surface for the rock-shaft gear, the lead-screw nut and the feed ratchets are gaged from hardened-steel surfaces on the jig. The two 1-in. holes carrying the ratchet feed mechanism are bored and reamed in this jig in the same manner. After the boring and drilling operations the bracket has the hubs turned on the engine lathe, and other unimportant operations are performed. It is then assembled complete and put into stock to be ordered out and assembled on a machine.

Machining the bracket in this manner, as may be readily seen in Fig. 4, brings the holes in alignment with the tracks of the bed; and as the saddle is bored in jigs that reproduce these same surfaces, there is no difficulty in assembling.

Plate Patterns

By A. E. Holaday

Mr. Duggan's article on page 300, regarding plate patterns and suggesting the exchange of ideas along this line, is of interest to me. For the benefit of the pattern-maker I give what information I can about the making of these plates. This information applies more particularly to very small castings and accurate work that must be true to pattern, where the orders are for a large number of castings.

There are many ways of mounting patterns on plates. They can be placed on wooden match boards, fastened to metal plates, or gated in the regular way and a cast-aluminum plate made from them. The latter method is used preferably for very small work where a large number of patterns are in a mold. The objections to mounting patterns on a wooden match board are many. The board is liable to warp, and the patterns to shake loose; if the board is put away in a pattern safe, it is apt to gather dampness. It is also impossible to mount all kinds of patterns on a wooden match board; however, for large heavy work this method may be preferable.

The thickness of the wooden match board is another objection, owing to the fact that, if the flask pin is the least particle out of place, the casting will have a seam along the parting line. This is more pronounced where a wooden plate an inch or more in thickness is used.

To mount patterns on a metal plate is a very easy matter, especially where each of the patterns is made to draw; that is to say, where it is not necessary to split the patterns. To increase the life of the finished plate, the patterns should be fastened with rivets placed in a diagonal position, as a straight rivet soon pulls out or becomes loose.

In placing a split pattern on a metal plate, the two halves of the pattern should first be put together with parallel dowel pins at right angles to the split and long enough to extend through the plate and into the other half of the pattern, thus insuring the lining up of the two halves. These should then be fastened with diagonally placed rivets.

It is also advisable to make sheet-metal leaders, secure them to one side of the plate and fasten the gate to the opposite side of the plate so as to connect with the leaders. Large-head rivets are used for this operation, as the head of the rivets can be left on to make a more substantial or lasting job. The most satisfactory and up-to-date method is to make aluminum cast pattern match plates.

Special Flask Necessary

For this method the patterns are made in the regular way and gated, allowing for the usual aluminum shrinkage of $\frac{3}{16}$ in. per ft. The patterns are placed in a specially made flask about 2 in. larger all around than the plate to be made. This flask, besides having the regular flask pins, is equipped with four or more thumb-screws set into threaded sockets on the cope side of the flask.

The patterns are placed in the mold in the regular way, and a good clean match is made, care being taken to have the parting line very true. On round or oval patterns this must be in the center, or the castings will have a seam. This parting line is the most essential part of making the plate, and too much care cannot be exercised.

The next operation is to make countersinks or indentations wherever possible, about $\frac{1}{4}$ in. in depth. This is to prevent the mold from slipping or shifting. Then the cope is rammed up in the regular way; and when this is completed, the adjusting screws or thumb-screws come into use for raising the cope from the drag in a very careful and easy manner.

After the cope is raised clear of the patterns, the flask can be raised in the regular way. Then an iron form the thickness of the plate desired, usually $\frac{1}{4}$ in., is placed in position to form the outside of the plate. This can also be accomplished by the use of flat cores in place of the iron form.

In making this form, stock should be left to make a handle about 3 in. wide and 3 in. long on each end, with an opening for the flask pins and also for mounting a flask-pin guide. The pattern is then removed from the drag. In the heavy parts of the mold, large-head iron nails or rivets are placed in the openings left by the pattern, to prevent the aluminum from shrinking. The iron form is then placed in position, the cope replaced, and the mold is ready to pour.

Advantages of an Aluminum Plate

The advantages of a cast aluminum plate are many. It eliminates the danger of the patterns becoming loose; the plate is lighter to handle and allows larger production, in most cases fully 20 per cent. The indentations, or countersinks, are easy to make, and a pattern of any kind can be successfully placed on this form of match plate.

Great care should be exercised in melting the aluminum, which should be kept covered with charcoal when in the crucible and poured when it is a cherry-red color and has a greasy appearance. If allowed to become too hot, a porous surface will be the result. In making patterns for plates, allow all the draft possible to insure good clean castings, as the amount of rapping or vibrating is very limited on plate patterns.

The Human Factor in Industry—I

By Luther D. Burlingame*

SYNOPSIS—The author points out the value of the human element in industry, as indicated by the skill, efficiency, health and contentment of the working force. Today America stands at the parting of the ways—one road leads to paternalism, the other to self-reliance. An outline of the social problems in process of solution by, or confronting, American manufacturers.

At the annual meeting of the American Society of Mechanical Engineers, held in December, 1916, a subject for discussion given a prominent place on the program was "The Methods of Obtaining Inventory Values of a Manufactory." Besides the tangible-property values considered, some attention was given to the value of organization and system as an asset; but the value of the human element, as indicated by the degree of skilled efficiency, health and contentment developed in the working force, was not mentioned.

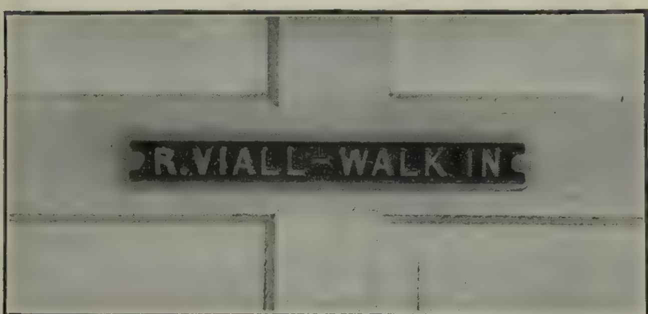


FIG. 1. OFFICE NAMEPLATE OF R. VIALL WHEN SUPERINTENDENT OF BROWN & SHARPE

A complete inventory would necessarily include the value of the human element as one of the most important assets of any manufactory—an asset that would be seriously diminished in value by an undue turnover or reduction of the force. This asset is increased by the stored-up experience in the working force, with its acquired skill; and when this is coupled with organized justice on the part of the management, it results in the kind of coöperation from which we can, under modern conditions, expect the most satisfactory relations between employer and employee.

Charles M. Schwab says of the Bethlehem Steel Corporation, "Bethlehem's biggest asset is not its rolling-mill plants, its big guns, its armor works, its rail mills—it is the men who make up its enthusiastic organization"; and Andrew Carnegie once said that his success was due, more than to any other one cause, "to the men he could get around him" (not "to the men he could get around," as he was wrongly quoted in the papers at the time).

Prof. F. H. Newell, former director of the United States Reclamation Service, speaking recently before the Providence Engineering Society on the work of carrying through to completion the great dams and other engineering enterprises for irrigating the desert lands, said that, great though the engineering problems were, the greatest problem of the engineers was that of dealing with the human element and that after all it was this on which the success or failure of the vast projects hinged, while F. C. Henderschott, of the New York Edison Co., says, "The modern employer is coming to realize that his true monument is not a great factory, but is a great, efficient, loyal, happy organization."

The radical changes in shop management looking to increased efficiency and the recent growth to great organizations have within the last generation completely changed the problem of dealing with the human element.

The Spirit That Brings Close Association

On the door of the superintendent's office in the old Brown & Sharpe shop the nameplate read "R. VIALL—WALK IN" (see Fig. 1). This is still remembered and commented on by workmen and by visitors to the shop in those days. It was typical of the relations existing between the men and the management, and the spirit back of it was one of the important factors in the growth and success of the business. It was the close association of the superintendent with the men which brought this result—a relation by which his personality was impressed upon them and their interest stimulated, also grievances, real or imaginary, given a hearing and adjusted before rankling into open sores, which often give trouble even after apparently healed.

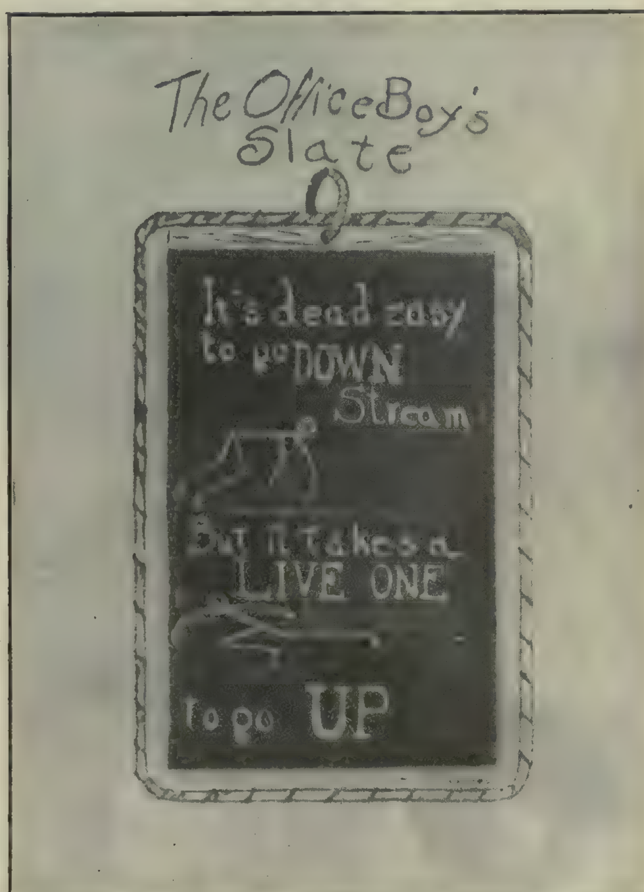


FIG. 2. DIFFERENCE BETWEEN CHARACTERS AS PICTURED BY A CARTOONIST

*Industrial superintendent, Brown & Sharpe Manufacturing Co.

When a business, either in its growth or on account of its method of organization, passes the point where personal contact with all the men is possible, it is important to supply a substitute—a substitute more effective than is usually supplied through the dealings of the men with their foremen or subforemen.

A recent series of editorials in the *American Machinist*, treating of some of the human problems of the shop, points to many organized methods of reaching the desired result in both small and large shops—methods that can go more to the root of the needs of the workmen than can unsystematized personal work, no matter how well intentioned.

One of the greatest dangers, however, arising whenever steps are taken to systematize such work, is that of having the human factor lost sight of in the system and thus, by forgetting or ignoring the workman and his personality, to lose the very advantage sought.

Too often such methods, adopted arbitrarily by the management, seem to thrust benefits in the workmen's faces, "like a gauntlet with a gift in 't," or so to paternalize what is done for the benefit of the employee as to undermine the fine qualities of independence, thrift and initiative, and may, while doing a certain amount of good in relieving suffering and distress, become a palliative only and, like some forms of charity, grow on one's hands in proportion to the giving, making the conditions worse the longer the method is pursued.

Dr. Royal Meeker, United States Commissioner of Labor Statistics, says that such methods may transform the workman into "a mere spoon-fed mollycoddle." But he goes on to say that he would rather see "a race of sturdy, contented, healthful mollycoddles, carefully fed, medically examined, physically fit, nursed in illness and cared for in old age and at death," than to see an independent, self-reliant race, a majority of whom became submerged in the struggle of life.

It may be contended that it is because a people, through easy living, low morals, immigration, lack of thrift, etc., lose their qualities as "an independent, self-reliant race" that there is danger of their becoming submerged or that there is need of treating them as "spoon-fed mollycoddles" and that the remedy lies, not in so treating them, but in preserving or restoring the finer qualities—qualities well exemplified by the "live one" in the cartoon by the artist of the Eastman Kodak Co., "The Office Boy's Slate" (see Fig. 2).

In this matter of industrial service America now stands at the parting of the ways as to which of these methods to pursue, and it becomes more than a matter of expediency or of profits, as to whether one path or the other should be followed; it becomes a matter of statesmanship, involving the prosperity and future happiness, not only of the employees, but of the American people.

FIG. 3. FOUNDRY LOCKERS, BROWN & SHARPE MANUFACTURING CO.

It is the purpose of this article to discuss these divergent methods in the light of past experience and present tendencies, with a view to throwing light on the path that should be followed so as best to conserve the human element in American industry.

Assuming that the importance of the human element is recognized and that its conservation and development along lines of efficiency are acknowledged to be of prime importance; assuming also that the inadequacy and inefficiency of old methods, such as have been ordinarily employed, are admitted, the question becomes one as to how to deal with the problem in ways best suited to the spirit of America and the present and future needs of American industry, including the conservation of the rights and interests of both employer and employee, regardless of what may have proved a success or failure with peoples of different training and traditions and living under other forms of government.

A familiar saying of one who had a keen insight into human nature—Richmond Viall, to whom reference has

already been made—was, "Every man is just as lazy as he dares to be"; and because there is so much of truth in this saying, the danger becomes the greater when the manufacturer sets out to do for his employees those things which they can and should do for themselves. This may be controlled to an extent from above in an autocratic or communistic government, and workmen may be forced into paths leading toward the desired end; but it does not seem that such methods are suited to the American people. Even under the former type of government the results are of questionable value. This was pointed out by Edson S. Lott at the recent meeting of the American Association for the Advancement of Science, when, in speaking on the question of "Compulsory Social Insurance," he said that social insurance abroad had so encouraged sloth that "not even the iron discipline of Prussia had driven out from insurance benefits those who are willing—more, grow accustomed—to depend upon the Government as a child depends upon an indulgent parent"; and he further aptly says, "Free and individualistic America should be shown before it is shorn." It is perhaps because I have been brought up in the atmosphere of Rhode Island—the state of Roger Williams, founded on individualism and having that element so strongly developed—that I see so much of objection and even danger in any program looking to paternal oversight on the part of the manufacturer or state toward the American workman. True, we have a large element to deal with, not native American and without American traditions; but should we not educate and train these aliens to our ideals, as we do in our language and political system, adapting the industrial service of our factories to the spirit of American institutions?

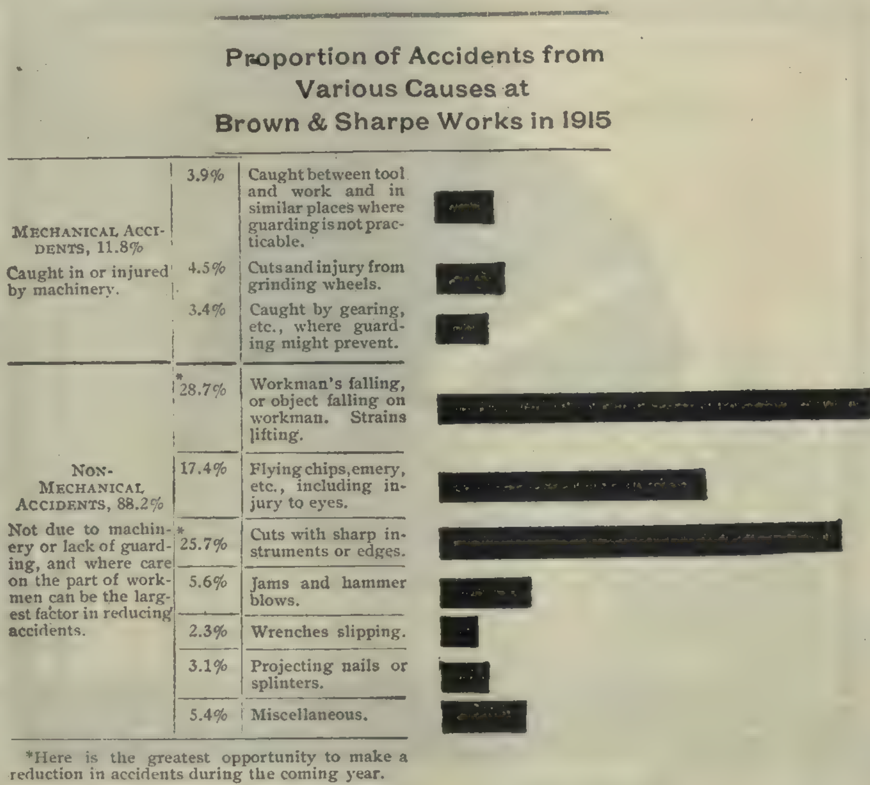


FIG. 4. GRAPHIC METHOD OF VISUALIZING ACCIDENTS AS TO KIND

Herbert Kaufman, in the January *Cosmopolitan*, discussing the factors of success in the lives of some of the greatest characters of the industrial world—men who had to go through struggle and privation in early life and who without doubt would not have accomplished noteworthy results without this stimulus—well says: "Folks whose needs and comforts have all been anticipated lack the incentives which stimulate the barehanded to maximum endeavor"; and Dr. Otto P. Geier, quoted in the editorial in the *American Machinist*, Vol. 45, page 1049, tells of the failure in this country of many attempts at so-called "welfare work." because the employer undertook to provide arbitrarily for the workman's needs. He says:

> These have failed deservedly, because as a rule the supposed benefits have been superimposed upon the group of workers, requiring and asking no service on their part. The average American workman is suspicious of an employer "bearing gifts." This same average American workman, however, is keen enough to engage coöperatively in any undertaking that is frankly advanced by the employer as a mutual advantage.

In this statement Dr. Geier has struck the keynote of true industrial, or as he calls it, employees' service, work, for here is a point of contact presenting problems in the solution of which lies the great hope of developing coöperation and a satisfactory understanding between employer and employee to their mutual advantage. Some of these problems that are either in process of solution or now ahead of us for consideration are: 1. Those dealing with the physical comfort and protection of workmen: (a) The sanitary condition of work places—light, air, water, toilets, etc.; (b) safeguarding and first aid in case of injury; (c) medical supervision; (d) lunchrooms; (e) recreation. 2. Provisions for financial help, aside from wages: (a) Sickness and death benefits—compensation; (b) investment and insurance; (c) loans. 3. Provisions for education and to develop character—to strengthen the moral fiber: (a) Apprenticeship-school instruction; (b) discipline—rewards and penalties; (c) the drink question; (d) cultivating loyalty and citizenship. 4. Hiring employees: (a) Employment departments; (b) the "turnover" of force.

Provisions for Physical Welfare

The problems dealing with the sanitary conditions, such as light (both natural and artificial), fresh air (at the correct temperature and without undue drafts), pure drinking water and sanitary toilets, are largely in the hands of the manufacturer and to some extent under the control of state laws, yet even here much can be done through coöperation on the part of the workman to secure the full benefits. If there is not such coöperation, it should be a matter of education and discipline to secure it.

It is a rule of the Brown & Sharpe foundry that men shall clean up before leaving the works. Lockers and shower baths, Fig. 3, are provided, so that the enforcement of this rule is no hardship. I recently heard of a

shop (it may have been a foundry) where provision was made to enforce cleanliness by making it necessary for the workmen to go through the shower baths before they could reach their street clothes.

When it comes to safeguarding, the responsibility is largely with the workman, as it has been repeatedly shown that a large proportion of the accidents are nonmechanical. An analysis of the accidents at the Brown & Sharpe works during the year 1916 showed that only 14 per cent. were mechanical, while 86 per cent. were nonmechanical. Among the mechanical accidents were 5 per cent. where the workmen were caught in gearing, belting, on setscrews, etc., and 9 per cent. where they were injured by cutters, grinding wheels or other tools, or caught between the tool and work, or in similar places, where guarding is not practicable. Under nonmechanical accidents were 27 per cent. from workmen falling, or objects falling on the workmen, and strains in lifting; 26 per cent., cut with sharp instruments or edges; 15 per cent., injuries to the eyes; 5 per cent., jams and hammer blows; 3 per cent., wrenches slipping; 3 per cent., projecting nails or splinters; besides miscellaneous. To visualize such accident records so as to make the meaning plain to workmen is one of the methods of education (see Figs. 4 and 5).

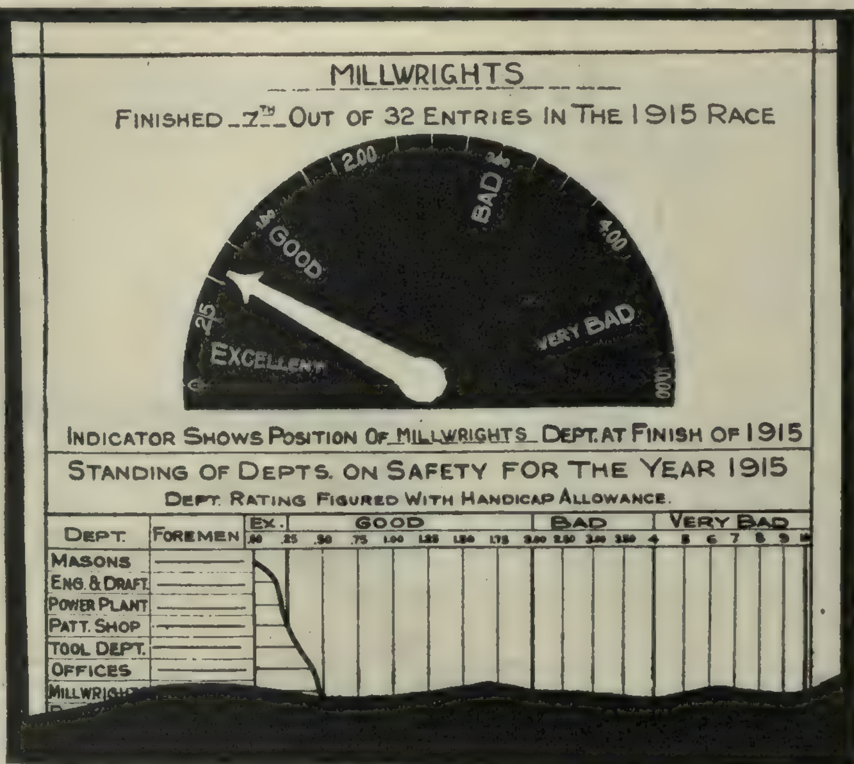


FIG. 5. GRAPHIC METHOD OF SHOWING ACCIDENTS, ARRANGED BY DEPARTMENTS

Even though a large majority of accidents are due to thoughtlessness or carelessness on the part of the workmen, it is being found that even these can be materially reduced and should not be classed as unavoidable.

It is still common to hear superintendents and foremen speak of accidents as being due solely to "carelessness" on the part of the workman and "unavoidable" on the part of the management. The same type of superintendent and foreman would have said the same about the accidents in the shop where "Chordal" once worked (see Fig. 6). He says in his "Letters":

> I once worked in a shop having open hatchways through the center of the building. I worked nearly under the hatchway, and never a day passed but something came tumbling down into the space supposed to be reserved for my operations. Today it would be a monkey-wrench, tomorrow an oil can, or a dinner bucket, or a lathe chuck, or an apprentice, or most anything.

Regardless of the responsibility for or the cause of accidents, it is now well established that the great burden of industrial-accident expense should be shared by the manufacturer as a hazard of the trade.

These responsibilities put it strongly up to the manufacturer not only to provide in all practical ways to prevent accidents, but also to provide efficient and adequate "first-aid" departments (see Fig. 7) to care for such accidents as do occur. Indeed it becomes more than ever for his interest to do so, for he saves not only the lost time of employees, thus keeping up production, but also reduces expense for compensation, in addition to the main reason of according his workmen "human" treatment.

There is a definite reason for including medical supervision also among the matters that should be cared for by the manufacturer, because of the direct influence which the health of the employee has on the production of the factory. Especially does this apply to acute cases of illness arising in the works, such that prompt attention and expert advice can often ward off a serious illness and prevent loss of time by the workman. The importance of this matter was pointed out in an editorial in the *American Machinist*, Vol. 45, page 1007, where it is stated, "Through the trained directors of service departments some employers are transferring from the great fund of human knowledge the best of skill in the care of the body to those who are ignorant of many of the commonest facts of hygiene and sanitation. From this point the social responsibility of the employer is to help in the great task of teaching men how to live"; and in the editorial in Vol. 46, page 38, constructive suggestions are made as to how this expert supervision can be taken advantage of through coöperation by a group of small shops so located that one physician can serve them all.

In order that medical supervision may be carried on most efficiently it is necessary for the physician to know the condition of each employee. It is also important, in hiring new employees, to see that they are in such physical condition as to be able to do the required work, and such as not to be a menace to those already employed. Some factories are even going so far as to make a periodic examination of employees in order that any unfavorable symptoms may be discovered and steps taken to restore health, before the ailment becomes serious.

When medical supervision passes the point directly affecting the shop, however, and takes up questions of chronic illness, fitting eye glasses, etc., or permanent dental work, aside from the relief of temporary suffer-

ing, and when it goes beyond the factory into the workman's family, to care for members who may be ill, then it would seem to pass beyond the jurisdiction of the shop, unless so located that outside help is not readily available.

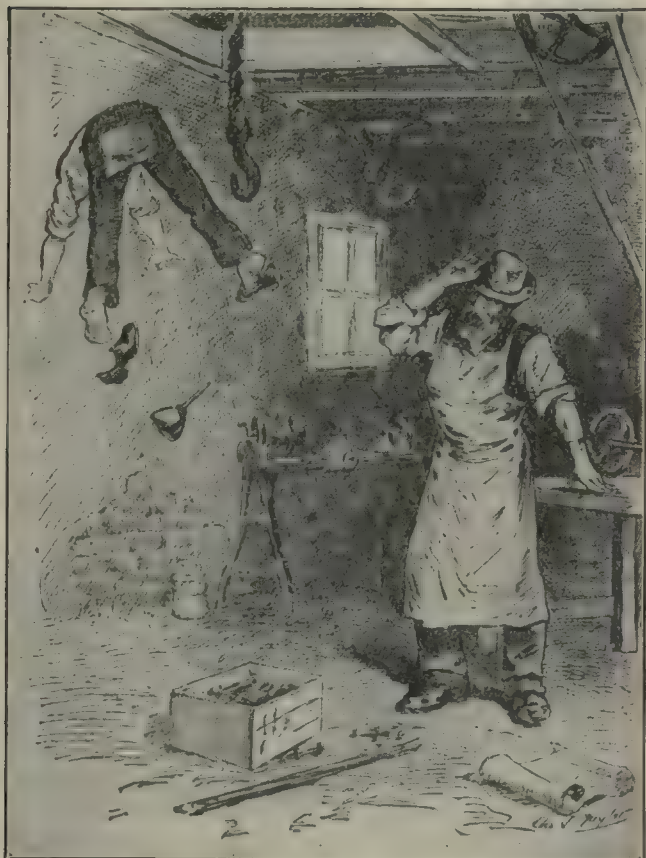


FIG. 6. ILLUSTRATING ACCIDENTS CLASSED AS "UNAVOIDABLE" IN THE OLD-TYPE SHOP
Such accidents are typical of many that are now wrongly set down as due to carelessness on the part of the workman

The same general reasoning can follow the establishment of lunchrooms and provision for recreation. When the factory is so located that good food, at reasonable

FIG. 7. CORNER OF A MODERN DISPENSARY

prices, cannot be secured during the noon hour and where there might be a lowering of the standard of health by such inadequate provision, then it is a proper function of the factory to provide nourishing and palatable food, furnished practically at cost. On the other hand, where the factory is so located that there are ample facilities for obtaining the noonday meal within easy reach of the factory, such provisions would seem superfluous. There is a certain advantage in encouraging the employees to go out at noon for a change and an "airing."

A method of handling the lunchroom problem in a suburb, at the same time carrying out the true coöperative spirit that is being urged in this article, has been successfully established at Oakley in connection with the employees' service work of the Cincinnati Milling Machine Co. (see Fig. 8), as reported by A. J. Baker at the annual meeting of the American Society of Mechanical Engineers last December. He says:

Among the matters investigated was the question of food. Oakley, the suburb where the works are located, had inadequate lunch facilities, and the men who did not live in the vicinity either brought a lunch with them, which they ate cold, or else went out to a saloon. After analyzing the situation it was decided to purchase a complete set of utensils, refrigerators, counters, etc., which were turned over to the employees, who were told to use the equipment for operating their own lunchroom. They appointed a committee to purchase their own food and set their own prices; in short, they had a representative organization, with which the management was not connected in any way, and it was extraordinarily successful. Starting with a patronage of 60 or 70 a day, there are now about 450 who secure their lunches there.

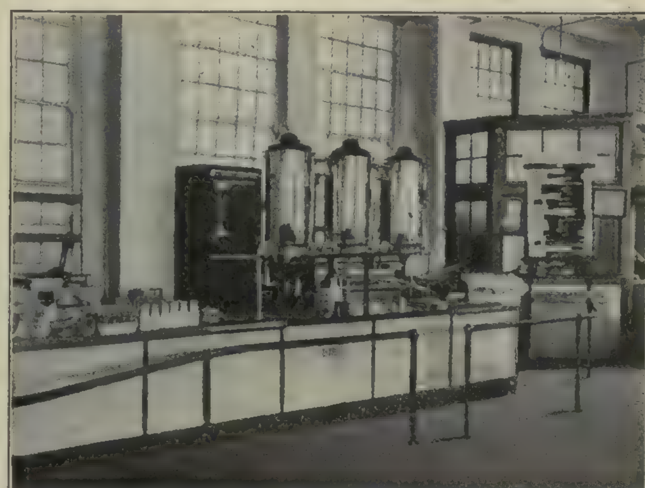


FIG. 8. LUNCHROOM OF THE CINCINNATI MILLING MACHINE CO.
The apparatus is furnished by the company, but the operation of the room is conducted by the workmen

Here again the physician comes in, for he is able to suggest to the men the dietetic value of certain foods and to assist them, not only in securing good nourishment, but in reducing the cost. By this means the health of the employees undoubtedly has been helped.

Including recreation in the list of activities undertaken by the management for the workmen may have three distinct purposes: One, to aid in maintaining a good physical condition on the part of the employees; another, in its general effect in providing healthful employment of time that might otherwise be occupied in ways to diminish the value of the worker; and last, to establish and cultivate a spirit of loyalty, which may be developed in contests where all employees enthusiastically "root for the home team" or for their own department. Here, again, the location of the plant in relation to public provision for recreation of a wholesome kind should govern the extent to which it is provided for by the management. If provided at all, the responsibility for carrying it on should be largely in the employees' hands, if good is to result.

[To Be Continued]

Designing of Round Broaches*

By Walter G. Groocock

SYNOPSIS—In this article the somewhat neglected subject of round broaches is discussed. Broaching with round broaches should be done oftener, as it affords a cheap and accurate method of machining. Solid broaches and those that are best made with detachable ends are illustrated. A type of standard sheet that has been found useful is described.

There is one side of broaching practice that appears to be undecided. Round broaches are not used nearly so extensively as they deserve to be. The reason for this may probably be that the machine shops are somewhat conservative in their methods.

For years reamers have been used to size holes—say in the drilling machine—and those who have had most experience with reamers must know what an uncertain tool a reamer is, yet the round broach for sizing work is comparatively neglected. While the broach will never entirely displace the reamer, there are in every plant innumerable pieces of work that are particularly suitable for broaching purposes, such as levers, single-hole brackets and the like. Take, for instance, levers; these can be rough drilled 1/32 in. undersize and then broached to size, thus giving a cheaper and better job.

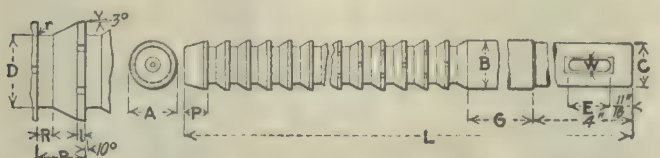


FIG. 1. STANDARD DRAWING FOR ROUND BROACHES

Broaching is cheap, because a round broach costs little more to make than a solid reamer of high-speed steel; and yet the broach will produce more holes within predetermined limits than will a solid reamer. This means that the tool cost per piece is relatively low and much in favor of the broach; and while the actual time of sizing the hole does not differ much for small holes, for holes over 1 in. in diameter the broach has a decided advantage.

DETAILS OF STANDARD SIZES OF ROUND BROACHES, IN INCHES,

Nominal Size	A	B	C	D	E	W	G	J	L	P	N	R	r	Remarks
3/4	0.751	0.735	..	17/32	1¼	7/32	4	3/32	25	3/8	8	1/8	1/32	Five notches
7/8	0.876	0.86	..	9/16	1¼	7/32	4	1/8	25	3/8	8	1/8	1/16	Six notches
1	1.001	0.984	..	5/8	1¼	1/4	4	1/8	25	3/8	8	1/8	1/16	Six notches
1⅛	1.126	1.1	1	3/4	1¼	1/4	4	1/8	25	3/8	8	1/8	1/16	Six notches
1¼	1.251	1.215	1⅛	7/8	1¼	11/32	4	1/8	25	3/8	8	1/8	1/16	Six notches
1⅜	1.376	1.34	1¼	1	1 5/16	3/8	4	1/8	25	3/8	8	1/8	1/16	Six notches
1½	1.501	1.47	1⅜	1⅛	1 5/16	13/32	4	1/8	25	3/8	8	1/8	1/16	Eight notches
1⅝	1.6265	1.59	1⅜	1¼	1 5/16	13/32	4	1/8	25	1/2	6	3/16	1/16	Eight notches
1¾	1.7515	1.72	1⅝	1 5/16	1⅝	7/16	4	1/8	25	1/2	6	3/16	3/32	Eight notches
1⅞	1.8765	1.84	1⅝	1 7/16	1⅝	7/16	4	1/8	25	1/2	6	3/16	3/32	Ten notches
2	2.0015	1.96	1⅝	1 9/16	1⅝		4	1/8	25	1/2	6	3/16	3/32	Ten notches

A type of standard drawing for making round broaches is shown in Fig. 1. The table gives dimension details of a few standard sizes the proportions of which have given satisfaction. It is best to leave the table blank on the tracing of the broaches, filling the sizes in on a blueprint as different sizes are put in hand. By so doing any change that experience suggests as desirable may be embodied in future broaches without erasures on the tracing.

Changes that may be found advisable are pitch of teeth, spacing of notches, or total load. For instance, it will be obvious that the pitch of the broach teeth must be less than the width of the work, or the work will drop into the teeth. Consequently, for a thin job like a washer the pitch may have to be finer, failing some special means of holding the work. On the other hand, for a very long hole the pitch may have to be coarser, to lessen the total load on the broach or to provide more chip space. The notching may have to vary to suit a given material. Usually, however, for sizing holes up to 1½ in. in diameter ⅜ pitch is satisfactory, and ½-in. pitch gives good results up to 1⅞ diameter. For broaches larger than this the pitch should be wider; and the depth of the spaces may be materially increased, thus lightening the broach, which makes for easier handling.

While there is no limit to the size of round broach that may be used—except the power of the machine to pull it—it should be stated here that all round broaches have a tendency to work downward, owing to their unsupported weight. Naturally, the effect of this would be greater with the heavier broaches.

For this reason—among others—it is desirable that broaching machines should be built with an outboard support, or extension, which should be integral with the main casting of the machine. A sliding block on this extension could then be used to keep the broaches in line. Where there is no support for the broach other than the pull adapter, the work adapter must be renewed frequently so that the broach cannot sag too far out of line. These adapter bushings may be bored out to the next larger size and consequently may be used again.

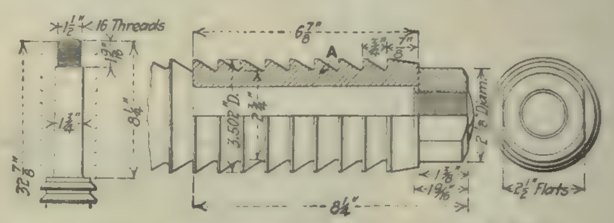


FIG. 2. BROACH WITH DETACHABLE END

Apart from ordinary standard broaches there are many cases where special round broaches are of advantage. Malleable-iron castings may be broached direct from a cored hole when the location of the hole is not important. For this work, round broaches that have lost their size may be ground to take out the necessary amount of material. Such a broach would of course be followed by a standard broach to size the hole. When the cored hole is not more than 1/16 in. below the required size, a reground broach may be used without rehardening, but generally, owing to irregularities in the cored hole, the reduction of the broach will necessitate rehardening.

Large round broaches made from casehardened steel, which have lost their size, may be brought back to standard by rolling up the last few of the teeth, say six, and then regrinding these to do the sizing. To do this a small roll is mounted on the end of a pin 1 in. square.

This holder is mounted on the lathe rest at an angle, the roll is applied to the front of the desired teeth, and pressure is applied while the broach is slowly revolving in the lathe. If the tooth faces have been frequently reground to sharpen them, it is a simple matter to increase the diameter of a tooth to the extent of 0.01 in. If, however, the case at this point is still deep, it takes considerably more effort to get an increase of, say, 0.005 in. in diameter.

Very large round broaches may be made with a detachable end, like the one shown in Fig. 2, the detachable portion being secured in position by a nut. In this type of broach it is advisable, to get the best results, to work along the following lines: When the broach is first made, only about two of the teeth on the auxiliary broach do any work, the remainder being idle teeth. When the broach has lost its size, beyond the rolling-up stage, the detachable portion is taken off and a new one taken from stock and secured in position. The detachable ends

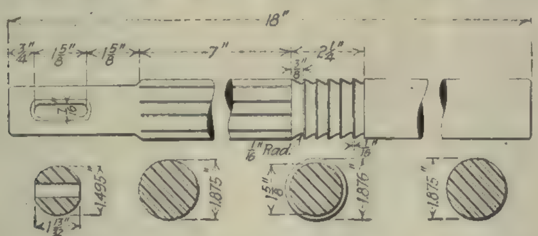


FIG. 3. BROACH FOR REMOVING BURRS FROM SPLINED HOLES

should be kept in stock, hardened, ground in the hole and on the end, but not on the teeth. After the broach is again built up, the new portion should be ground to size and the remainder of the broach reground. To do this the taper, or slope, of the broach is slightly changed, which allows all the teeth to be resharpened on their diameter, the replaced end having fewer idle teeth than the original end, according to the condition of the broach teeth that have not been changed. This design of detachable ends is only applicable to the larger type of round broach.

Another type of round broach that has been found useful for taking off burrs from splined holes is shown in Fig. 3. This needs little description. Only a few teeth are cut about the center of the broach, the front part of which is grooved to clear the burrs. The plain back portion acts simply as a guide to keep the work in alignment.

Owing to the fact that there is little work for such broaches to do—that is, they only have to remove burrs—they retain their size for quite long periods.

Method of Testing Cutting Compounds or Coolants for Millers

By Charles N. Underwood*

The ultimate economy of production must always be the deciding factor in determining what shall be purchased. We are repeatedly told that the goods offered by all salesmen are "the best on the market," but those of us who are from Missouri must be shown. Of cutting oils and compounds there are a great many on the market, all of which are claimed to be the best. A scientific test of any article is the only way of determining its relative value.

The test described below is the one adopted by the Remington Typewriter Co. in determining the relative value of cutting compounds. Three years ago a certain oil was adopted, after a thorough test, for milling and drilling work. For the purpose of this article we will refer to this oil as oil A. Since the adoption of this oil as a cutting compound or coolant, tests on many other oils have been made at this factory. The performance of tools when using oil A is taken as 100 per cent., and the value of the tested oil is expressed in per cent. of oil A.

A certain milling operation was chosen on which to make all oil tests, because it is one that runs constantly and can therefore be used in making tests of the various oils received from time to time. This is for convenience only, and any milling operation that runs long enough may serve as a medium for making the test.

Equipment for the Test

The machine selected for the test is a No. 2 Hendy & Norton plain miller. It has been equipped with a cast-iron tank 12 x 20 in. in inside dimensions. When filled to a depth of 12.5 in., this tank holds 13 gal. The compound to be tested is placed in this tank and is supplied to the cutters by means of a No. 1 Brown & Sharpe rotary pump that delivers at the rate of 4 gal. per min. The entire stream of coolant is confined to the cutter by means of a hood that surrounds the cutter and fits snugly around the arbor at the sides.

The cutters used on this job are interlocking form cutters 3½ in. in diameter and have 12 teeth with a 10-deg. undercut. The cutters are run at 400 r.p.m., or a cutting speed of 365 ft. per min., and are fed into the work at 0.048 in. per revolution, or at the rate of 19.2 in. per minute.

The stock of which this particular part is made is soft crucible steel. Analysis shows the following: C, 0.57; Mn, 0.46; Si, 0.09; S, 0.025 and P, 0.024 per cent. The cut is a light one and is made on three sides of the piece. The length of cut is but 0.27 inch.

For the purposes of the test, the oil to be tested, which we will call oil B, is mixed in the proportions that will give the same price solution as is regularly used with oil A.

The Regular Mixture and One To Be Compared

Oil A is saponified by the addition of soda ash, 1 oz. for each gallon of water used, and is made up in 150-gal. lots. The cost of these solutions is figured as follows:

Oil A:	Gal.
Total mixture made	150
Amount of oil used	7
Amount of water used	143

$$\text{Amount of soda ash used} = \frac{143}{16} = 9\tfrac{1}{2}\text{ lb.}$$

7 gal. of oil @ $0.35	$2.45
9½ lb. soda ash @ $0.028	0.266
Total	$2.716

$$\text{Cost per gallon} = \frac{\$2.716}{150} = \$0.0181$$

$$\text{Proportion of water to oil} = \frac{143}{7} = 20.4\text{ to }1$$

Oil B:

x = Number of gallons of oil to use.
If oil B costs $0.32 per gal.

$$\frac{\$0.32 + \$0.266}{150} = \$0.0181;\ x = 7.65\text{ gal.}$$

$$\text{Proportion of water to oil} = \frac{150 - 7.65}{7.65} = 18.6\text{ to }1$$

*Mechanical engineer, Remington Typewriter Co.

Inasmuch as our tank holds but 13 gal., we need only to mix that amount of oil B at a time. The amount of oil B required for such a mixing would therefore be

$$\frac{7.65}{160} \times 13 = 0.663\ gal. = 2.65\ qt.$$

Some of the solution is carried away by the chips, and every few days some fresh solution must be added to the tank in order to keep up the supply. As this amount is small and as the percentage of oil in the solution is low, a 5-gal. sample of B is generally quite sufficient for the test.

This mixture is placed in the machine tank, and the regular operator proceeds with his work. It is necessary to have a first-class operator and one who is interested in the experiment. When the cutters become dull, as shown by the quality of work done, the cutters are taken out and sent to the grinding room. The number of pieces milled by the cutter is found and recorded. This process is repeated several times until enough data have been accumulated to give a fair idea of what can be accomplished. Two sets of cutters are used in making the test. They are used alternately, one cutter being used in the machine while the other is in the grinding room.

The mixture of oil B is then removed from the machine, and the mixture of oil A taken from the regular supply is put in and the test proceeds as before, records of the number of pieces milled between grindings being kept. A data sheet of a regular test is shown in the accompanying table.

COMPARISON OF OILS A AND B

Run	Kind of Oil	Solution	No. Pieces per Grind	Condition of Cutter
1	B	18.6 to 1	5,111	Dull
2	B	18.6 to 1	5,171	Dull; 3½ gal. added
3	B	18.6 to 1	4,667	Dull
4	B	18.6 to 1	3,780	Dull
5	B	18.6 to 1	4,377	Dull
6	B	18.6 to 1	2,741	Dull
7	B	18.6 to 1	2,916	Dull
8	B	18.6 to 1	2,088	Dull
9	B	18.6 to 1	2,174	Dull; 3½ gal. added
10	B	18.6 to 1	3,785	Dull
11	B	18.6 to 1	3,762	Dull
12	B	18.6 to 1	3,115	Dull
13	A	20.4 to 1	3,710	Dull
14	A	20.4 to 1	3,598	Dull
15	A	20.4 to 1	4,485	Dull
16	A	20.4 to 1	4,545	Dull
17	A	20.4 to 1	4,555	Dull
18	A	20.4 to 1	4,379	Dull
19	A	20.4 to 1	2,262	Dull
20	A	20.4 to 1	4,589	Dull
21	A	20.4 to 1	4,458	Dull
22	A	20.4 to 1	4,561	Dull

It will be seen by a glance at the data sheet that oil B started off very well when fresh, but that after a few runs the life seemed to drop out of it. Replenishing the tank with fresh mixture seemed to add new life to it, but not enough to bring it up to its original state. On the other hand, it will be noticed that the results obtained with oil A are much more uniform in character.

In the 12 runs made with B the average life of the cutter was 3640 pieces, while with oil A the average life was 4114 pieces. The latter figure includes the run of 2262 pieces, which is probably low on account of some accident; but as none was observed, the run was taken into account in figuring the average. Assuming the cutter performance with A to be 100 per cent., then the cutter performance with oil B $= \frac{3640}{4114} = 88.4$ per cent.

It is therefore shown that oil B at 32c. per gal. is not as economical as oil A at 35c. per gallon.

Should the oil B have shown up as well as A in this test, as has happened in some of our tests, the procedure would have been to reduce the price of the two solutions an equal amount until one of them fell below the other in performance. Should B have given a higher performance than A, a more extensive test would have followed before changing oils.

It would have been quite necessary to determine first that B would not gum up the fixture, clog the pipes or rust the work when used for a long time. In order to determine these factors at least a barrel of the oil should be tried and carefully observed.

Triple Joint Convention

A joint convention of the Southern Supply and Machinery Dealers' Association, the National Supply and Machinery Dealers' Association and the American Supply and Machinery Manufacturers' Association was held in Memphis, Tenn., Apr. 12, 13 and 14. In addition to joint and separate sessions the three associations united in a program of entertainments that will be long remembered by members and their friends. Among these events may be mentioned the smoker and vaudeville at the Chisca Hotel, on Thursday, the ball at the same place on Friday evening, and the "Grand Southern Barbecue and Brunswick Stew," which event took place on Saturday, at the close of the session.

The principal speakers at the joint sessions were Lewis E. Pierson, chairman of the board, Irving National Bank, New York, whose address was on the subject of trade acceptances, and A. A. Ainsworth, of New York, who spoke on the subject of some results of open competition.

The newly elected officers of the American Supply and Machinery Manufacturers' Association are: President, R. F. Valentine, Boston Woven Hose and Rubber Co.; first vice president, George T. Bailey, Oliver Iron and Steel Co.; second vice president, C. J. McFarland, William Powell Co.; third vice president, C. W. Beaver, Yale & Towne Manufacturing Co. The secretary-treasurer is F. B. Mitchell, 4106 Woolworth Building, New York.

Officers were elected for the National Supply and Machinery Dealers' Association as follows: President, H. W. Strong, the Strong-Carlisle & Hammond Co., Cleveland, Ohio; first vice president (in charge of machinery interests), W. J. Radcliffe, E. A. Kinsey Co., Cincinnati, Ohio; second vice president, Crannel Morgan, Hardware and Supply Co., Akron, Ohio; secretary-treasurer, Thomas A. Fernley, Philadelphia; advisory secretary-treasurer, T. James Fernley, Philadelphia.

Newly elected officers for the Southern Supply and Machinery Dealers' Association are as follows: President, George H. Manning, Tennessee Mill and Supply Co., Knoxville, Tenn.; first vice president, W. P. Simpson, C. T. Paterson Co., New Orleans; second vice president, W. J. Schaefer, Russell Hardware Co., McAlester, Okla.; secretary and treasurer, Alvin M. Smith, Smith-Courtney Co., Richmond, Virginia.

Spring Meeting of the A. S. M. E.

Again is attention called to the A. S. M. E. meeting in Cincinnati, May 21-24, by an artistic booklet issued by the Lodge & Shipley Machine Tool Co. This booklet not only calls attention to the meeting, but also contains a number of interesting shop views.

Manufacturing a Sheet-Metal Radiator

By Robert Mawson

SYNOPSIS—In this article are shown the principal operations in manufacturing a sheet-metal radiator. These radiators are made in uniform sections, each consisting of two plates of special alloy steel, which are united by welding. The sections are then welded on the inside at the top and bottom until the desired length of radiator sections is obtained.

The manufacture of radiators from sheet metal is not new, but the development of the system by the American Pressweld Radiator Corporation, Detroit, Mich., is interesting. The radiators are made up of two uniform sections and welded along the seam to form a steam- and water-tight joint. The metal used in the construction of the radiators is pure basic iron, to which is added a small proportion of copper. This mixture is found to be a good noncorrosive metal under varying climatic conditions.

The radiators are used for heating, for refrigerating coils, for large and small installations, for automobile heaters and many other purposes. In Fig. 1 may be seen a number of finished radiators. In front, is shown one built up in a curved shape. It was designed for heating a room in a pleasure boat. At the rear of this radiator may be observed many others of different sizes and number of sections, completed and ready for shipment.

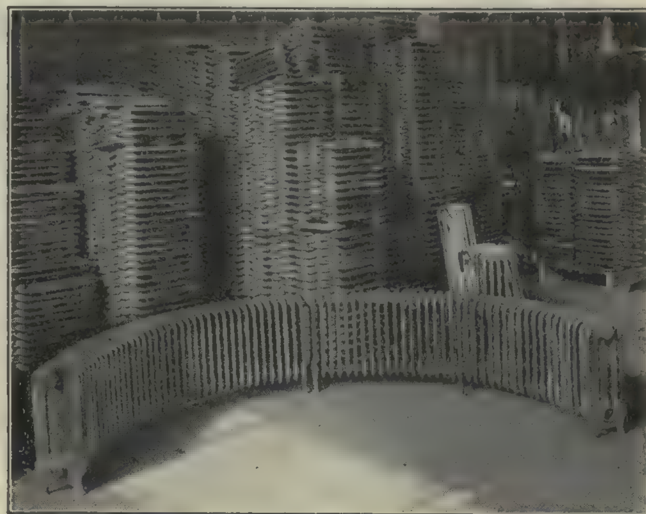


FIG. 1. NUMBER OF COMPLETED RADIATORS

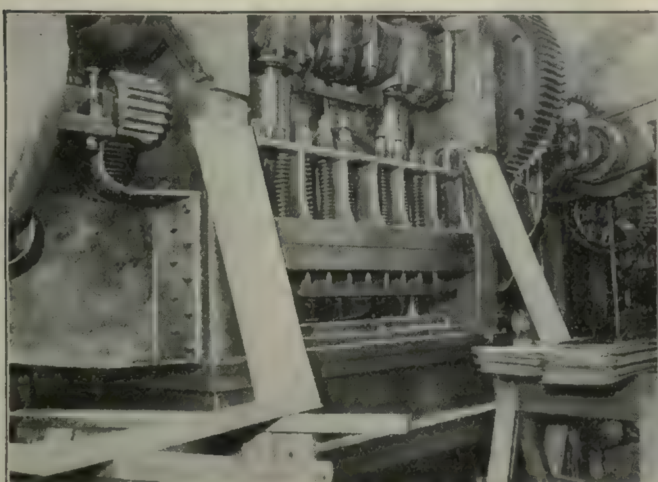


FIG. 2. FIRST FORMING OPERATION

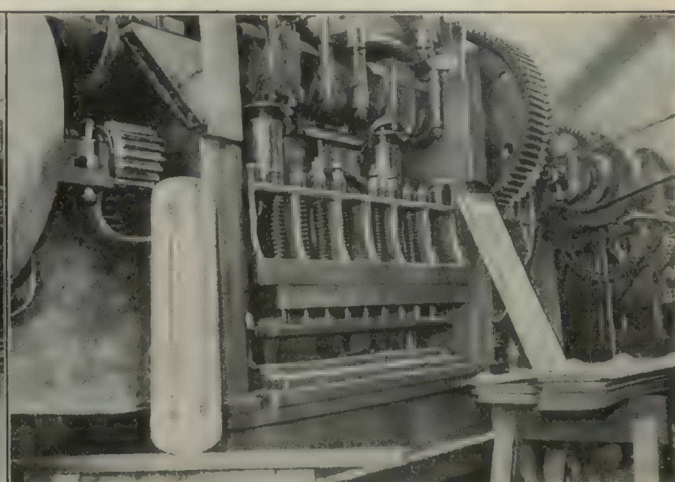


FIG. 3. TRIMMING OPERATION

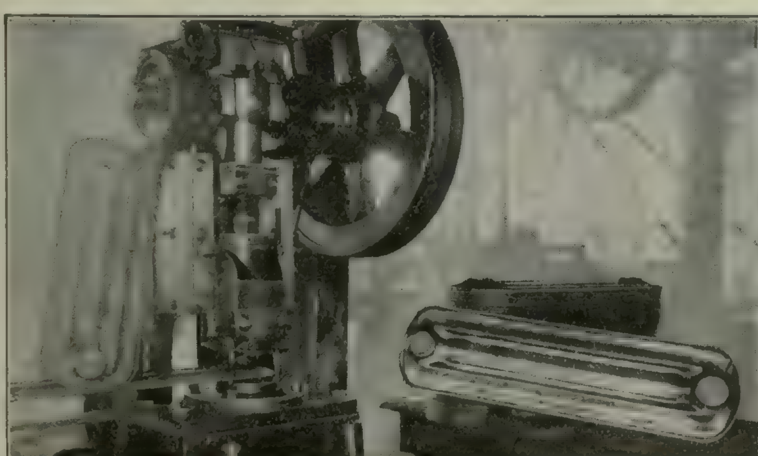


FIG. 4. PUNCHING CONNECTING HOLES

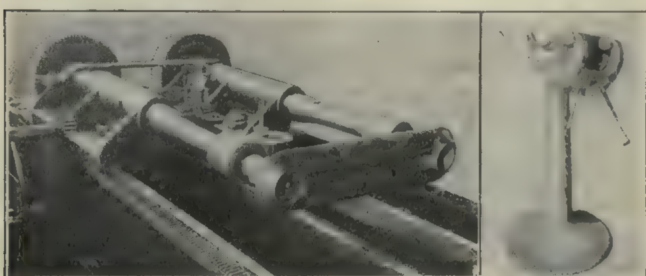
FIG. 5. SECTION WELDING

The metal, which is 0.05 in. (No. 18 gage) thick, is first cut to the correct width and length. These strips are then fed into the specially designed 600-ton press, Fig. 2, for the breaking-down, or first forming, operation.

FIG. 6. HYDRAULIC TESTING THE SECTIONS

One of the strips upon which this operation has been completed may be seen at the left of the press. The rate of production on this work is 300 per hour.

The strips are then fed into a similar punch press having another set of punches and dies, and the second



FIGS. 8 AND 9. TAPPING AND WELDING OPERATIONS
Fig. 8—Tapping end sections. Fig. 9—Welding leg

forming operation is completed. The average production from this second forming is approximately the same as for the first. The third operation is trimming the strips. The press for this work is shown in Fig. 3, and one of the trimmed sections may be seen at the left of the illustration. The average production is the same as for the two forming-press operations that have already been illustrated and described.

The next operation is punching the male and female holes that join the sections together. The punch press set up for this operation is shown in Fig. 4. The section is fed under the punch against a stop, and the descending

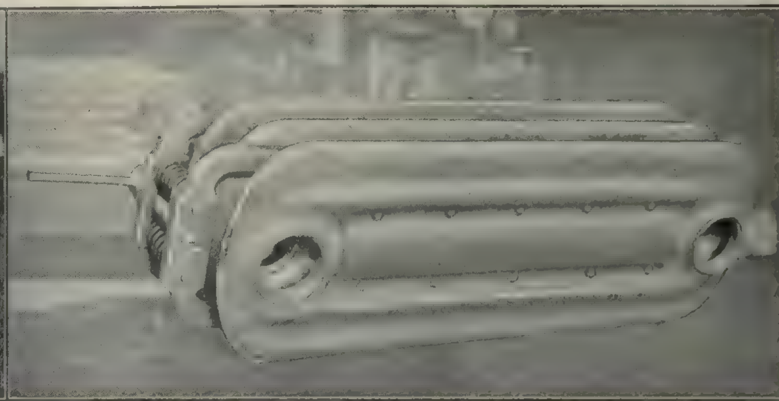


FIG. 7. ASSEMBLE WELDING THE SECTIONS

punch blanks out the hole. One of the sections before the punching may be seen at the left, and one after the punching is shown at the right of the machine. The rate of production for this operation is 320 per hour.

The sections are then formed with a recess around the two holes on one section and a projection on the two holes of another section, thus making a pair. The rate of production is the same as for the preceding operation.

Two sections are welded along the longitudinal seam as the next operation, illustrated in Fig. 5. The sections are located by pins, as shown, which fit into the punched holes. In placing the sections on the fixture, one having a projection is fitted into one with a recess, thus making a pair. The two sections are held together with a clamp nut fitting on the lower locating pins, as may be observed in the illustration. The pins may be slid along the fixture to various positions to suit different lengths of radiator sections.

The joint is then welded with the oxyacetylene torch, the average rate being 60 ft. per hour. The consumption of gases required for the operation is 5 cu.ft. of acetylene and 7½ cu.ft. of oxygen per hour. The apparatus for the oxyacetylene welding was supplied by the Davis-Bournonville Co.

The next operation is punching the rivet holes. This work is done on a small punch press at the rate of 1000

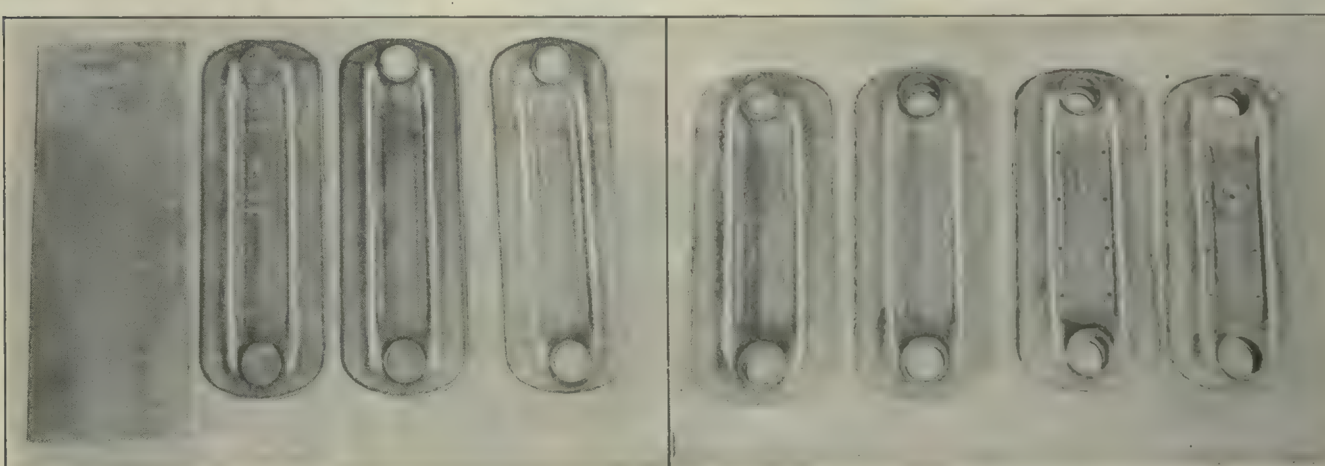


FIG. 10. SEQUENCE OF OPERATIONS IN THE MANUFACTURE OF A SHEET-METAL RADIATOR

holes per hour. Rivets are inserted in the holes, and a washer is placed on the shank, which is then burred over at the rate of approximately 75 rivets per hour. The shanks of the rivets are riveted over on a standard machine. About 50 rivets are completed per hour.

The sections are given a hydraulic test of 50 lb. pressure. For this purpose the sections are attached by means of unions to the water inlet and outlet pipes, as shown in Fig. 6. The section units are then welded along the fitted projections to suit the length of radiator desired, as illustrated in Fig. 7. Two sections are held together with clamps at both ends, as shown, and the joint around

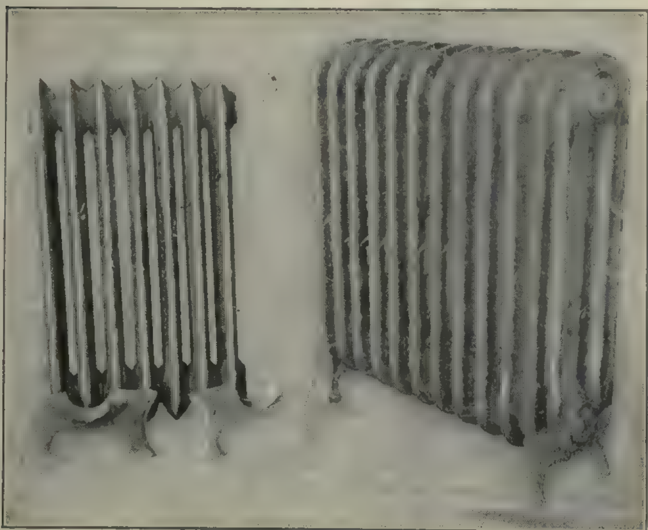


FIG. 11. ASSEMBLED RADIATOR

the hole is flame welded. The average production is 250 sections per hour.

In Fig. 8 is shown the special machine used to tap out the end sections to suit the pipe nipples. The average production from this machine is 75 sections per hour. The assembled radiator is then given a final hydraulic test at 50 lb. pressure. After passing this test, the radiator is painted and is then ready for service.

The leg to support the radiator is also made of the same sheet metal. In manufacturing this element the sheet is first formed, then trimmed and finally welded. For the last operation two of the pieces are held in a fixture, as shown in Fig. 9, and the edges are welded with the oxyacetylene torch. It will be seen that the fixture is made to oscillate on a pin, so that the leg being welded may be swung to suit the best position. On an average, 40 of these legs may be welded in an hour.

The sequence of operations in manufacturing the radiator section is shown in Fig. 10, from the cut sheet to the finished riveted and welded section. In Fig. 11, on the left, may be seen a finished radiator of seven sections, with the two supporting legs in front. At the right of the illustration is shown a radiator of eleven sections mounted on legs ready for installation.

The Spring Meeting at Cincinnati

The spring meeting of the American Society of Mechanical Engineers is to be held in Cincinnati, Ohio, May 21 to 24, scare-head reports that the meeting might be called off having been officially denied by the national secretary. A year ago, when the country began to take up the question of industrial preparedness, the society devoted a session of its spring meeting in New Orleans to a discussion of this subject. This discussion was the means of bringing out many valuable ideas—one of them that of an industrial inventory, which was later put into effect by the Committee on Industrial Preparedness of the Naval Consulting Board. As the result of this inventory, the Government now has on file important data regarding the capabilities of nearly 30,000 industrial concerns in this country to manufacture munitions in case of necessity. It is expected that the munitions session at the coming spring meeting in Cincinnati will bring out a large amount of first-hand experience in munitions manufacture from firms that have specialized in this business during the last two years. Such information will afford a valuable supplement to that contained in the industrial census.

Special Sessions

The meeting is in charge of the Committee on Meetings and the Cincinnati Section Committee. Other professional features will be a session on high-speed gasoline engines, at which recent developments in connection with internal-combustion engines for automobile and aviation service will be presented; a session on machine-shop practice, devoted to questions relating to design and construction of machine tools; and a joint session with the National Machine Tool Builders' Association. Commenting on this John T. Faig, chairman of the Cincinnati section says:

"The outstanding feature of the spring meeting for 1917 is the fact that it will occur at the same time and place as the meeting of the National Machine Tool Builders' Association, and that one of the professional sessions and several of the entertainment features will be joint sessions. This will bring our own society in closer touch with machine-tool building. The building of all forms of heat motors, of waterwheels, of railway apparatus, of heating and ventilating devices and of transmission machinery seems to be recognized as belonging more clearly to the field of the mechanical engineer than does machine-tool building. This is probably due to the fact that early machine tools were largely empirical, that very little was known regarding the laws underlying the cutting of metals and the power required to remove material by means of cutting tools. Improvements in various cutting steels and more rigid demands made upon machine tools by the general introduction of interchangeable parts have caused an extremely rapid development in the machine-tool industry, which is fast raising machine-tool building to a science.

"It is natural that special emphasis should be placed on machine-tool building at the Cincinnati meeting, for the reason that an amazing development of the machine-tool industry has occurred there during the past 30 years—a development apparently out of all proportion to that which has occurred in other lines in mechanical engineering.

"It seems particularly fitting, therefore, that the American Society of Mechanical Engineers and the National Machine Tool Builders' Association should meet together at Cincinnati and that these two organizations, already closely related, should come into more intimate contact. The local session, which is to be devoted to industrial education and to welfare work, will be a joint session of these two societies and of equal interest to

both. Inspection trips to the various shops will be of interest to both societies.

"A word about the entertainment features will not be out of place. The Entertainment Committee is making strong efforts to provide some novel and very attractive features that will maintain the reputation made when the British Institute of Mechanical Engineers visited Cincinnati in 1904. May is usually a lovely month in Cincinnati, and the topographical features of the Queen City make it attractive to those who enjoy being out of doors in the early spring. A number of very beautiful spots are to be visited on the automobile ride, which is scheduled for Thursday afternoon. Arrangements have been made to afford visiting members, who desire to relax, an opportunity to play golf at one of the country clubs. For those who have the latter part of the week to spend, delightful trips may be made to the famous mound known as Fort Ancient, at Morrow, Ohio, about 40 miles away; to the famous Blue Grass Region of which Lexington, Ky., is the center, which is a veritable garden in May, and to the world-famous Mammoth Cave in Kentucky.

"Besides visits to the well-known machine-tool and steam-engineering firms, a number of invitations from large concerns making steel, soap, pianos and other commodities have been received, so that a visiting member will have a wide choice in his selection.

"In general, the practice of the society of holding professional sessions in the mornings and devoting the afternoons to entertainment and visits will be followed, except that on Tuesday afternoon there will occur a special professional session, which will be the joint session already mentioned.

"Cincinnati is well supplied with hotels of every class. As May is a busy month, however, and as Cincinnati is rather popular as a convention city, members who expect to attend the meeting are urged to make reservations at once."

Tentative Program

The different events planned have been arranged tentatively as follows:

Monday, May 21, morning, registration; afternoon, registration, trip to hospital, visits to shops in Cincinnati; evening, informal gathering, address of welcome, dancing.

Tuesday, May 22, morning, business meeting machine-shop session, visit by ladies to Rookwood Pottery and Art Museum; afternoon, joint session with National Machine Tool Builders' Association, visits to shops in Cincinnati, trolley ride by ladies to Fort Thomas; evening, smoker for gentlemen, reception for ladies.

Wednesday, May 23, morning, munitions session lasting all day or else adjourning to Thursday morning, trip for ladies through leading stores and skyscraper; afternoon, boat ride for all to Fernbank dam or waterworks; evening, informal dance.

Thursday, May 24, morning, miscellaneous session, gasoline-engine session, trolley ride for ladies to the zoo; afternoon, visits to machine plants, motor-car ride to Mount Storm, University of Cincinnati, Observatory and Ault Park.

Friday, May 25, morning, trip to Fort Ancient (extra), trip to Mammoth Cave, Ky. (extra), trip to Lexington, Ky. (extra).

Among the technical features of the entertainment will be a visit to the Union Gas and Electric Co., which is really of metropolitan dimensions, a visit to the waterworks system and a visit to the Fernbank dam. The dam in the Ohio River, at the western city limits, is said to be the largest movable dam in the world. It is one of a series of 54 locks and dams being built by the Government in this river to make it navigable from Pittsburgh to Cairo.

Visits will also be made to some of the great machine-tool factories in and near Cincinnati, and also to such great concerns as the Procter & Gamble Soap Company.

Places of Interest

Besides the engineering features of Cincinnati, those attending the spring meeting will find many places of particular interest to visit.

The famous Rookwood Pottery is located on the brow of Mount Adams, overlooking the downtown section of the city. Here the beautiful Rookwood ware is produced.

The Cincinnati University, in Burnet Woods, comprises McMicken, Cunningham and Hanna Halls, the Van Wormer Library, Engineering Hall, Chemistry Building, Gymnasium, Power Plant and Observatory, which latter is on Mount Lookout, six miles from the center of the city. It is the only municipal university in the United States.

The Ohio Mechanics' Institute is another great educational institution. It is now housed in a magnificent new structure at Walnut, Canal and Clay Sts., which accommodates 4000 students.

Cincinnati has a city hall that cost $2,000,000, and three new high schools that in architecture and appointments are not excelled in any city in the United States. The Government building and custom house on Fifth Ave. cost over $6,000,000. A new municipal hospital cost $4,000,000.

Cincinnati has a system of public parks and boulevards which covers about 2500 acres and is now undergoing extensions and improvements. The oldest is Eden Park, located on the crest of Mount Adams.

Among points easily reached from Cincinnati are Chattanooga, Tenn., with the battlefields of Lookout Mountain, Signal Mountain and Missionary Ridge; Boonesborough, Ky., the oldest settlement established by English-speaking people in the Mississippi Valley; Lincoln's birthplace, near Hodgenville, Ky.; Mammoth Cave and Colossal Cavern; the tomb of President Harrison at North Bend; Point Pleasant, the home and birthplace of Ulysses S. Grant; and Georgetown, where the great general spent his boyhood.

Calling Attention to the A.S.M.E. Meeting

A large number of Cincinnati firms are boosting the spring meeting of the American Society of Mechanical Engineers in their city, May 21 to 25, by inclosing attractive circulars with their advertising literature. Two of the more recent examples are one from the Worthington Pump and Machinery Corporation, inviting the engineers to visit it, and the other from the Baldwin Piano Co., which combines some interesting information along with a convenient hand map of the city with indicated shops and points of interest.

Routing from a Central Department

By P. W. Haywood*

SYNOPSIS—A study of a shop making 2000 parts, which are assembled into 400 different articles for seasonal sale. The advantages of a planning department, or central control, for this kind of work are pointed out, also its weakness in emergencies, such as breakdowns.

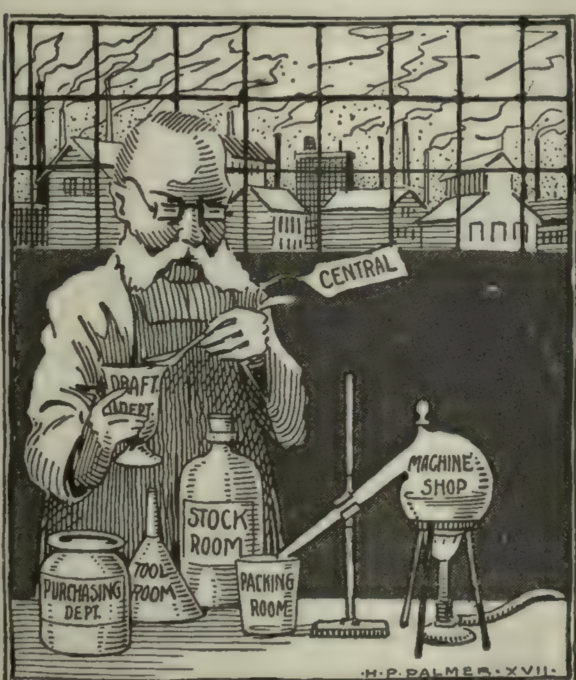
Before expressing opinions on such an important manufacturing function as the routing of work, it will probably be better to look first at the matter from the standpoint of what actually comprise the definite functions of routing and what benefits accrue from them.

It is obvious that we must also consider the type of products being made and the methods of management employed. Take a factory where the principles of scientific management are recognized and where these principles are followed to the extent of planning production as a whole and scheduling the work to each department, also planning productive units.

Looking for the Solution

We will assume that the articles manufactured are seasonable goods and comprise approximately 400 completed items built up of 2000 different parts, which can be carried in stock on a maximum and minimum basis. This, I believe, will help to regulate our thoughts when discussing each of the functions of routing. I am not enumerating every function connected with routing, but am rather stating the particular functions that are most common and have the greatest bearing on the subject. I am, therefore, going to assume the following as the

*Assistant Manager, Standard Silver Co.



principal functions and by adopting these as a basis try to find the answer:

A. The production of parts and completed goods to the dates set by the sales, stock or order departments to meet the customer's requirements.

B. The balancing of factory orders as issued from the sales, stock or order departments, so that each department or productive unit will at all times have sufficient work to keep its units working full time.

C. The obviating of overtime work.

D. The avoiding of congestion.

E. The supplying of interdepartmental requirements of parts needed for semi-assemblies and full assemblies.

F. The keeping to a minimum the investment in labor on parts carried in stock—that is, not carrying these parts longer than is required for assembly work.

G. Having the raw material or parts delivered to the particular department and location at the time required.

Now let us take each of these functions and endeavor to find our answer.

A. The production, or central, department will first analyze the orders received and from the dates set for delivery will issue purchase requisitions for material, giving the dates such material is required. The production department can begin on any part or semi-assembly order for which the stock is on hand and which will require for its manufacture the full length of time up to the date specified for the completed article. In order to find the correct dates for starting the different parts in the factory, it would seem obvious that a central department having access to all departmental standards of time needed for production is the best place to get the most accurate results on this function.

B, C and D. One of the most difficult functions to manage efficiently is the balancing of departmental work so that the production of one department will release to its fellow departments an amount of work (even in some cases irrespective of dates) that will give its productive units full-time work. In addition to this it should at all times work ahead on the chance of a breakdown, which we all know frequently happens, either as the result of machinery troubles or of poor material. Again, the balancing of production is actively concerned with the future; and if the function is receiving its necessary care, it will avoid overtime work, dividing its production equally week by week or increasing its labor to meet the requirements specified by the sales department. There is no doubt in my mind that this function must be handled by a central department, as it requires

attention that could not be given by an individual foreman, especially as it affects the factory in its entirety.

E. This function requires the attention of a planning department, or a central department, where it can very easily be handled, as it is more or less arithmetical calculation based on standard times of operations. For instance: With three departments, each with a capacity of 100 productive hours' work daily, two departments will have to release 50 hours' work each to the third department; or if the two departments combined release only 50 hours' work to the third department, then, of course, it will be necessary to release from the stock department raw material for 50 hours' work.

F. In a factory such as I have taken for the purpose of this paper, the making of parts on a maximum and minimum basis for stock certainly will require very careful attention on the part of the production department, in order to keep its maximums at the correct point so that other parts dependent upon the parts carried in stock will not have to wait.

Preventing an Accumulation of Labor by Exercising Care

Care will again have to be exercised so that the material will not be made up into stock parts before the time absolutely necessary to fill the requirements; otherwise, the labor put into these parts will be dead for the length of time they are carried in stock. The dates when parts will be required will be obvious to a central department. And although the material for this may be in stock, it will be much more economical to save the investment in labor on such parts and avoid congestion in some department where they must await component parts for assembly, unless the parts are required at once.

G. This is also the central department's work, for in order to meet this function everything will be dependent upon the raw material being delivered to the right department, as desired, to comply with the work scheduled for all productive units. The central, or planning, department, having access to all records, will be thoroughly acquainted with the periods when raw material is required and where it is required. This department is also in a position to take up immediately with the purchasing department the matter of ordering material that is needed for parts, as it is conversant with the importance of such material and the relation it bears to other parts already being routed in the factory.

A Central Department for Routing Seems To Be Best

In summing up the different functions it would seem to me that a central department is undoubtedly the best placed where routing can be most economically dealt with. Yet at the same time, in order for it to be a success, it is absolutely necessary that the foremen or floor supervisors coöperate to the extent of taking care of the internal routing of their own departments and so keep within the schedule laid down by the central department. When breakdowns occur, the central department should be notified immediately. This makes it possible for the foremen to suggest a means of sidetracking a breakdown job much more quickly than even the central department can, which has to go through all its records before it can suggest the simplest manner of dealing with the change in that particular department's routing.

A Machine Shop on Wheels for Military Use

By C. L. Edholm

A complete practical repair shop, with equipment for extensive repairs, a power and lighting plant and sufficient floor space for half a dozen mechanics, has been devised to travel upon a three-ton chassis, thus enabling the trucks that carry supplies for our troops to receive prompt and efficient attention.

The portable shop is a marvel of compactness. When the side panels are raised, it occupies no more space than an ordinary car with a moderate load; but when the panels at the sides and rear are extended, they provide ample floor space for the workmen. These are the dimensions: When folded, the inside measurements are 11 ft. 4 in. long and 5 ft. wide; when open, the platform has a length of 13 ft. 7 in. and a width of 9 ft. 5 in. Thus the body when traveling is narrow enough to go along a narrow road with other traffic, and when in use as a repair shop it has generous working room outside the machines.

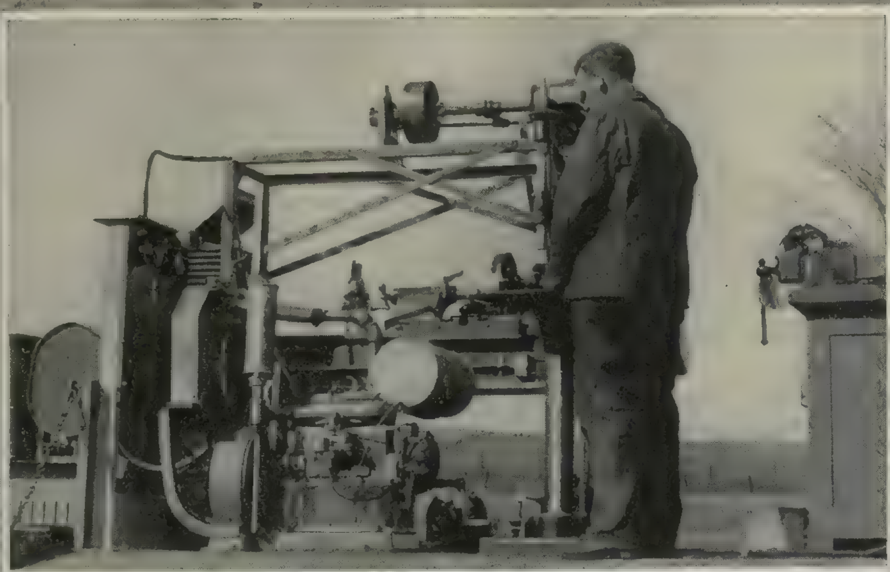
The power for operating the tools is supplied by a direct-current generator, connected direct to a 9-hp. four-cylinder gas engine—a power plant that is independent of the motor used to propel the car. This equipment provides plenty of light, as well, for night work and is of such capacity that, if desired, the lighting plant can be extended for other uses when the machine shop is not working. A 5-hp. electric motor and rheostat are employed to operate the lathe. There is a 1-hp. motor for the drilling machine. A similar motor serves the electric bench grinder and the electric breast drill.

The Machine-Tool Equipment of a Traveling Motor Shop

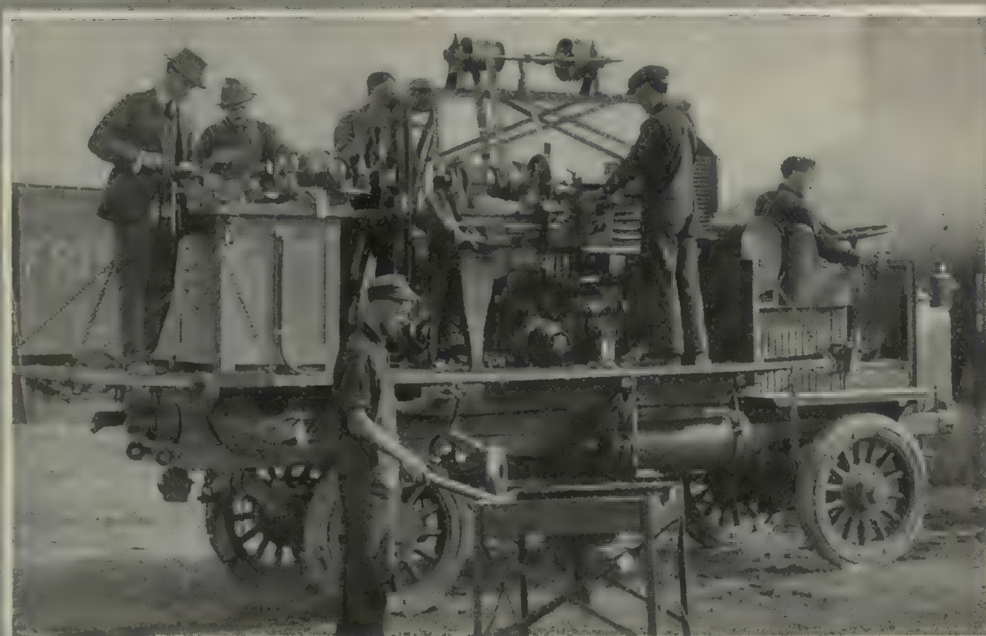
The machine tools consist of a 16-in. drilling machine and a 13-in. swing by 5-ft. screw-cutting lathe, equipped with a compound rest, suitable faceplates, chucks and steady and back rests. There is a forge, with blower designed to be set up on the ground. At the rear of the truck is a solid oak bench cabinet. It is bolted securely to the body, and upon it are mounted the electric grinder and the machinist's and pipe vises. The drawers of this bench are provided with places where all the small tools required may be found. Not an inch of space is wasted, each object having its own place.

For the miscellaneous equipment, such as fire pots, blow-torches, chain falls, etc., there are special racks, or braces are clamped to the body in accessible places. Under the body may be found a welding outfit installed in a sliding cabinet, while the acetylene and oxygen tanks are hung on brackets under the back of the platform. Here too, is found a 300-ft. coil of rope, while in drawers set under the body are blacksmith and carpenter tools. Altogether, the portable machine shop contains more than 1000 tools large and small, and the outfit is sufficient to keep a number of mechanics busy.

Several of these motor-truck shops, carried by Four Wheel Drive chassis, were used by our army on the Mexican border, where they were employed on repairs to road-building machinery and in keeping the extensive motor-truck fleet in good condition. The outfit as described costs $10,000. The United States Army is using 15 or 20 of these machine shops on wheels, and an equal number are in service abroad.



A MACHINE SHOP ON WHEELS



Punch and Die Standards

By M. S. Wright

SYNOPSIS—From time to time valuable information has been published in the "American Machinist" on the subject of punch and die standards. This article and the thirty-two figures used in connection with it were compiled with the idea of adding new and uptodate information to this subject and to show the extent to which the standardization of press tool-holding devices has been carried by one progressive manufacturer.

All the presses used by the company with which I am connected are manufactured by the E. W. Bliss Co., Brooklyn, N. Y., which allows for a little more uniformity of design than could have been accomplished with presses made by several different manufacturers. The presses used are Nos. 0 and 75-D Stiles and Nos. 19,

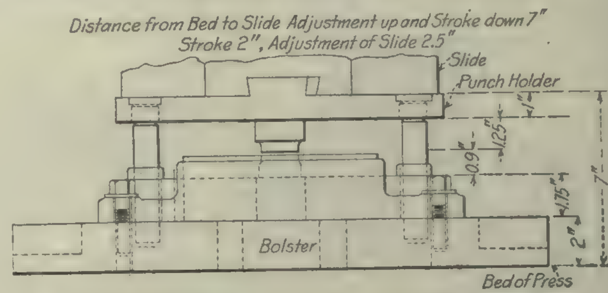


FIG. 8. TOOLS FOR NO. 20 BLISS PRESS

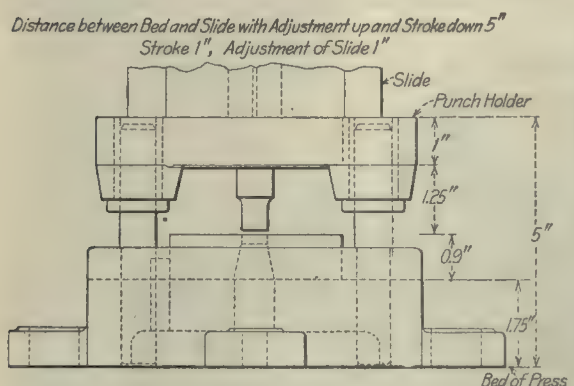


FIG. 1

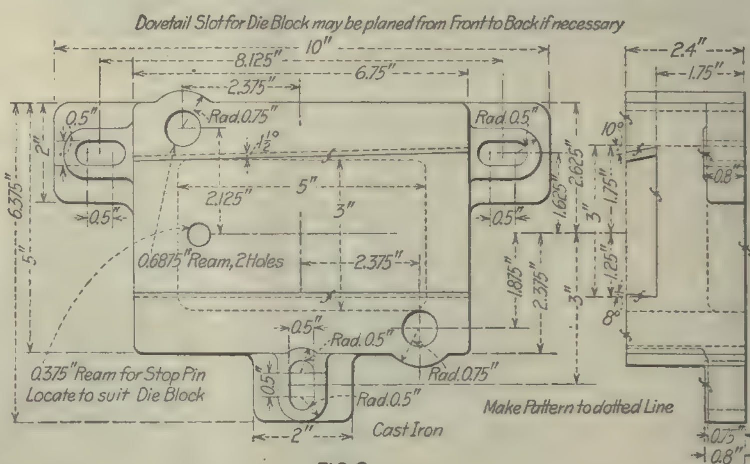


FIG. 2

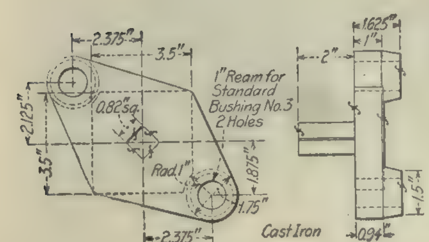


FIG. 3

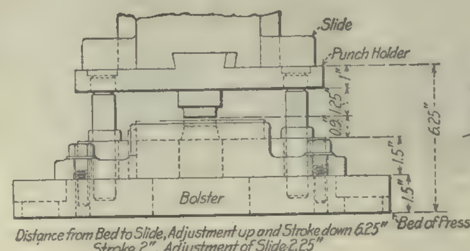
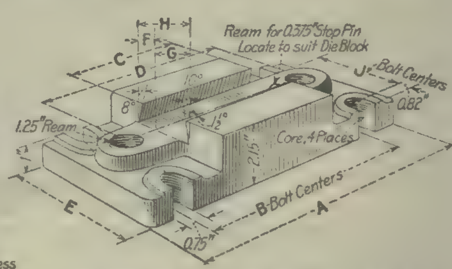


FIG. 4



No.	A	B	C	D	E	F	G	H	J
40	11.5"	8.5"	4"	6.5"	6"	1.25"	1.75"	3"	4.75"
41	11.5"	8.5"	5"	7.5"	6"	1.25"	1.75"	3"	4.75"
42	11.5"	8.5"	6"	8.5"	6"	1.25"	1.75"	3"	4.75"
43	12.5"	9.75"	4.5"	7"	7"	1.75"	2.25"	4"	5.75"
44	12.5"	9.75"	5.5"	8"	7"	1.75"	2.25"	4"	5.75"
45	12.5"	9.75"	6.5"	9"	7"	1.75"	2.25"	4"	5.75"

FIG. 5

FIGS. 1 TO 5. STANDARD DIMENSIONS FOR VARIOUS PRESS PARTS

Fig. 1—Dimensions of tools for No. 0 Stiles punch press. Fig. 2—Standard shoe for No. 0 Stiles punch press. Fig. 3—Standard punch holder for No. 0 Stiles press. Fig. 4—Dimensions of tools for No. 19 Bliss inclinable press. Fig. 5—Standard shoes for No. 19 Bliss inclinable press

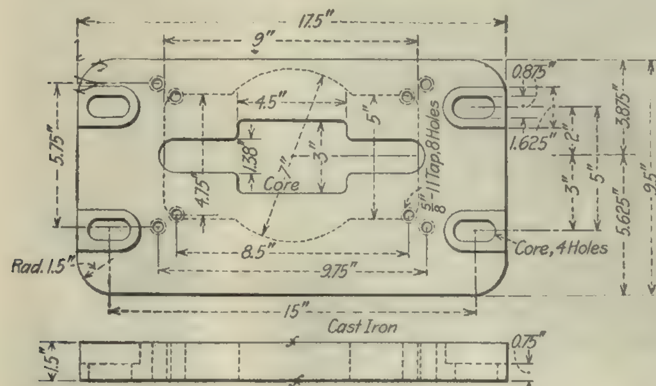
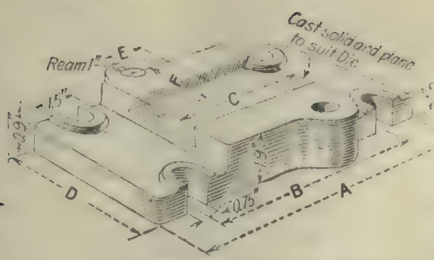


FIG. 6. BOLSTER AND BED OPENING, NO. 19 BLISS PRESS

20 and 73½ Bliss. This line of five presses was found quite enough to manufacture all the sheet-metal stampings for a typewriter.

In Figs. 1 to 3 are illustrated the standards for the No. 0 Stiles press. The construction drawing, Fig. 1, shows the tools assembled, the stroke and the adjustment of the press. It will be noted that guide posts and bushings are used on all these tools, making each outfit practically a subpress.

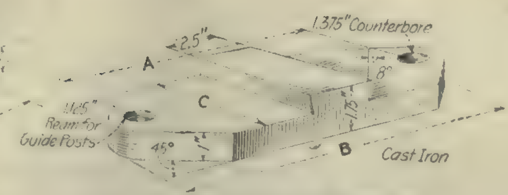
In Figs. 4 to 7 are illustrated the outfit for the No. 19 Bliss press. The shoe and punch holder for this press are made in six sizes. The punch holders are shown on Fig. 11 and are the same as those used on the No. 20 press.



No.	A	B	C	D	E	F
50	11.5"	8.5"	6"	6"	1.5"	2.875"
51	12.5"	9.75"	7"	7"	2.125"	2.875"

FIG. 10

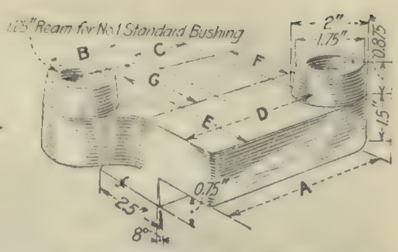
STANDARD SHOES FOR No. 20 BLISS INCL. PRESS



No.	A	B	C	No.	A	B	C
1	6.5"	9"	3.5"	6	9"	11.5"	4.5"
2	7.5"	10"	3.5"	7	8.5"	11"	5.5"
3	8.5"	11"	3.5"	8	9.5"	12"	5.5"
4	7"	9.5"	4.5"	9	11"	13.5"	5.5"
5	8"	10.5"	4.5"				

Nos. 1 to 6 inclusive are also used on the No. 19 Bliss incl. Press

FIG. 11



No.	A	B	C	D	E	F	G
50	5.125"	2.875"	2.25"	4.5"	5"	2.5"	1.5"
51	5.125"	2.875"	2.25"	4.5"	6.25"	3.125"	2.125"

FIG. 12

FIGS. 10 TO 12. STANDARD SHOES AND PUNCH HOLDERS

Fig. 10—Standard shoes for No. 20 Bliss inclinable press. Figs. 11 and 12—Standard punch holders for No. 20 Bliss inclinable press

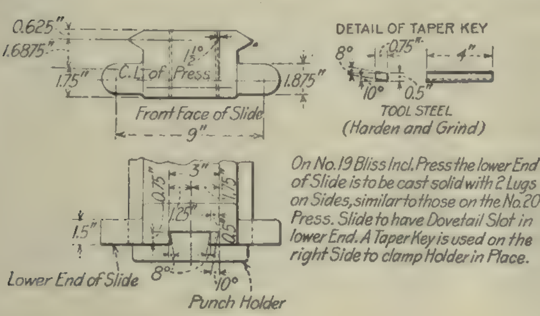
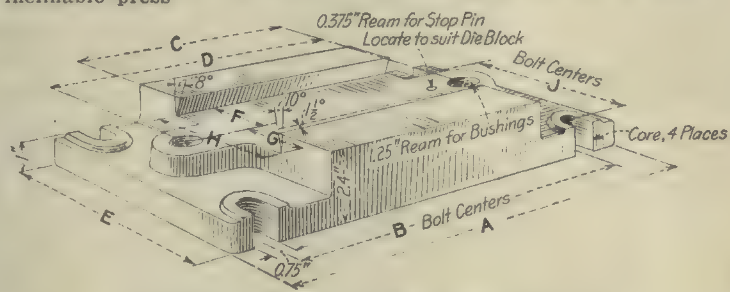


FIG. 7

FIGS. 7 AND 9. STANDARD PUNCH HOLDERS AND SHOES

Fig. 7—Punch holder for No. 19 Bliss inclinable press. Fig. 9—Standard shoe for No. 20 Bliss inclinable press



No.	A	B	C	D	E	F	G	H	J
1	11.5"	8.5"	4"	6.5"	6"	1.25"	1.75"	3"	4.75"
2	11.5"	8.5"	5"	7.5"	6"	1.25"	1.75"	3"	4.75"
3	11.5"	8.5"	6"	8.5"	6"	1.25"	1.75"	3"	4.75"
4	12.5"	9.75"	4.5"	7"	7"	1.75"	1.25"	4"	5.75"
5	12.5"	9.75"	5.5"	8"	7"	1.75"	2.25"	4"	5.75"
6	12.5"	9.75"	6.5"	9"	7"	1.75"	2.25"	4"	5.75"
7	14.5"	11.5"	6"	8.5"	8"	2.25"	2.75"	5"	6.75"
8	14.5"	11.5"	7"	9.5"	8"	2.25"	2.75"	5"	6.75"
9	14.5	11.5"	8.5"	11"	8"	2.25"	2.75"	5"	6.75"

FIG. 9

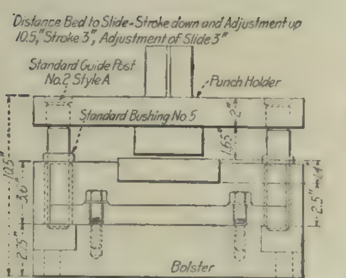


FIG. 16 DIMENSIONS OF TOOLS FOR No. 73½ BLISS PRESS

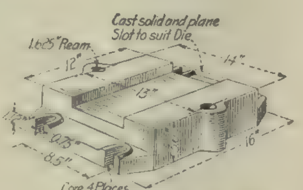


FIG. 17-a SHOE No. 60

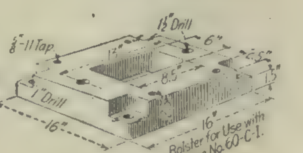


FIG. 17-b

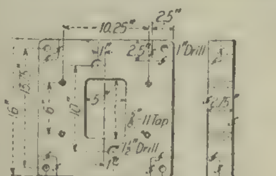


FIG. 18-a BOLSTER FOR USE WITH SHOE No. 61

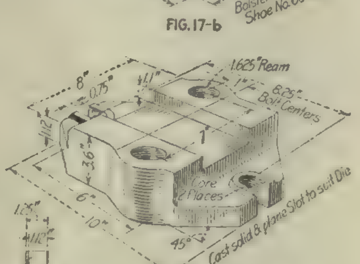


FIG. 19-a SHOE No. 62

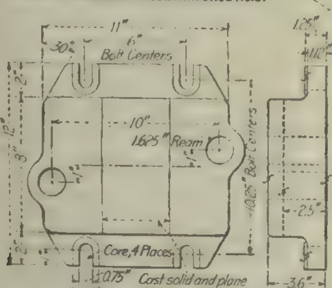


FIG. 18-b STANDARD SHOE No 61 FOR No. 73½ BLISS PRESS

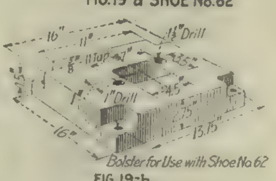


FIG. 19-b

FIGS. 16 TO 19. STANDARDS FOR NO. 73½ PRESS

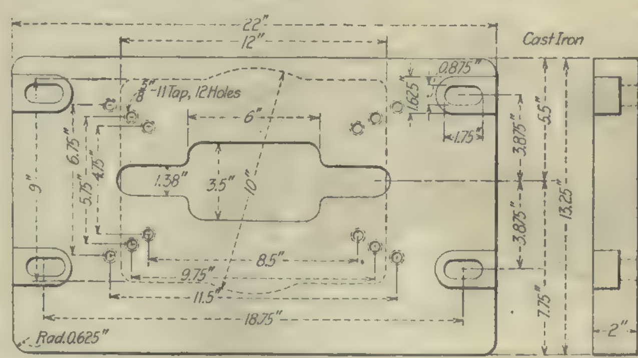


FIG. 14 PLAN SHOWING BOLSTER AND OPENING IN BED OF No. 20 BLISS INCL. PRESS

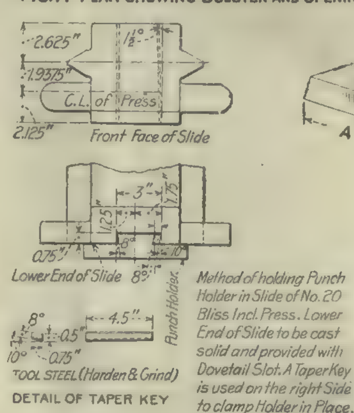
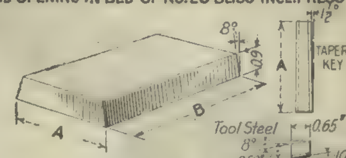


FIG. 15



No.	A	B
1	2.5"	3.5"
2	2.5"	4.5"
3	2.5"	5.5"
4	3.5"	4"
5	3.5"	5"
6	3.5"	6"
7	4.5"	5.5"
8	4.5"	6.5"
9	4.5"	8"

No.	A
1	4"
2	5"
3	6"
4	4.5"
5	5.5"
6	6.5"
7	6"
8	7"
9	8.5"

FIG. 13

STANDARD BLANKS FOR DIE BLOCKS USED ON Nos. 19 & 20 BLISS INCL. PRESS

FIGS. 13 TO 15. STANDARDS FOR NO. 20 BLISS PRESS

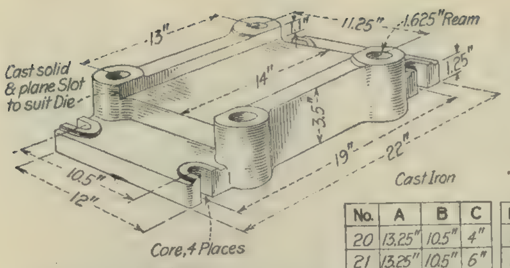


FIG. 24

STANDARD SHOE FOR No. 75 D STILES DOUBLE PITMAN PRESS FOR USE WITH 4 GUIDE POSTS

No.	A	B	C
20	13.25"	10.5"	4"
21	13.25"	10.5"	6"
22	14.75"	12"	4"
23	14.75"	12"	6"
24	14.75"	12"	8"

No.	A	B	C
25	16.75"	14"	4"
26	16.75"	14"	6"
27	16.75"	14"	8"
28	18.75"	16"	4"
29	18.75"	16"	6"
30	18.75"	16"	8"

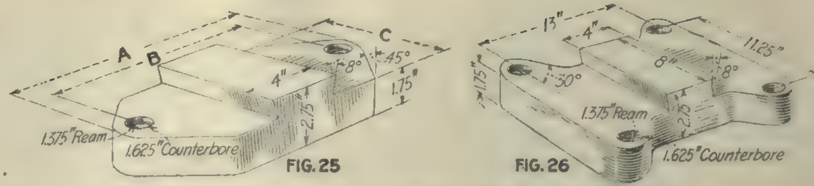


FIG. 25 FIG. 26

STANDARD PUNCH HOLDERS FOR No. 75 D STILES DOUBLE PITMAN PRESS

FIGS. 24 TO 26. STANDARDS FOR NO. 75-D STILES PRESS

In Fig. 7 is shown the planing for all the gates for No. 19 presses and also the key for holding the punch holders in the gate.

The standards for the No. 20 press are given in Figs. 8 to 15. There are two combinations of standards for this size of press—one in which the guides are on the center line of the press sidewise, and the other when the guides are placed one in front and the other in the rear of the center line of the press.

As Nos. 19 and 20 presses are most in use, standard die blanks are carried in stock, also the keys for holding the dies in place. These blanks have tapered sides. The shoes for all the sizes of presses are carried in stock rough-planed, and they are finish planed as required to suit specific conditions. In many cases rectangular blanks are employed, being screwed into place without the aid of

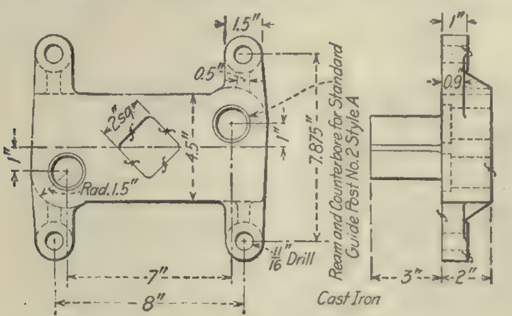


FIG. 20

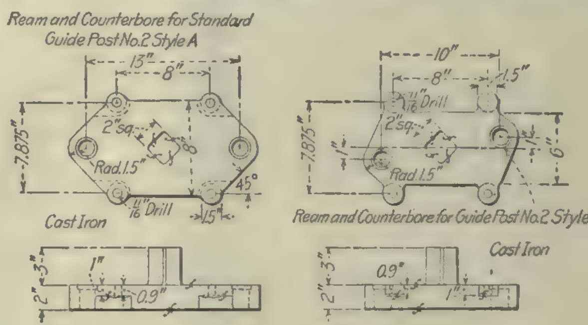


FIG. 21

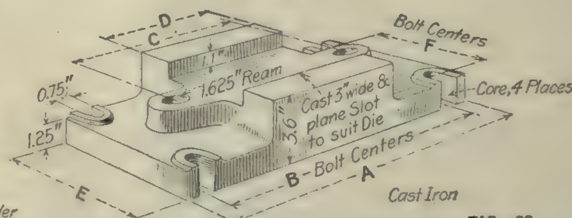


FIG. 23

No.	A	B	C	D	E	F
20	16"	13"	10.5"	8"	7"	5.75"
21	16"	13"	10.5"	8"	9"	7.75"
22	16"	13"	12"	10"	7"	5.75"
23	16"	13"	12"	10"	9"	7.75"
24	16"	13"	12"	10"	12"	10.75"
25	20"	17"	14"	12"	7"	5.75"
26	20"	17"	14"	12"	9"	7.75"
27	20"	17"	14"	12"	12"	10.75"
28	20"	17"	16"	14"	7"	5.75"
29	20"	17"	16"	14"	9"	7.75"
30	20"	17"	16"	14"	12"	10.75"

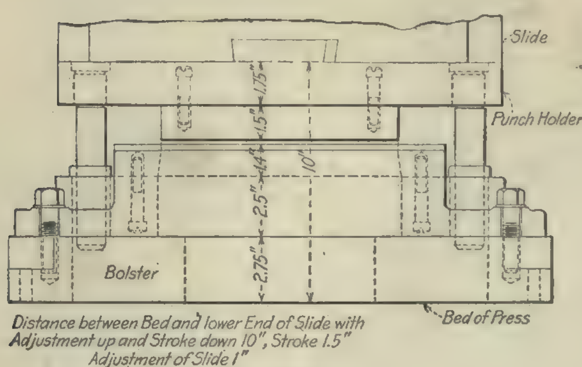


FIG. 22

FIGS. 20 TO 23. DIMENSIONS FOR PUNCH HOLDERS, TOOLS AND SHOES FOR VARIOUS PRESSES

Fig. 20—Punch holder No. 62 for No. 73½ Bliss press. Fig. 21—Punch holders Nos. 60 and 61 for No. 73½ Bliss press. Fig. 22—Tools for No. 75-D Stiles double-pitman press. Fig. 23—Standard shoes for No. 75-D Stiles double-pitman press

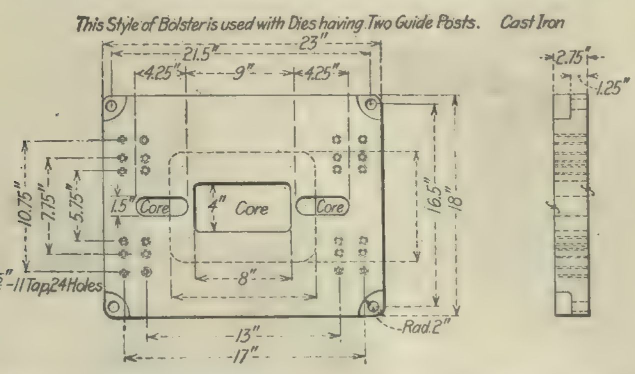


FIG. 27. BOLSTER AND OPENING IN BED OF NO. 75-D STILES PRESS

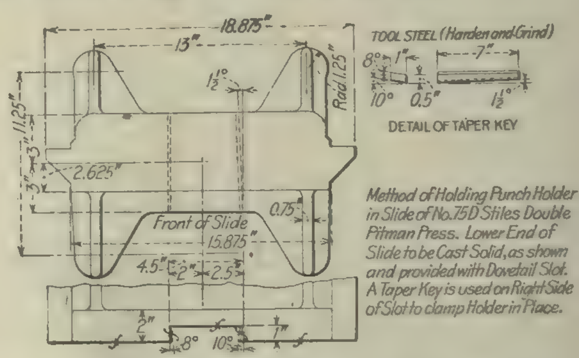


FIG. 29. PUNCH HOLDER IN SLIDE OF NO. 75-D STILES PRESS

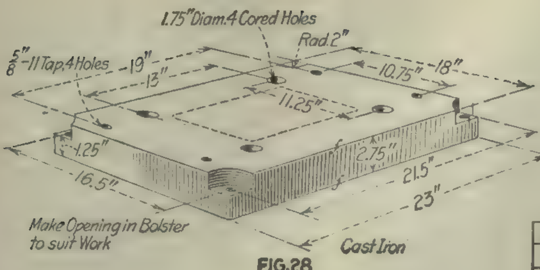
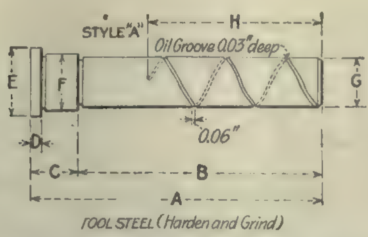
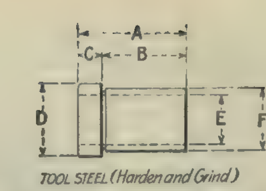


FIG. 28



No.	A	B	C	D	E	F	G	H
1	6"	5"	1"	0.25"	1.375"	1.126"	0.9995"	3.5"
2	7.75"	6"	1.75"	0.38"	1.625"	1.376"	1.2435"	4"



No.	A	B	C	D	E	F
1	2.25"	1.75"	0.5"	1.44"	1"	1.251"
2	3"	2.5"	0.5"	1.75"	1.25"	1.626"
3	1.87"	1.62"	0.25"	1.25"	0.75"	1.001"
4	2"	1.5"	0.5"	1.44"	1"	1.251"
5	4.1"	3.6"	0.5"	1.75"	1.25"	1.626"

FIG. 30

FIGS. 28 AND 30. A SPECIAL BOLSTER AND STANDARD GUIDES

Fig. 28—Special bolster showing opening in bed of press for use, with dies having four guide posts, on No. 75-D Stiles double-pitman press. Fig. 30—Standard guide posts and bushings

keys. The bolster plate and the standard opening in the bed of the press are shown in Fig. 14.

In Figs. 16 to 21 are shown the standard holders for the No. 73½ press. These holders are made in three different styles of one size each to suit varied conditions.

No.	A	B	C	D	E
1	4.75"	2.25"	2.50"	0.6885"	0.7495"

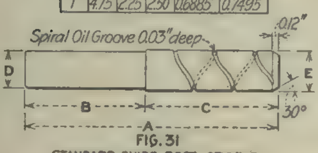


FIG. 31
STANDARD GUIDE POST, STYLE B

No.	A	B	C	D	E
1	4.60"	1.90"	2.70"	1.001"	0.999"

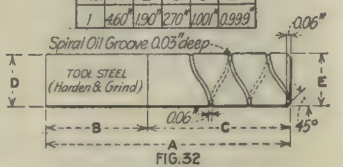


FIG. 32
STANDARD GUIDE POST, STYLE C

FIGS. 31 AND 32. STANDARD GUIDE POSTS

In Figs. 22 to 29 are shown the standard punch and die holders for the No. 75-D Stiles double-pitman press. These need no description.

The standard guides and guide bushings are illustrated in Fig. 30, and two other forms of guide posts are shown in Figs. 31 and 32.

Practical Wartime Shell Making*

By Lucien I. Yeomans

So many utterly foolish statements have been offered the public in regard to the manufacture of munitions and the possibility of this or that automobile factory or implement works or other equally ill-adapted shop being turned upon very short notice into a shell factory that it seems well to consider of how little value for the manufacture of munitions is the present equipment of the average shop.

It should be emphasized that, outside of the already existing munitions plants, the old equipment which manufacturers brought to the new business of shell making consisted mostly of their money, their credit and the nucleus of an organization. Even the old floor space was infrequently used. The machinery and tools were more than 90 per cent. new, and it is significant that the greatest success has been made by those companies which were not even owners of machine shops of any kind.

It is well for the mechanical engineers and the manufacturers to review carefully accepted methods of munitions production and to ascertain just what time-honored precedents may be abandoned, what "red tape" may be cut, what traditions of the mechanic arts are sacred but unnecessary, where the corners may be cut and the result attained economically, directly and without delay.

It would seem ridiculous to construct an office building of steel and terra cotta for the field headquarters of an army division, but we see nothing strange in the equally ridiculous proposition of a nicely built permanent factory for the comparatively simple operations of machining shells.

There is a strange twist in our mental conception which permits an engine for one purpose to be nicely housed in a pressed-brick and tile-lined structure, while another equally expensive and nicely made engine may be properly located on the open deck of a vessel, entirely unprotected from the weather. It is the same deference to tradition that makes us assume that machine tools must be guarded from every exposure, and we fail to see readily that their performance would be equally good for unusual service if they were heavily coated with rust on every idle surface.

The suggestions made here for emergency factory construction are to be understood as applicable strictly to emergency conditions and to meet a demand for an unusual amount of ammunition with the least possible delay and in no way as suggestions for permanent private or Government arsenal construction.

First must be considered locality with reference to labor supply and transportation. Within easy reach of all our large centers of population may be found level, unoccupied, naturally well-drained acreage that is suitable for the purpose and that is gridironed by railroads. These are the sole requirements for such a plan.

The essential difference between this method and the conventional one is in the assumption that this particular machine work is no more an indoor occupation than is carpentry, bricklaying, car repairing or structural ironwork, and that in such emergency it should promptly be decided that outdoor equipment is satisfactory.

Final inspection, cleaning, painting, toolmaking, etc., would be provided for in fully inclosed buildings at the delivery end of the plant; but the large part of the work would be performed with the lightest kind of shelter over machines, operators and transfer track, and in the opinion of the writer circumstances would not always justify even this.

The dimensions of the plant should be determined by the size of shell to be manufactured, and units of a given hourly capacity would be located between, and perpendicular to, two lines of railroad siding at the ends of the plant. One track would be entirely a receiving track

*Abstract from a paper to be presented at the spring meeting, Cincinnati, Ohio, May 21 to 24, 1917, of the American Society of Mechanical Engineers.

and the one at the opposite side a shipping track. The distance between the tracks would represent the proper length of each unit to avoid congestion and afford the simplest movement and transfer of product.

The number of units required, as so determined, would establish the other general dimension of the plant.

Assuming that the shell was to be the well-known British 9.2-in. high-explosive and the required output 250 per hour, the general dimensions of the plant would be approximately 1000 ft. long by 300 ft. wide, and it would contain six units each capable of producing 42 shells per hour.

Each unit, commencing at the rear of the plant, would start with an unloading platform and extend in a double row of opposed machines for the different operations toward the finishing end, where the machinery installation would be replaced by hand operations and inspection, to the packing and shipping track.

From the end of the machine installation to the finishing end a single-story shelter would be built to house these operations and also the tool-maintenance sections.

All machine tools would necessarily be horizontally belted, but since space is not considered, the convenience of having all transmission machinery within easy reach is a consideration.

In the construction of the plant, lines of concrete piers would be located to carry the line shafting, storm-water drains would parallel the lines of piers, concrete foundation walls for the machine tools would come next, and transfer tracks intermediate the machine foundations.

Distribution System for Cutting Compound

Throughout the length of each machine-foundation wall would extend a cutting-compound drain to a sump and pump at the end of the line or at intermediate locations. From each concrete pan under or at the machines would extend a chip channel, having a slightly raised bottom, connecting with chip tanks sunken in the ground and covered, but readily removable by the cranes.

Between each two rows of machines would be an industrial railway upon which would be operated platform cars for transfer. At each machine would be car-floor-height platforms from and to which all tools and material would be transferred.

Such a complete plant could be erected and operated to capacity within 60 days from the time authority was given to build it.

The purpose of this paper is to invite discussion, suggest a practical departure from the conventional and present a method of emergency construction.

A complete series of machines for all shell-making operations could be designed along lines that would permit of their construction in immense quantities within 30 days from the time when the necessity for them arose, and at a rate of output that would supply any conceivable demand within the following 60 days.

The United States Government could easily be prepared to deliver such machines in the desired daily quantities within 30 days by the following method:

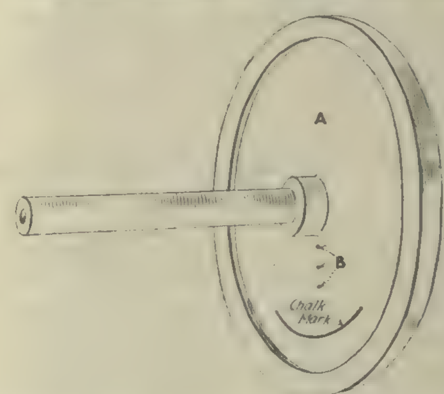
In each selected industrial center establish a Government storage plant in which would be stored the necessary patterns, jigs and equipment to make such machines, and in which would also be kept a list of the plants in the territory equipped to make the required parts. Upon order from Washington the patterns would be shipped to the designated foundries and, beginning with the third day, castings would be received at the rate of one casting a day per pattern. It would probably require about three weeks to manufacture the various working parts of the machine, but within 30 days at the outside completed machines would be ready to run in the munition plants. The number of machines added to the equipment daily would be the same as the number of patterns from which castings were made. This record could be bettered by stocking in the warehouse the various machine parts, aside from the large bed castings, sufficient to make up machines of a desired daily output during the period found necessary. If this were done, completed machines could be delivered to the munition plants within a week of authorization by the Government.

Ten such manufacturing centers could be established, as for example, Philadelphia, Cleveland, Cincinnati, Buffalo, Pittsburgh, Minneapolis, Milwaukee, Birmingham, St. Louis and Chicago, and within 30 days each unit could be producing shell-making machines at the rate of from 10 to 40 machines a day, depending on the size and nature of the machine being produced. Moreover, the total cost to the United States Government for the patterns, jigs and equipment necessary for such a plan of preparedness would be approximately but $1,000,000.

Peening a Disk Straight

By Horace Welch

The disk shown at A was 40 in. in diameter, $\frac{3}{8}$ in. thick and had a rim $1\frac{1}{2}$ in. wide. The hub was only $2\frac{1}{2}$ in. through and was bored $3\frac{1}{2}$ in. to press on the shaft at 20 tons. After the pressing, the job was put back on the



SHAFT WITH DISK THAT WAS PEENED STRAIGHT

lathe centers and found to be $\frac{3}{32}$ in. out of true on the edge. A second shaft fitted to the disk showed just as poor results. It was corrected by peening.

After marking the disk with chalk where it ran out, I laid it on the floor and peened it heavily at *B* with a 5-lb. hammer, testing it continually until it ran perfectly true. Peening on the same side as the chalk mark stretched the steel there and threw the disk in the opposite direction, causing it to run true in the lathe.

A. S. M. E. Convention

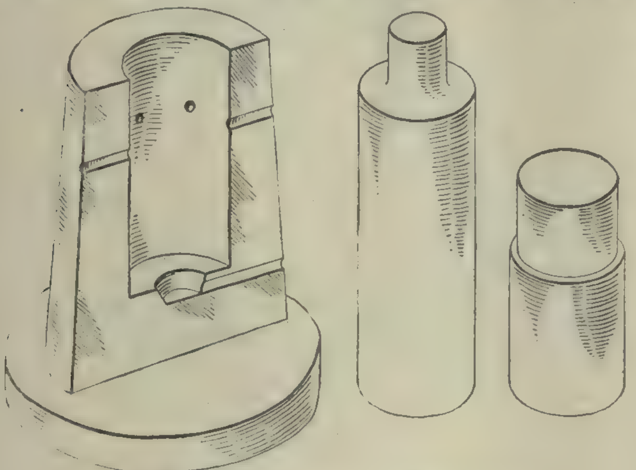
The latest booklet issued by the Cincinnati Milling Machine Co. calls attention to two things: One that the American Society of Mechanical Engineers meets in Cincinnati, May 21-24, and the other that this company has some interesting features to show visitors.

Cannon for Removing Rusted Bolts

By Joseph K. Long

When repairing locomotives in the shop, it is necessary to remove dozens of bolts, take frames apart, cylinders off, etc. Some of these are in so tight that they cannot be driven out with a sledge, and often they have to be drilled out.

The cannon, illustrated herewith, will take tight bolts out in a hurry. To the left of the diagram are shown a top and sectional view of the device, the fuse hole, and



CANNON FOR REMOVING RUSTED BOLT

the depression at the bottom. The plungers are $\frac{1}{16}$ in. less in diameter than the bore of the cannon, which is $2\frac{1}{4}$ in. Paper is wrapped around the plunger to make it air-tight.

The plunger with the reduced-size end is used where a bolt is broken off flush with the frame. The diameter is such that it will enter the hole when the explosion takes place and loosen the bolt. After it is once started, the bolt comes out easily. The flat end plunger is used where the ends of a bolt protrude. Care must be taken when using this outfit to see that the plunger, when set in on top of the powder, is tight against the offending bolt. This is easily done by driving a wedge under the cannon, but it must be set squarely. No tamping is necessary, as the paper wrapped round the plunger answers the purpose.

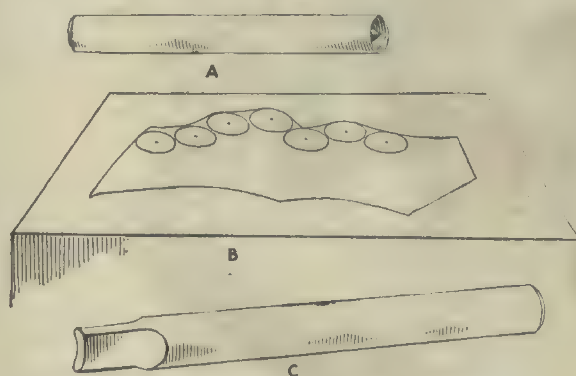
It is best to use this cannon during the noon hour, when there are not so many men in the shop, and to put heavy blocking around it and on top of the bolt, so that the bolt will not fly or the cannon do any injury. The man using the "gun" should have a helper who will keep every one away while the cannon is doing its work. This contrivance is a good thing to have, and I have never heard of any one being hurt, as the necessary precautions are always taken. We use smokeless powder from $\frac{5}{8}$ to 1 in. deep in the cannon.

Roughing Out Blanking Dies

By A. C. K.

After reading Mr. Pusep's articles on "Roughing Out Blanking Dies," page 166, I cannot help but submit my way, which I consider much easier and quicker. To use the punch he describes, it is necessary to draw a model line, then a line as a guide for the punch, which takes considerable time on a die that has an irregular outline. To make a punch that will eliminate the drawing of a second line, I put a piece of drill rod, 0.015 in. larger than the drill I decide to use, in a spring chuck in the lathe and with a lathe tool or graver form a fine point in the center; also a sharp outer edge, as shown at *A*. Harden and draw, and it is ready for use.

After drawing the blank outline on the die block, I put the sharp edge of the punch on the line and tap



THE SPACING CENTER PUNCH AND DRIFT

lightly, which leaves a center punch mark and circle to which I set my punch for the next hole, as shown at *B*.

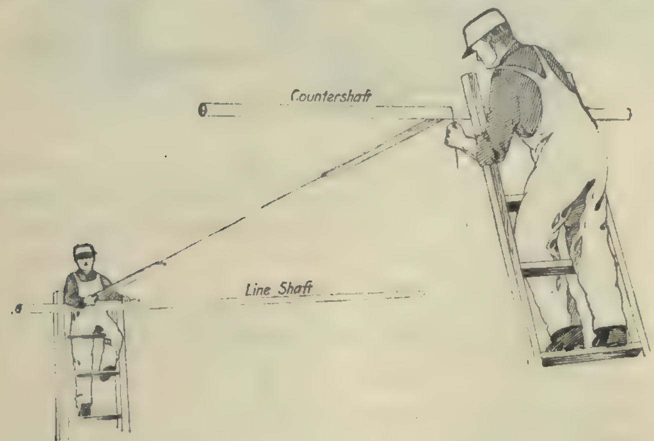
After drilling, there is a web left between the holes; to remove this I make a drift from drill rod twice the diameter of the drill used minus 0.015 in.; file or mill it on two sides to 0.010 in. thinner than the drill, round the other two sides to approximate the drill radius, put a slight concave in the end, as shown at *C*, harden and draw, and it is ready to use.

To remove, or rather separate, the pieces and at the same time remove the web, drive the drift through the perforated places and the piece will come out and leave 0.0125 in. for finishing.

Lining Up Widely Separated Line-shafts and Countershafts

By J. A. Raught

On page 967, Vol. 45, and page 253, Vol. 46, G. B. Fairman and Daniel W. Rogers, respectively, describe methods of lining up countershafts at a distance from the lineshaft, both using the floor to aid them in getting their points. However, with the floor obstructed with machinery, partitions and other immovable things, I have found it necessary to resort to a different method. The method I employ in such a case is shown in the accompanying drawing, which is self-explanatory. Since adopting this method I no longer go to the trouble of chalk-lining the floor. Of course, in this method it is necessary to have a man at each end of the line.

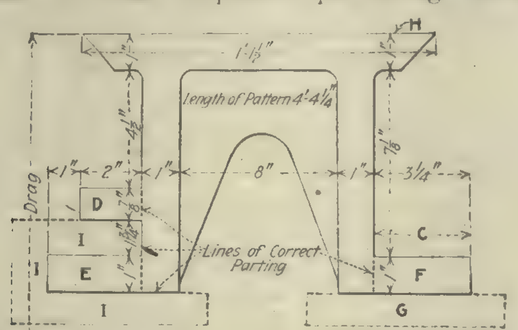


METHOD OF LINING UP THE SHAFTS

How Would You Make This Pattern?

By M. E. Duggan

Ten castings were required. The patternmaker who made the pattern does not believe in reading technical journals. He made the pattern split through the middle at the center line vertically, one-half of the pattern in the drag and one-half in the cope. A core 8 x 10 in. by 5 ft. long was made for the pocket. After the pattern was delivered at the foundry, the molder suggested a more practical way to make and mold it. The molder's method is as follows:



THE PATTERN AND THE CORRECT WAY OF MOLDING

Plan and make this pattern to be molded in the drag, with the parting or cope face up, as at *H*. Make *D*, *E* and *F* loose on the pattern; *D* and *E* and the coreprint are made in one piece, loose on the pattern, as shown by the heavy dotted lines; *F* and *G* are one piece and loose. The molding is done as follows:

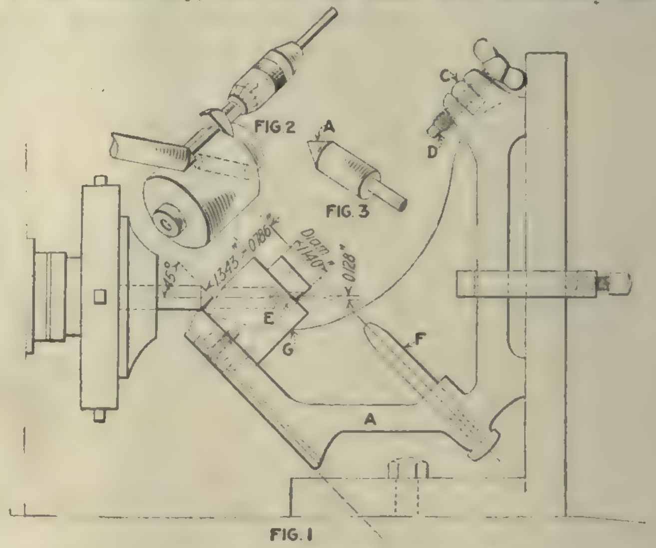
The pattern is placed in the flask with the cope face *H* down and resting in the "bottom" board. Sand is filled in up to the top of the prints *I* and *G*. At this point the filling in of the sand is stopped, and the loose pieces are lifted out of the mold. The cores *I* and *G* are now set in place in the mold, the filling in of the molding sand is continued, the drag is finished and rolled over ready for the cope. The making of the cope requires no description. The whole pattern is molded in the drag.

Precision Locating Method for a 45-Deg. Hole

By Walter Gabriel

The illustration, Fig. 1, shows a side view of a drilling jig clamped to an angle plate, the latter being secured to the miller table. The jig consists of the casting *A*, the locating stud, the swinging leaf *C*, which contains the clamping screw *D*, the drill bushing *E*, and the locating pin *F*.

The four feet on the bottom of the jig were finished in the usual way, and the two bases were accurately finished to an angle of 45 deg. The center lines of the stud *G*, the drill bushing *E*, the pin *F* and the screw *D* were all in the same plane.



FIGS. 1 TO 3. THE JIG AND METHODS OF TESTING
Fig. 1—The finished jig. Fig. 2—Testing the plug. Fig. 3—Testing the bushing

To accurately determine the location of the hole for the drill bushing *E*, a piece was turned up parallel in the miller chuck and tapered off on the end, to an included angle of 90 deg. The table was then adjusted to get the center of the stud in alignment with the machine spindle, and then the location of the 45-deg. hole was effected by raising the knee of the miller until the turned piece just touched the periphery of the stud, and the distance from the shoulder to the piece was 1.345 in., which could be measured with the micrometer depth gage, Fig. 2.

The hole, which had previously been drilled out approximately, was then bored to the proper size and the drill bushing inserted.

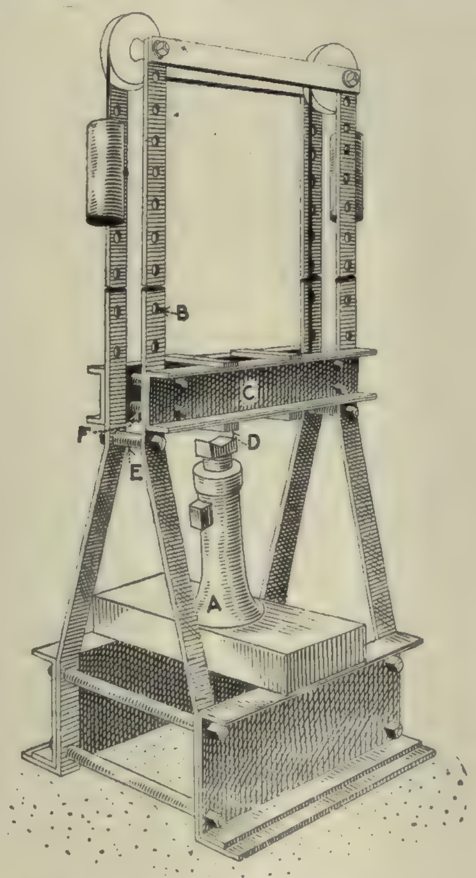
The 0.128-in. hole in the bushing was finally checked up by sliding in the ground piece shown in Fig. 3 until the point *A* was just even with the periphery of the piece (Fig. 1). Then the distance from the point to the shoulder was measured and found correct.

A Home-Made Forcing Press

By James E. Myers

In the small shop, where expenditures and space are limited, we must often resort to makeshifts and tools of our own manufacture to overcome the difficulties connected with the general run of work in the jobbing shop. The accompanying drawing shows how we eliminated the bane of the machinist's life—the sledge-hammer fit.

Shoproom being scarce, we decided to go up, and the results have been most gratifying. The press, as we built it, has uprights 12 ft. long and will handle almost any



HOME-MADE FORCING PRESS

job rapidly and well. At A is an ordinary portable "whiskey" jack. We have also used a common screw jack when the big jack was out on a job, or could not be secured.

The drawing is self-explanatory. The stop-pin holes B in the uprights we spaced to 6-in. centers. In the ends of the crossrail C, matching up with the stop-pin holes B, we drilled two holes; the first, from the top edge of the crossrail to the center, is $3\frac{1}{4}$ in. and the second $7\frac{1}{4}$ in. which gave us a minimum adjustment of 2 in. to the crossrail. The bars D are fastened to the small plates directly above them by stiff tension springs, which hold them snugly in place at all times but leave them free enough to be moved to suit the job in hand, be it either a press fit or a straightening job. When used as a straightening press, the shaft, or bar, is put through between the uprights, lengthwise of the press, and laid on short studs E; the bars D are adjusted to suit the bend, the crossrail C is pulled down, the $1\frac{7}{8}$-in. cold-rolled stop pins are inserted in the nearest holes and the pressure applied.

The spacers F are long enough and set far enough apart so that while acting as guides they still allow the crossrail to be moved freely up or down.

With a few short pieces of 2-, 4-, 6- and 8-in. pipe faced on both ends and a number of extra bars of $\frac{3}{4}$-, 1-, $1\frac{1}{4}$-, $1\frac{1}{2}$- and 2-in. square cold-rolled stock handy, the pressing in or out of pins and bushings and the changing of automobile transmission gears becomes a pleasure.

The pump, being hand-operated, allows one to get the "feel" that is so essential in straightening work.

Forming an Awkward Radius in Sheet Steel

By George Wood

Referring to the article by W. D. Forbes on page 178, it is my opinion that the tool maker desired to convey the idea that he obtained the radius by some wonderful work.

However, the job itself seems simple enough, for in the course of experimental work I have often had occasion to make pieces similar to the one described.

I would form this particular piece with the aid of two pairs of $\frac{3}{4}$-in. parallels, a $1\frac{1}{2}$-in. piece of round stock and four spacing blocks, two of $1\frac{1}{2}$ and two of $1\frac{5}{8}$-in. thickness, as shown in Fig. 1. One set of the parallels would be spaced with the $1\frac{1}{2}$-in. blocks and the whole held together by means of suitable clamps. The $1\frac{1}{2}$-in. piece of round stock would then be placed between this set of parallels. This arrangement could be used to act as the male part of a forming die. The other set of parallels would be spaced with the $1\frac{5}{8}$-in. blocks clamped together and used as the female part of the die. Then it is only necessary to place the three units in the vise, square them up and press the $\frac{1}{16}$-in. stock into the female die. Of course, the stock is left generously oversize and when taken out of the vise will look as shown in Fig. 2. It is then a simple matter of laying out and cutting the sheet to the proper dimensions.

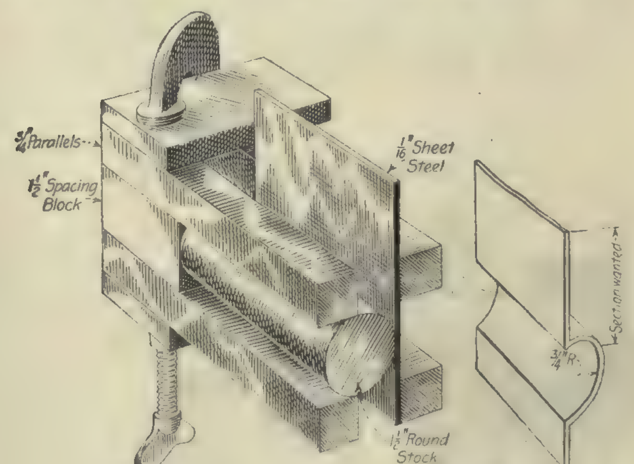


FIG. 1 The Method used to make the Piece FIG. 2 The Shape of the Piece produced

FIGS. 1 AND 2. WORK AND THE METHOD USED

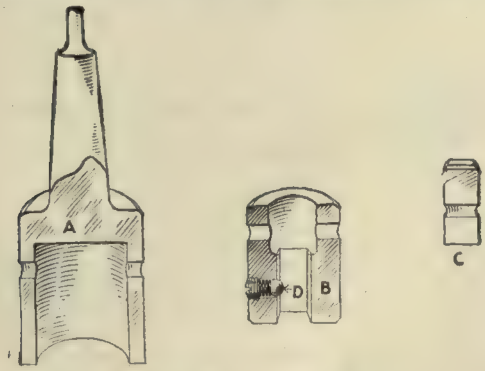
How the tool maker knew the radius was about 0.001 in. oversize can be accounted for easily. The piece would naturally open up 0.001 in. or so when taken out of the vise.

Quick-Acting Tap Chuck

By K. F. Rausch

The illustration shows a tap holder and driver that permit easy and quick removal and replacement of the tap.

At *A* is shown the main body of the tool, which receives the tap holder shown at *B*. The tap holder is pinned in



QUICK-ACTING TAP CHUCK

place with a removable pin, to enable the use of holders for various sizes of taps in the same main body.

The tap shanks *C* have a recess ground around them close to the top, as shown. This permits the ball in the holder to engage and hold the tap in place.

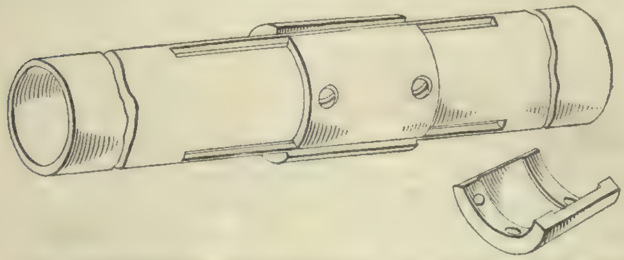
The holder *B* fits into the body of the tool, and the square hole receives the tap shank. Clearance is provided in the round hole. The ball is held in place by a few coils of a small stiff spring backed up by a short grub screw.

Lap for a Long Hole

By Henry J. Notz

Having a steel cylinder $2\frac{3}{4}$ x 26 in. long to bore, I found it quite a task to bore it smooth, straight and round, using the old method of clamping the cylinder on a lathe carriage with the boring bar between centers. Owing to the pressure of the clamps and the length and diameter of the bore, the required accuracy could not be obtained by boring. I then decided to make a lap, as shown in the illustration, similar to one that I had made before.

Upon a piece of $2\frac{1}{2}$-in. pipe of suitable length and about equidistant from each end were placed three sections of a cast-iron bushing that was one-third the length of the cylinder to be bored. Before cutting this bushing length-



LAP DESIGNED FOR HOLE TOO LONG TO BE BORED

wise into the three sections, it was bored to fit the outside of the pipe. After the sections were mounted upon the pipe, they were turned to a size 0.010 in. larger than the bor d cylinder. Three $1\frac{1}{8}$ slots 16 in. long were then milled in the pipe. These slots were cut in the same line with the split bushing and practically equidistant from each end. The three slots permit the lap to expand and contract.

When this type of lap becomes worn, it can be very easily brought to the required size by placing paper or thin metal shims under the pads or sections. The pads may be made of cast iron, brass or copper, according to the material to be lapped.

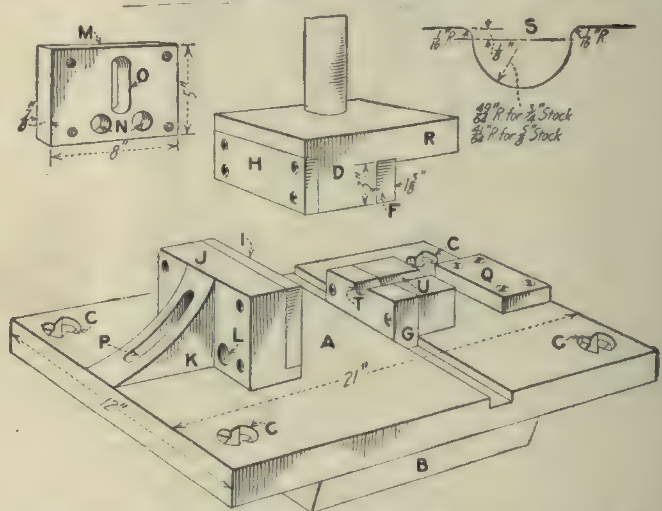
Punch and Die for Round Stock

By Hugo F. Pusep

The shearing-off punch and die here presented were built for continuous duty, shearing $\frac{5}{8}$-in. rods to length.

The illustration shows the construction of the punch and die. At *A* is the cast-steel die shoe, or rather combination of bolster plate and die shoe, because it is intended to be bolted direct to the press in place of the regular bolster plate, through the T-head bolt holes *C*. The part *B*, which is cast integral with *A*, is a reinforcement necessary on account of the heavy jarring incident to the work.

At *D* is the punch holder, made of cast steel, with a shank for securing it to the press ram. The shearing blades *F* and *G* of the punch and die are identical; they



SHEARING PUNCH AND DIE FOR ROUND STOCK

are made of tool steel hardened and ground, as are also the guide plates *H* and *I*. The projection *J*, to which the guide plate in the die is fastened, is further reinforced by the thick web *K*. Four $\frac{3}{4}$-in. special square-headed screws secure the shearing blades, the holes in the blades being countersunk for screw heads. The guide plates *H* and *I* are held by eight $\frac{5}{8}$-in. fillister-headed screws, as can be seen clearly in the illustration.

The holes *L* through the projection *J* are opposite the screw holes in the shearing blade *G* of the die. The purpose of these holes is to serve as clearance holes for a long socket wrench, thereby making it possible to change the shearing blades without disturbing the alignment of the punch and die in the press. At *M* is shown the lower guide plate, with clearance holes *N* for the socket wrench. These holes, of course, correspond to the holes *L*. The elongated slot *O* is the clearance slot for the stock and is opposite the slot *P*, extending through the web *K* and the projection *J*.

An adjustable stop, not shown, is secured to the planed surface Q by four capscrews. The machined recesses serve to seat the shearing blades and insure them against side motion. An enlarged view S shows the round-bottomed cutting groove T of the shearing blades, which are identical for both the upper and the lower shears. Two sets of shearing blades were made with this punch and die, one set each for shearing $\frac{5}{8}$-in. and $\frac{3}{4}$-in. stock, the dimensions of the various radii being given.

In action the punch and die work as follows: The bar stock is inserted through the elongated slot P into the cutting groove T and along the clearance groove U till it comes in contact with the adjusted stop, when the punch, descending, shears off the stock. It takes two men to operate this punch and die successfully—a helper to feed the bar stock, and the punch-press operator to trip the press and remove the sheared rods.

Sharpening Rifle-Barrel Drills

By W. L. Olmstead

Methods having a bearing on greater production have probably not been overlooked by the men in charge of barrel drilling in shops using barrel-drilling machines for drilling the hole in the barrel of a modern military rifle. It is a fact, however, that the method used for resharpening the drill is not generally given the consideration warranted for a maximum output.

The output of one large manufacturer for one unit of 10 two-spindle horizontal-type machines is 170 to 175 bbl. every 10 hours, approximately 35 min. for drilling each barrel. The barrels are $32\frac{1}{2}$ in. long, 0.315 bore. The feed approximates $1\frac{1}{4}$ in. per minute.

In this connection, it is interesting to mention that one firm scrapped only 300 barrels out of a total of 250,000 finished barrels—one-eighth of 1 per cent. This was only made possible by consistent attention to the methods used by the men held responsible for the manufacture and upkeep of the drills. In this shop an average of five drills is required for 1000 barrels.

Experience has proved that a barrel drill that has been sharpened on an emery wheel will not produce satisfactory results when ground to mechanical form on either a wet or a dry wheel. One of the objections to the emery wheel is that it has a tendency to draw the temper along the entire cutting edge or burn in minute spots, allowing a rapid breaking down of the keen edge of the drill when in use. The rapid breaking down of the emery wheel during abrasion is also unfavorable for obtaining a smooth, close-grained cutting surface on the lip of the drill, the minute particles of detached emery scoring the surface. This considerably lessens the endurance of the drill.

It has been demonstrated that the best results are obtained when the drill has been sharpened on a wet grindstone by a man trained to the work. The sharpening should not be done in a perfunctory manner, nor the responsibility placed with the operator of the machines. One well-trained man can perform the sharpening operation for 60 spindles. He will soon find that drills for some spindles require a certain style of grind, owing to some peculiarity in the motion of the machine. Oftentimes the spindle thrust adjustment, equipped with ball bearings, cannot be kept in perfect adjustment, the balls becoming out of round or flatted, with resultant pounding of the barrel against the drill. In general, spindles show this condition from vibration up to a perceptible pounding, and it has a marked effect on the efficient work of the drill.

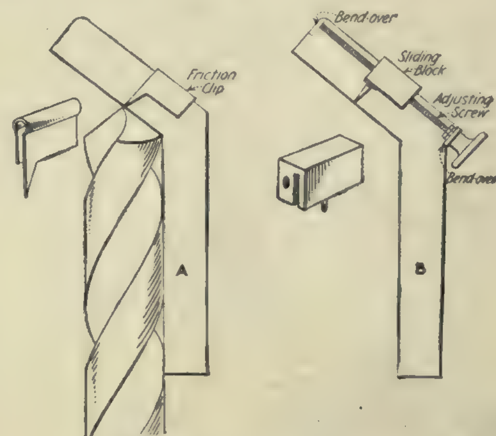
The drills can easily be sharpened to offset this and other drawbacks to efficiency by a man especially assigned to the work. Drills that are sharpened to a set form by Tom, Dick or Harry cannot do the same effective work. It takes only one spark from an emery wheel to cause drilling trouble.

Grinding Gage for Use in Sharpening Twist Drills

By H. H. Parker

The illustrations show a couple of modifications of the angle gage sometimes used for determining the correct angle when sharpening twist drills. Means is provided for assistance in making the lips of equal length.

The body in each case is made of sheet steel shaped to the proper angle for the drills. Then a sliding pointer



GRINDING GAGE FOR TWIST DRILLS

is provided for determining the width of the lips. In one case this is merely a spring-steel clip which is held by friction and which may be slid along the inclined end of the gage. At B is shown a more elaborate arrangement, where a grooved block straddles the gage body and carries the pointer. This block slides along as in the first arrangement, but may be closely adjusted by means of a knurled-head screw. If desirable, a pointer may be attached to each side of the sliding block.

Drawing Out High-Speed Steel Under the Hammer

By J. A. Raught

On page 162, James Ellis speaks about drawing out short solid tools to fit toolholders. I have been practicing this method for some time, but the bits drawn out recently do not stand up. They do not seem to show the same velvety grain that they did before they were forged; the grain in them is dark and coarse and more like that of fine-grain cast iron. Can someone suggest a remedy?

Machine Tools and the Matter of Priority

An Editorial

ALL of the munitions used on the battlefield—the cannon, the field gun, the automatics, the rifles—and all of the ammunition—the shells, the cartridges and bombs—are created by machine tools.

All of the means of motor transport on land and through the air—the motor trucks, the "tanks," the motor ambulances the airplanes and the dirigibles—are the product of machine tools and metal-working machines.

All of the locomotives and freight-cars and the rails over which they carry the coal and iron and steel and merchandise of many sorts needed by a modern army exist solely because of the prior existence of machine tools.

All of the eng nes in ships at sea, their propeller shafts and propellers, their auxiliaries—pumps, dynamos, motors, cranes, hoists—the thousand and one mechanisms of the battleship and the hundred and one mechanisms of a cargo ship—come into existence through the operation of machine tools.

Then why overlook the builders of machine tools when it comes to priority in the distribution of raw materials?

□ □

If it is because of the belief that the existing machine tools are sufficient, and that more will not be needed, why are deliveries on machine tools now months behind and machine-tool builders forced by the demand for their products to seek Government advice as to the disposition of their first available machines?

The trouble is that the public and the public legislators and officials fail to perceive the fundamental place the machine tool occupies in all modern industries, be they applied to peace or to war. They see in the finished battleship and in the finished machine gun, highly spectacular products that we need and must have in order to win this war. They see in mach ne tools (if they see anything in them at all) prosaic mechanisms of secondary importance that can well be left to take their chances in the general scramble for materials after the really important things are given preference!

□ □

You men who build and use machine tools and who know that they are fundamental to mechanical industry, and that all modern industry is mechanical, are to blame for this public misconception. The men who do not know are not to blame. Education and instruction must come from those who know.

You, and we as well, are to blame, because we have never gone systematically to work to spread the economic truths about our business outside of our own field of machinery users. The *American Machinist* has been published for machinery builders and users—not for Congressmen and public officials. But we wish to tell you that Congressmen and public officials are hearing from the *American Machinist* now and that they will continue to hear from us—*and that they must hear from every one of you as well.*

For it is going to take a lot of hammering to drive home the facts that these people need to know about our business.

We must hammer home the fact that the increased efficiency that the President calls for means wearing out machinery as fast as possible to get the maximum production rate from it, and means then buying new and improved machines to take its place.

□ □

We must hammer home the fact that machinery—and all of it created by machine tools—is the vital factor in saving labor; and that labor, through machinery, must be greatly economized if we are to survive and help others to survive the world-wide labor shortage that confronts us. Machinery must be put to work before the women and children are put to work.

□ □

We must hammer home the fact that machinery—and all of it created by machine tools—must till the soil and reap the harvest, if armies abroad are to be fed and those at home kept from starvation and poverty.

□ □

We must hammer home the fact that machinery—and all of it created by machine tools—must weave and spin and sew the uniforms for our soldiers and the clothing that is to keep our wives and children warm; that it is the machine tool primarily that does this work, just as it is primarily the machine tool that mines the coal and the ores and that transforms the trees of the forest into wares of wood.

We must spread the truth that the machine tool, the sole modern means of creating machinery, is the vital cause back of all mechanical effects.

□ □

When we have made these truths as plain to others as they are to us, the following things are going to happen:

There will be no more talk or intention of devoting the entire output of the steel mills of this country toward the building of ships, disregarding the needs of those who build the machines that build and equip these ships.

There will be no more idea of getting machine-tool building plants to manufacture munitions, for it will be realized that one machine-tool building plant can, in a year, turn out enough machines to equip from four to ten munition plants of similar size based on equivalent equipment value. Those who at present advocate this plan might with equal judgment advocate commandeering the farmer's seed for food, instead of using it to produce its fourfold to tenfold harvest.

There will be no more false rumors, such as have been circulated during the past week, of the requisitioning of machine-tool building plants, and such as have tended to upset the plans and disturb the minds of those patriotically intent on speeding up the production of these machine-tool plants to meet the coming needs.

There will then be no overwhelming sense of patriotic sacrifice evident on the part of those who make a low price to the Government on materials for apparatus and munitions, and a high price to the builders of the machines that will be used for and by the Government in the transformation of these raw materials into finished form.

□ □

This editorial is going to every Representative and Senator in the United States, and to every member of the Council of National Defense, and its subcommittees. This is something that the *American Machinist* can do and will, and it is up to you machinery builders and users, also, to send a copy of this editorial with a letter of indorsement to your particular Congressman, and to any other public officials whom you know. Do this, and in addition to this, take united action, and that quickly, toward putting your business on the Federal map, and assuring our country of a sane priority that will protect the industry most vital to all others in war or peace.

Shop Equipment News

Toolroom and Heavy-Duty Lathes

A new line of toolroom and heavy-duty lathes has been placed on the market by the Joseph Crawford, Jr., Co., Erie, Pennsylvania.

A quick-change heavy-duty lathe is shown in Fig. 1. This is made in 20- and 25-in. sizes and may also be

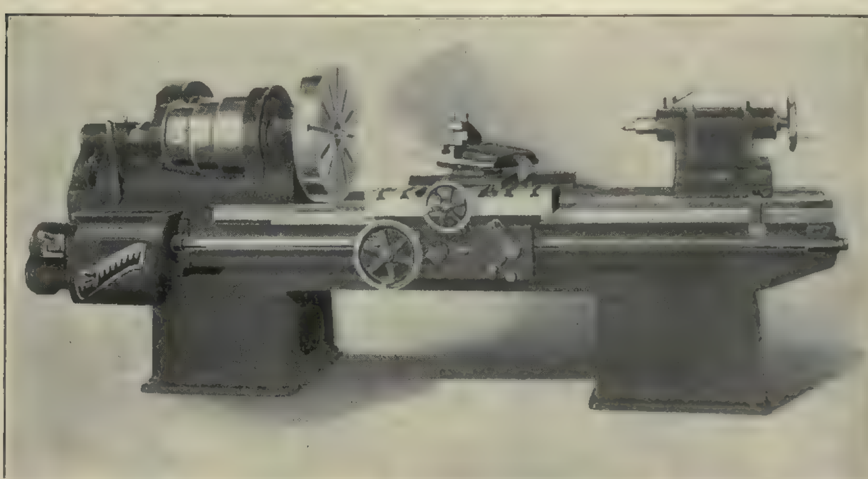


FIG. 1. QUICK-CHANGE HEAVY-DUTY LATHE

Swing over ways, 21½ in.; swing over carriage, 14½ in.; distance between centers, 46 in.; width of belt, 4 in.; diameter of front spindle bearing, 5 x 6 in.; diameter of back spindle bearing, 3 x 5 in.; diameter of hole in spindle, 2 in.; diameter of nose of spindle, 4 in.; diameter of tail spindle, 3 in.; travel of tail spindle, 8 in.; depth of bed, 14 in.; width of bed, 16 in.; toolpost opening, ¾ x 1¾ in.; capacity of center rest, 6 in.; ratio of back gears, 3.2 and 8.4 to 1; threads per inch cut, 1 to 56; countershaft pulley diameter, 14 x 14½ in.; speed of countershaft, r.p.m., 185; size of centers (Morse), No. 5; floor space, 2½ x 9 ft.; weight, 4200 lb.

had in the semi-quick-change style. The quick-change mechanism contains a train of 12 gears which, together with the three speeds given by the outer compound box, provide 36 speeds for threading or feeding. The hollow spindle is ground to size and threaded to receive a chuck or faceplate. All bearings are of the self-oiling ring type. The tailstock has a set-over screw for taper work and is moved along the ways by a crank rack-and-pinion mechanism. A cast-iron feed nut is used, the head screw being 2 in. in diameter with a four-pitch acme thread. Regular equipment includes large and small faceplates, steady and follow rests, countershaft, toolpost and wrenches. The lathes may also be had with taper attachment and with any length bed desired. A countershaft of the friction cone type is used. The 15-in. toolroom lathe is shown in Fig. 2. The spindle is of carbon steel ground to size and has a 1¼-in. hole through its entire length, terminating at the spindle nose in a Morse taper. The spindle nose is threaded 2¼ x 6 U. S. S. All bearings are bronze bushed.

Twelve gears in the quick-change mechanism, together with the compound box, give 36 speeds for threading or feed purposes. The taper attachment is bolted to the carriage and may be engaged instantly. The attachment allows the turning of all tapers up to 3 in. to the foot, 15 in. in length on a lathe with a 6-ft. bed. The spiral relieving attachment will do straight or taper, inside or outside relieving on both right- and left-hand work, with any number of flutes from 2 to 28. The attachment is mounted on the gear box, and the tool slide interchanges with the compound rest on the cross-slide, thus embodying the swiveling feature of the slide necessary for side and end relieving. Varying numbers of flutes are taken care of by means of change gearing supplied with the attachment. A universal joint and bearing block for axial relieving are furnished as an extra. The lathe is made either with or without tie-bar. The lathe may be fitted with oil pan and pump, taper attachment, collet equipment, and arranged for metric threading work as extras if so desired.

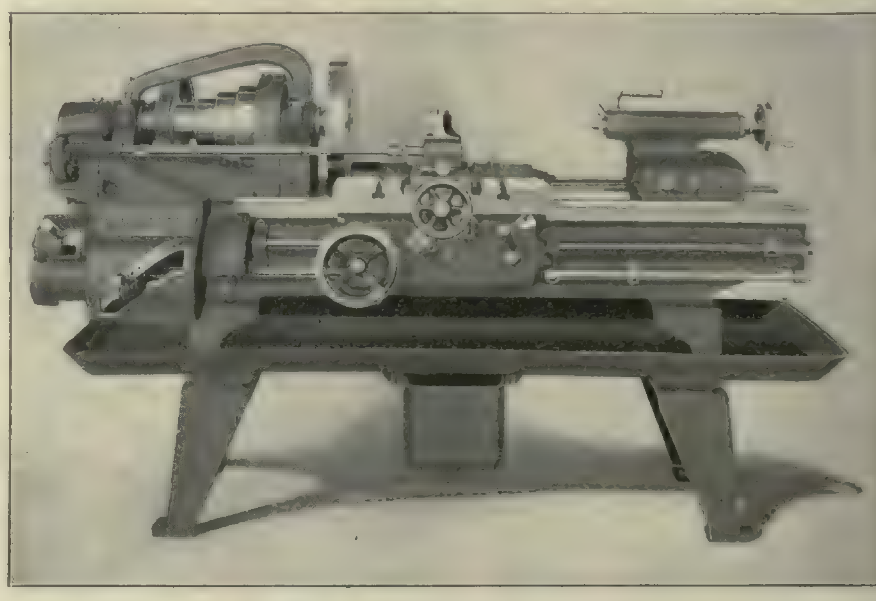
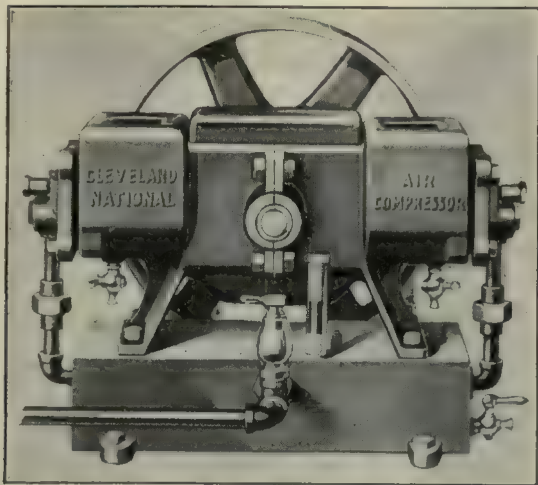


FIG. 2. TOOLROOM LATHE

Swing over ways, 16½ in.; swing over carriage, 9½ in.; distance between centers, 36 in.; cone diameters, 4, 5½, 7, 8½ in.; width of belt, 2 in.; hole in spindle, 1¼ in.; front bearing, 4½ x 2⅝ in.; back bearing, 3¾ x 2¼ in.; diameter of tail spindle, 1⅝ in.; travel of tail spindle, 6 in.; carriage bearing on ways, 21 in.; countershaft pulleys, 3 x 10 in.; countershaft speed, 150-180 r.p.m.; capacity of toolpost, ½ x 1 in.; capacity of center rest, 4½ in.; back gearing ratio, 8½ to 1; cuts threads from 1 to 56; centers, Morse taper No. 3; center, spindle sleeve, Morse taper No. 5; weight, 1900 lb.

Air Compressor

The air compressor illustrated has been placed on the market by the National Motor Supply Co., Cleveland, Ohio. It is of the double-opposed type, with a 2-in. bore



AIR COMPRESSOR WITH DOUBLE OPPOSED CYLINDERS
Cylinders, 2 x $2\frac{1}{2}$ in.; capacity, 5 cu.ft. of free air per min.; horsepower required, $\frac{1}{2}$

and a $2\frac{1}{2}$-in. stroke, both pistons and the yoke being cast in one piece. The crankshaft is a drop-forging, and all bearings are bronze bushed.

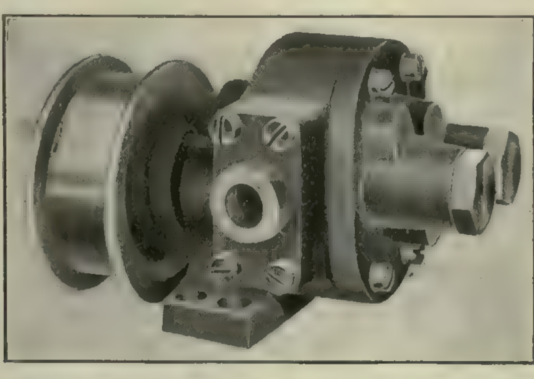
Water-cooled cylinders are used. Both inlet and outlet valves are contained in the cylinder heads, which may be removed without disturbing either the cylinders or the pistons. From the cylinders the air is pumped to an auxiliary base tank that contains a series of baffle plates for removing oil and moisture.

A check valve is placed between the base tank and the main storage tank; and when the compressor is stopped, the air gradually escapes from the small base tank. This acts as an unloader and allows the compressor to get up speed, when again started, before having to pump against the full pressure in the main storage tank. The machine can be supplied for either belt or motor drive, and either with or without automatic pressure regulator.

Gear Pump for Cooling Oil

The Inter-State Machine Products Co., Inc., Rochester, N. Y., has placed on the market a pump for circulating cooling oil on lathes, screw machines and other machine tools.

The pump is of the well-known gear type, the one shown being equipped with automatic relief valves—a feature



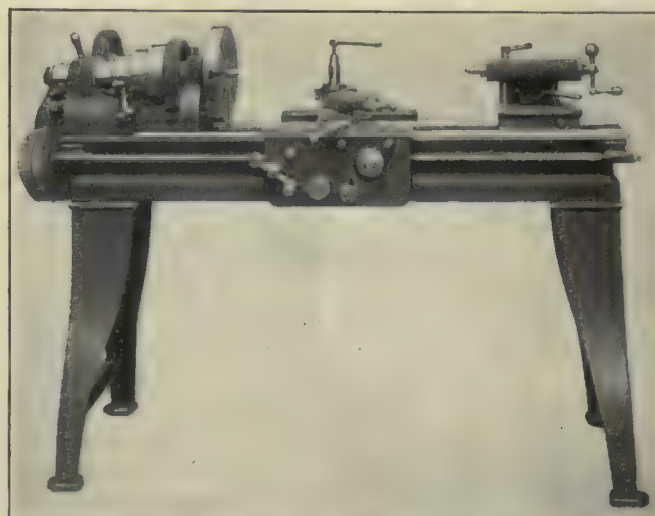
GEAR PUMP WITH AUTOMATIC RELIEF VALVES

that allows the operator to shut off the liquid at the point of discharge without creating undue pressure in the pump and makes the use of an auxiliary relief valve unnecessary. Pumps are also furnished without the automatic relief valves, if so desired. Steel gears are used. The weight of the pump is 11 lb., and its capacity is $1\frac{3}{4}$, $2\frac{1}{4}$ and $2\frac{3}{4}$ gal. at 300, 400 and 500 r.p.m. respectively.

Engine Lathe

The illustration shows the "Lancaster" 13-in. engine lathe manufactured by the Champion Blower and Forge Co., Lancaster, Penn. The spindle is of 60-point carbon steel ground to size and mounted in bearings of phosphor bronze. The hole through the spindle is $\frac{3}{4}$ in. in diameter and terminates at the inside end in a No. 3 Morse taper.

The bed is made with three V's and one flat. An offset tailstock is used to allow the compound rest to swing parallel to the bed. Carriage and apron are cast in one piece, the apron being equipped with a safety device that



ENGINE LATHE
Swing over shear, $13\frac{1}{2}$ in.; over compound rest, 8 in.; over carriage, 9 in.; distance between centers with 5-ft. bed, 30 in.; front spindle bearing, $1\frac{3}{4}$ x $3\frac{1}{4}$ in.; rear spindle bearing, $1\frac{1}{2}$ x $2\frac{5}{8}$ in.; spindle nose threaded $1\frac{5}{8}$ x 10 U.S.S.; tail spindle, $1\frac{5}{8}$ in. diameter, 5-in. traverse; centers, No. 3 Morse taper; cone-pulley diameters, 7, $5\frac{3}{4}$, $4\frac{1}{2}$ and $3\frac{1}{4}$ in.; width of belt, 2 in.; ratio of back gearing, $8\frac{1}{2}$ to 1; spindle speeds, 16; travel of compound rest 4 in.; size of tools, $\frac{1}{2}$ x $1\frac{1}{8}$ in.; weight with 5-ft. bed, 1000 pounds

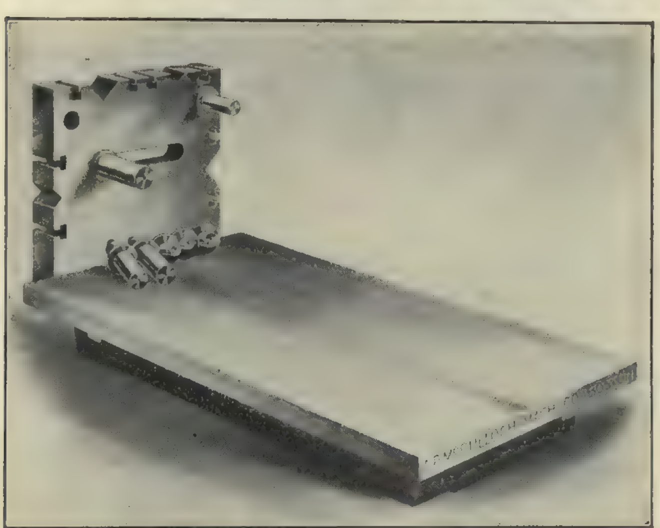
prevents the half-nuts from being thrown in when either feed is connected. The compound rest is graduated in degrees. Three feeds are available without the necessity of changing gears. Equipment furnished also includes follow and steady rests, change gears, large and small faceplates, double friction countershaft and wrenches. All gears are guarded.

Compound Bench Plate

The compound bench plate shown has just been placed on the market. It is the product of the A. P. McCulloch Machine Co., Boston, Mass., and has been produced especially for the use of inspectors of machine parts.

It consists of a flat plate, to one end of which is attached a vertical plate equipped with T-slots, V's, round holes and slots, as shown. Seven standard plugs of different sizes are furnished, which fit into the holes and

slots in the angle plate. By means of these devices various machine parts, including gear trains, jigs and fixtures, may be set up for testing and inspecting. The



COMPOUND BENCH PLATE FOR INSPECTORS

plate is furnished with either scraped or planed surfaces, and either plain or complete with angle, bronze yoke and seven standard plugs.

Safety Cleaning Tank for Tools and Small Parts

The cleaning tank illustrated has been placed on the market with the intention of providing a device by means of which oil, grease, chips or dirt can be quickly cleaned from small tools or machine parts with gasoline or other inflammable liquids without involving danger of fire. The Spicer Tabulating Machine Co., Washington, D. C., is the manufacturer. The tank body consists of a single casting the lower part of which forms a storage reservoir for the liquid. It is separated from the upper, or cleaning, chamber by means of a transverse partition and a removable strainer that prevents dirt from getting into the reservoir. A self-closing cover is fitted to the top of the tank; when this is opened for use, it brings into action a pump that raises fluid from the storage chamber and ejects it through a nozzle or vent against the article to be cleaned. The fluid enters all holes or corners forcibly, thus washing away the dirt and grease.

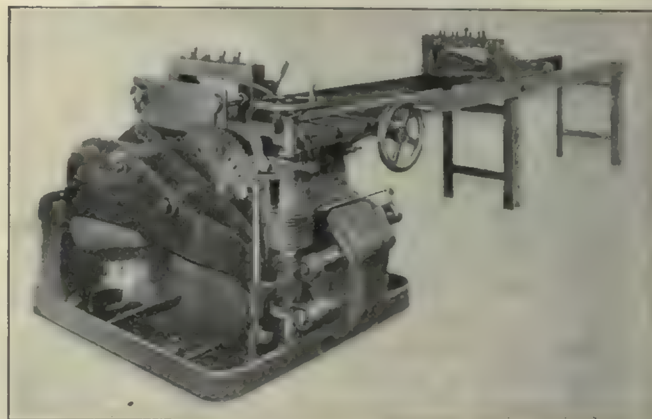
CLEANING TANK FOR TOOLS

The tanks are made regularly in 7-, 10- and 13-in. sizes, but any other reasonable size can be furnished if desired. They are made in either the pedestal type, as shown, or with a bracket to be fastened to the wall.

Cold-Metal Saw

The Earle Gear and Machine Co., Philadelphia, has recently placed on the market the special-type Lea-Simplex cold-metal saw shown in the illustration. The machine is designed especially for handling bars in multiple, the one shown being fitted for cutting twenty-four $1\frac{3}{4}$-in. round bars arranged eight rows wide and three high. The bars are arranged in vertical rows, not staggered.

The rear cradle is in the form of a carriage running on rollers on a structural-steel framework at the rear of the



MULTIPLE-TYPE COLD-METAL SAW

saw table. By means of this carriage and a handwheel-operated lead screw the work is fed to the successive positions for cutting. The lead screw is equipped with a releasing nut, which permits a quick return of the carriage to the loading position.

While being cut, the bars are held in position by means of clamp screws, one being placed over each vertical row of bars. An adjustable gage plate is attached to the front of the cradle on the saw table. A sheet-metal apron, or chute, is so placed as to carry away the stock as fast as it is cut. This apron is above the upper limit of the travel of the swinging arm, which feeds the saw to the work.

The boxes into which the chutes discharge the finished work are made with double bottoms and outlets for returning any cutting compound to the base of the saw. The base forms a tank for the cutting compound, and a gear-type lubricant pump is provided. The saw blades are of the solid milling toothed type. In operation an automatic stop and power return stop the travel of the saw when the cut is completed and drop it below the level of the table on the return.

Convention of National Metal Trades Association

The nineteenth annual convention of the National Metal Trades Association was held at the Hotel Astor, New York City, Apr. 25 and 26.

The following officers were elected for the coming year: President, W. H. Van Dervoort, of the Root & Van Dervoort Engineering Co., East Moline, Ill.; first vice president, Murray Shipley, of Lodge & Shipley Machine Tool Co., Cincinnati, Ohio; second vice president, H. W. Hoyt, of the Great Lakes Engineering Co., Detroit, Mich.; treasurer, F. C. Caldwell, of H. W. Caldwell & Son Co., Chicago, Ill. Homer D. Sayre, Peoples Gas Building, Chicago, was reappointed secretary.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., May 12, 1917—Not a day passes without bringing letters from different parts of the country asking how to get in direct communication with the right party to utilize some particular plant or manufacturing capacity. In answering these inquiries I can do no better than to quote from a recent interview with Secretary of the Interior Lane in the New York *Times*, who calls the war "a test of the ability of this particular democracy, the United States, to organize itself out of and away from the dangers of economic anarchy. There is a country-wide willingness to serve; its usefulness will depend on the ability of the Government to translate that willingness into effective effort, freed of waste of time, materials and money."

Offers of ideas, of service and of material are flooding the capital. But the machinery for using it all, in the way that will do the most good, has not yet been perfected. It is a slow process. The indispensable thing is an agency for coördination, and that seems to be lacking. Here is a case in point: Practically all the available steel of the country was offered to the Navy Department and accepted for the building of big warships that are needed, but which cannot be finished for several years. This meant the diverting of steel from other industries, which has seriously handicapped the country in its work of feeding the Allies and in making its own internal preparations for war.

The steel should not have been turned over to the Navy Department, but placed at the disposal of the Government, to be parceled out in a more immediately effective way. And so with all classes of material and effort.

It should be stated here that the Priority Board is not yet an actual part of the system. This the secretary believes to be necessary to tie the groups together. He says:

"The group organization is progressing rapidly, but the groups themselves must be tied into a whole machine abundantly lubricated with the oil of coördination. The transportation of the country has been organized into an interlocking whole, making 250,000 miles of roads into a single coöperative system and eliminating wasteful competition. Even now the duplication of trains on the roads running into Washington on different roads is being eliminated to save locomotives and cars for other work. But that does not go far enough. Beyond all this arises the question as to what shall be shipped first, and in what quantities."

This will give some idea of the situation as viewed from one in a better position to know than any correspondent can be, and his advice seems to be sound in every particular. The sooner this coördination can be secured, the faster we shall get on and the fewer mistakes we shall make. And when that time comes, we shall be able to find out exactly what to do and when to do it, with the least possible delay.

In the meantime we can only offer our services, get our shops in the best possible condition for efficient work and wait the call that is sure to come, unless of course our regular work is of more importance than any new work we might undertake. In that case the Council of Defense will recommend that it be not disturbed. In fact, it is the intention to disturb existing business as little as possible; and where it is necessary to do so, to take only a portion of the plant for the new work. In this way the old line of business and of customers can be retained to a large extent, which will be much better when the period of readjustment comes after the war.

No Time for Experimental Work

As soon as Congress takes off the brakes, which will possibly be before this gets into print, the one watchword in every shop should and must be production and ever more production. This does not refer solely to the manufacture of munitions, but of everything that enters into both military and civil life during wartime. With the working force depleted by those in military service and the regular lines of industry made supplementary to the supply of military material, the greatest economy of production becomes necessary; and this means producing the greatest quantity with the least waste of material and the least expenditure of time and labor.

This naturally leads to the abandonment of practically all experimental work except such as is absolutely necessary to develop something that has been found meritorious or a new device that is considered absolutely necessary. It is obvious, however, that it is not the time to design a new airplane motor and present it to the aviation board with the idea of its being adopted now, for no matter how excellent it may be, if it presents radically new ideas in either design or construction, it will probably take at least a year to develop it and another year to get it on a manufacturing basis.

The crying need of the aviation department is motors and more motors of the dependable kind. Our lack of support to the development of airplanes has resulted in a number of different types and designs of motors, but with only a very few of these on a manufacturing basis. In some cases, even with motors that have been specified by different boards, there has been almost no standardization; and even such obviously necessary standards as bolt

holes for fastening the motor to its bed on the plane have not been maintained. What is needed is a far greater capacity for turning out motors of acceptable workmanship from some of the designs that have proved fairly satisfactory in actual service, rather than new and perhaps better designs that cannot be manufactured in less than a year.

It was supposed that manufacturers in general knew that the shell-making capacity of the country is ample, not only for our own needs, but for any foreign orders that it might seem wise to divert to this country; but this does not seem to be the case. Word has just reached me that a silk mill in the vicinity of New York is equipping its shop to make shells, when there are several good shell-making plants with not only the equipment, but the experience, lying idle, one of them only 10 miles from the silk mill in question.

The question of shells is being well taken care of, and any attempt to get into this part of munition work will not only result in financial loss for those interested, but will take away productive capacity from other lines in which it will be needed. Any expenditure by a new plant for machinery for shell making is not only an unwise investment, but may take machines that are urgently needed elsewhere. The things that are needed now are cannon of various sizes, with the mounts and fittings that must go with them, material for the new ships that are just getting under way, airplane motors and similar parts, and a host of things that go to make up the supplies of an army; but shells and fuses are well provided for, especially the former.

The New Wooden Ships

While nothing definite has been given out as to the final decisions concerning the new fleet of ships, there seems to be little doubt that the following figures will be found approximately correct: Length, 275 ft.; width, 46 ft.; molded depth, 26 ft.; draft, 23 ft. The main propelling engines will be triple expansion of either 750 or 1500 indicated horsepower units, which will give a normal speed of 10 knots with a reserve large enough to bother a U-boat in catching them in a long chase. Turbines may also be used in some of them; but it is probable that reciproating engines will predominate, unless oil engines of the Diesel or semi-Diesel type can be secured, which seems doubtful. The boilers will be of both the water-tube and Scotch types, will carry 200 lb. pressure and have perhaps 15 per cent. excess over the rated engine power.

The necessary machinery will include that of any ocean-going vessel, such as propellers, condensers, air pumps, circulating pumps, boiler-feed pumps, fuel-oil burning apparatus, evaporators, feed-water heaters, forced-draft apparatus, fuel-oil tanks, refrigerating apparatus, piping and fittings, generator sets, wireless apparatus, steering engines, deck winches, capstans, windlass, anchors and chains, davits, bits and chocks, turnbuckles, wire and hemp rope, metal berths for cabins, galley equipment, lifeboats and navigating apparatus.

If you can supply any of this equipment complete, or any part of it, it would be well to get in communication with the Shipping Board, Munsey Building, Washington, D. C., at once, as there will probably be at least a thousand of these ships built, according to present indications.

When the time comes for ordering the thousands of things that must be ordered as soon as Congress acts, the probable procedure will be about as follows: The army, through its Ordnance Board, will probably announce the articles desired and call on the Munitions Board for information as to the firms likely to be in position to do this work well and quickly. Here is where the industrial inventory taken by Mr. Coffin's committee last year will come into play, and all those who seem to be equipped for the different kinds of work will be asked to bid on whatever it is believed they can handle to the best advantage. Specifications and blueprints will be furnished and the bids called for at an early date. This is not an official statement, but it is the probable method of handling orders, at least in the beginning.

Competitive Bids Probably Unsatisfactory

In cases where the work is entirely new to most manufacturers, owing to the fact that we are not and have never been a warlike nation, it will probably be impossible to secure competitive bids that will be at all satisfactory either to the bidders or to the Government. In such cases there is a provision made in a bill passed by Congress at a recent session, making it possible to give contracts on a "cost plus a specified percentage of profit" basis. It seems likely that there will of necessity be considerable of this kind of work, which makes it highly desirable from the standpoint of the builders as well as of the Government that there shall be some effective system of checking actual costs and of utilizing the best methods possible with work of this kind. The services of a few men who are familiar with accounting of this class, to act as instructors in shops where the work is new, would undoubtedly be of great help to all concerned.

As to just what will be ordered first, there is no definite information at this time. As shells are well provided for, so far as shop equipment and shell-making capacity are concerned, these may be dismissed from mind except as orders for firms already in the business. Cannon of all sizes from 3 in. up to the big howitzers will be needed and needed badly, and shops that can handle work of this kind will be filled to the brim very shortly. Gun limbers, now made largely of steel, although it is quite probable that some wooden wheels will be used, will also be needed in equal quantities. This means considerable fairly heavy pressed-steel work, riveted, oxyacetylene or arc welded, as the case may be. The poles are now made of steel, and some at least are made from sheets rolled up into a tube and welded; drawn tube can also be used, but a taper is required, and this is not a usual product of the tube mills.

Subcontracts Likely

Recoil mechanism, sighting mechanism and ammunition caissons naturally go along with this group. While these parts will in many cases be made by the man who makes the gun, there are likely to be subcontracts awarded by him.

There is also likely to be a lot of metalwork in the shape of field kitchens, cooking utensils, soldiers' mess equipment, probably metal helmets, trenching tools and dozens of articles with which we civilians are not at all familiar.

As the question of gages, next to materials, is fundamental in the making of munitions of all kinds, I may be pardoned for mentioning it once more, as there seems

to be a tendency to overlook its importance at this time. While some contracts are under way for the making of master gages, or more properly, checking gages, for some classes of ammunition, we seem to have overlooked the experience of Canada in this connection and to have underestimated the number of such gages that will be necessary.

The wear of gages, even of checking gages, is greater than many seem to realize, and the work of inspecting and of salvaging such gages as may be reclaimed is far greater than seems to be understood, especially by those who are not familiar with the production of materials in large quantities. Referring again to the experience of the Canadian Munitions Committee, it is interesting to notice that its inspection plant at Ottawa handles about 20,000 gages per month, of which 16,000 are new gages and the remainder those which have been reclaimed after wearing beyond the prescribed tolerance. To show further what an immense undertaking this central inspection bureau is, it received $171,000 worth of gages during the month of March, making a total of over $1,250,000 worth of gages that have passed through its hands since the beginning of the war.

Central Inspection Bureau Very Successful

This central inspection bureau has proved so successful that it seems to point out the advisability of following the method in this country, with the central bureau here in Washington at the Bureau of Standards, as has already been mentioned. There are some arguments being advanced in favor of establishing inspection departments in charge of Bureau of Standards men at the different plants making gages for the Government, but the greatest advantages seem to lie with the plan of the central bureau where all gages must be sent for final inspection. The only disadvantage seems to be the time required to send gages to Washington and to return them, should they not be found acceptable. As few will probably have to be returned and as the distance from Washington will seldom reach beyond a 500-mile radius, this plan does not seem to have nearly so many objections as the establishing of separate inspection departments, especially as the number of concerns making gages is likely to be largely increased as the months go by and the need of a great quantity of gages becomes more apparent.

Among the advantages of the central bureau is the smaller force required, the tendency to eliminate the personal equation of the inspector and last, but by no means least, the opportunity of exercising judgment as to priority of the gages inspected, as pointed out by Secretary Lane and previously quoted. It is further interesting to mention that work is already going forward at the Bureau of Standards so as to be ready to test the gages as soon as they are received. The only thing that can delay the work will be the failure to secure enough suitable measuring instruments, owing to lack of appropriations, rather than to the inability to secure the instruments themselves. This work will be in charge of Dr. Louis A. Fischer, which insures careful attention and thoroughness as to all essential details.

This is as good a place as any to set at rest the rumors that the advocates of the metric system at the bureau are attempting to have the system adopted on all shells at this time. This report, I am assured, is entirely a creature of someone's vivid imagination, so far as the bureau is concerned, although it is quite possible that some individual may have suggested that it be done. But the men who will have the shellwork in charge are too thoroughly practical to advocate such a change at this time, no matter how strongly they may believe in the advantages of the system as a general proposition.

The Problem of Exemptions

One of the next problems we shall be up against, and that as soon as Congress gets through quibbling over the exact details of the new army bill, is the matter of exemptions for the men in the trades that are vital, not only to the conduct of the war, but to the maintenance of such regular occupations as are necessary for the vast number of workers who must always be behind the army itself, supplying it with its fighting material and other necessaries. Wires are already being pulled by some employers in some industries to secure exemption for their men, so as not to interfere with their business, and in some cases at least there is not the slightest excuse for such exemptions. Their idea of universal service seems always to refer to the other fellow and not to themselves.

The problem will be difficult at best and with everyone trying to solve it for the best interests of the country at large; but it will be complicated and made much more difficult when such lines of business as are not necessary to our welfare, but exist only to cater to some luxurious whim, begin to demand exemption. If it happens that toolmakers in jewelry-making firms can be used elsewhere to advantage, there is good reason for exempting them, but not to remain in the jewelry-making trades.

A Suggested Plan

It has been suggested, and the suggestion seems to have its good points, that the exemptions might take the form of assignments to certain kinds of work or even to certain shops, just as a soldier or an officer is detailed for specific work. This policy would in nowise affect the status of a man as a workman, and he would be paid by the man who employed him, at the regular wage or salary for that work. But he would be in touch with authorities at all times so that, although exempted to do certain necessary work, he could not be used on something that was entirely unnecessary. Being enlisted, so to speak, in the industrial army, he would have some sort of badge or identifying mark, such as that given the munition workers in England—a practice that has been found to be very helpful in many ways.

The decisions as to who shall be exempt present a delicate problem entirely apart from the personal side, which cannot be overlooked. It would evidently be very bad judgment to exempt a man who wanted to go to the front and send the man next to him, who would much rather do his bit in the shop. It is also difficult for any employer to decide just what men are most necessary to keep his business going for the real benefit of the country at this time. There must be some coördinating board or head that can determine first what industries are most necessary at this time and then what classes of men are most needed to conduct them. A careful balancing of the whole situation is required, and the plan must not be upset by individual employers, particularly in trades of doubtful value, endeavoring to exempt their men for purely business reasons.

Fred H. Colvin.

Location of Time Clocks

By Fred H. Korff*

Relative to the article on time clocks, on page 352, the writer wishes to submit the following system, which he has used and found to be very successful:

Located in each of the factory departments is a time clock electrically controlled by a master clock, under the supervision of the chief engineer. Clothes lockers placed immediately within the entrance to the factory are provided for all employees. When an employee enters the factory, he first puts away his clothes and then goes to his department, punching his time card upon entering therein.

The department time clocks are adjacent to the foreman's office, and at one minute past the opening hour in the morning and afternoon it is the duty of the foreman to see that they are locked. Employees arriving late are obliged to have the foreman O.K. their time card. At the time of such approval the department clerk unlocks the clock and records on the employee's card the time of arrival. The "Within Time" punchings on the time card are shown in blue, all tardy marks are shown in red, thereby bringing out most forcibly one's attendance and regularity.

As a further means of keeping accurate check of the time spent on each job, the following method is used: An electrically controlled clock, governed by a master, is placed in each department office, under the direct supervision of the layout clerk. The daily-work card of each man is kept in a rack with a number stamped thereon corresponding to his time-card number. When the work, drawings and order have been apportioned to a workman, he goes immediately to the layout clerk, to whom he gives his number and the order number of the work that he has been instructed to do. The layout clerk takes the daily-work card corresponding to the workman's number, enters the order number and stamps the time of starting. When the job is finished, the workman notifies the layout clerk, who then stamps the time of finishing and closes out the order.

As mechanics are not intended to be bookkeepers, this system eliminates all chances of error on their part due to incorrect figuring and places the burden of clerical work in the factory office, where it undoubtedly belongs.

*Assistant Superintendent, Stromberg Motor Devices Co.

New Publications

Preliminary Mathematics—By Prof. F. E Austin. One hundred and sixty-eight 4½ x 7½-in. pages; two illustrations; cloth bound. Published by the author at Hanover, N. H. Price, $1.20.

This book is intended for students who wish to make up for lost time in their mathematical preparation. The author states his position regarding the method of presentation of the subject as follows: "While many of the problems presented for solution in ordinary textbooks dealing with algebra are absolutely without practical application, one should not ignore the importance of the mental training one receives from their logical and careful solution. One unconsciously employs mental training many times in one's career, and many years of careful and continuous practice are needed to realize the attainment of a notable success that is effected in a few moments."

From the preceding it may be gathered that the man who wishes to kill two birds with one stone by learning something of practical value at the same time he is acquiring mental training, should not seek it in this book. There are no problems of practical value given.

The work covers arithmetic, laying some stress on rapid methods and proofs, logarithms, algebraic operations, through the use of quadratic equations; in other words, the usual college-entrance requirements.

There is no word of inspiration in the book, simply rules of procedure, and the threat that if the pupil does not work consistently day by day he will not be able to pass the examinations.

The Design of Machine Elements—By W. G. Dunkley, B. Sc. Vol. 1, 206 4½ x 7-in. pages; 123 illustrations; 16 tables; Vol. 2, 215 4½ x 7-in. pages; 123 illustrations; 15 tables; bound in cloth. Published by Scott, Greenwood & Son, London. Price, $1.50 each volume.

The first volume is devoted to a general statement regarding forces, stresses and strains, or strength of materials, and their application to the design of shafts and studs, bearings, both plain and ball bearing, keys and couplings and springs.

No attempt is made to present any new material, but the books cover in small space the generally accepted application of the laws of mechanics to the elementary parts of machines. To this is added considerable empirical material regarding proportions of parts not usually designed in strict accordance with the stresses which they carry in the natural operation of the machine of which they are a part.

The second volume covers screw threads, belts and pulleys, driving clutches, gearing, driving and lifting chains and wire rope for hoisting purposes.

As in the first volume, this is a presentation of such elements of design as are capable of calculation under the laws of mechanics and also considerable empirical matter.

The presentation, in all cases, is clear and concise, and such as to be of value to both students of machine design and to practicing engineers.

Personals

A. L. Lewis, formerly superintendent of the plant of Sleeper & Hartlet, Inc., Worcester, Mass., will take charge of the company's new plant for the manufacture of wire-nail machinery, as soon as it is completed.

Dr. Henry M. Howe was presented with the John Fritz medal on May 10 in the auditorium of the United Engineering Building. This honor comes to Dr. Howe for his "investigations in metallurgy, especially in the metallography of iron and steel."

Business Items

The Industrial Service and Equipment Co. has moved its offices to 226 Devonshire St., Boston, Massachusetts.

Bullard Machine Tool Co. has recently acquired the foundry of the Gray Iron Casting Co. and the plant of the Taylor Foundry Co., at Black Rock, Connecticut.

The Lincoln-Williams Twist Drill Co., Taunton, Mass., has been entirely reorganized and is now known as the Lincoln Twist Drill Co., with Frederick H. Payne, president; Edward Blake, Jr., vice president and general manager; James H. Ball, treasurer; and Jerome W. Lincoln, clerk. The board of directors consists of Frank O. Wells, Frederick H. Payne, Edward Blake, Jr., Alfred L. Lincoln and Clement R. Ford. The capital has also been increased from $200,000 to $1,000,000.

The S K F Ball Bearing Co. of California, Inc., has been organized for the sale of various types of ball bearings. The office of this company is under the direction of A. M. MacLaren and is located at 341 Larkin St., San Francisco.

The S K F Administrative, 1 Wall St., New York City, has recently been incorporated to administer the affairs of the S K F Ball Bearing Co., and the Hess-Bright Manufacturing Co., Philadelphia. The board of the new company consists of Frank A. Vanderlip, Thatcher Brown, F. B. Kirkbride, S. Wingquist, Axel Carlander, Marcus Wallenberg and B. G. Prytz. Mr. Prytz is president of the new company, while Mr. Gray, of the Hess-Bright Co., will become technical adviser.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice-president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeteing at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The National Machine Tool Builders Association. The spring consultation will be held at the Hotel Sinton, Cincinnati, Ohio, May 21 and 22.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio, on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

The American Society of Mechanical Engineers will hold its annual spring meeting at Cincinnati, Ohio, May 21 to 25. There will be a joint session with the National Machine Tool Builders Association on May 21. The headquarters will be at Hotel Sinton.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The Ordnance Department requirements for brass cartridge cases of all types used by mobile artillery are given in the following specifications:

1. All cartridge cases will be constructed in accordance with drawings provided or approved by the Chief of Ordnance, and no deviation therefrom will be allowed without his authority.

2. The necessary working gages, templets, etc., will be furnished by the contractor except such as the Ordnance Department may furnish for inspection purposes exclusively. The working gages furnished by the contractor will conform to the inspection gages.

3. The manufacture of the articles contracted for and of all material therefor shall be open to inspection by the officers and employees of the Ordnance Department assigned to duty for that purpose and shall in all its details and in all its stages receive the approval of the inspector or such of his assistants as he may designate.

4. A lot of cartridge cases of calibers up to and including 3.8 in. will consist of 20,000 cases. A lot of cartridge cases of 4.7 in. or greater diameter will consist of 10,000 cases.

5. Before beginning the manufacture of cartridge cases in quantity, the contractor will be required to demonstrate to the satisfaction of the inspector, in the case of at least one caliber, by the actual firing test prescribed below and by microscopic examination that he has established such methods of manufacture as will produce cartridge cases that will be satisfactory in service and of a crystalline structure in all parts satisfactory to the inspector.

6. This ballistic test will consist of firing three cases, five rounds each, at a pressure 12 per cent. above the maximum powder pressure allowed by the powder specifications in the particular gun or howitzer for which the cartridge cases are intended. The cases will be resized after each round; and after five rounds have been fired and the cases have been resized four times, none of them shall show longitudinal or transverse cracks, bulges or other defects that will prevent complete obturation or in any other way affect their serviceability for further use.

7. If during the firing any case swells to such an extent that it cannot be extracted by the service extractor of the cannon, it shall be considered unfit for further use.

In addition to the preliminary ballistic test prescribed in the preceding paragraphs, not less than five cases will be sectionalized and microscopically examined to determine whether the various mechanical operations and subsequent heat-treatments have been such as to leave the crystalline structure of the material in proper condition for storage. These sectionalized cases will also be examined to see whether the walls or heads of the cases show any folds either external or internal.

8. As the object of the preliminary test is to determine whether the manufacturer has so regulated the mechanical and heat-treating operations as to produce satisfactory cases, and as it is not a question of accepting or rejecting a lot as the result of this test, any further preliminary tests that he may desire will be made at his expense.

9. An analysis will not be required of the materials used in making the brass, but the finished brass will be analyzed and must in all cases show a total copper and zinc content not below 99.88 per cent. with a lead content not above 0.12 per cent. and an iron content not above 0.02 per cent. with negative results as to tin, antimony, bismuth and cadmium.

Any spelter and copper that will give the above results may be used by the contractor at his own risk subject to the chemical, ballistic and microscopic tests herein prescribed.

The chemical analysis of the brass used in cartridge cases 3.8 in. in diameter and under will have a copper content of 68 per cent. plus or minus 1 per cent. and a zinc content of 32 per cent. plus or minus 1 per cent. The brass used in cartridge cases of 4.7-in. diameter and larger must show a copper content of 70 per cent. plus or minus 1 per cent. and a zinc content of 30 per cent. plus or minus 1 per cent.

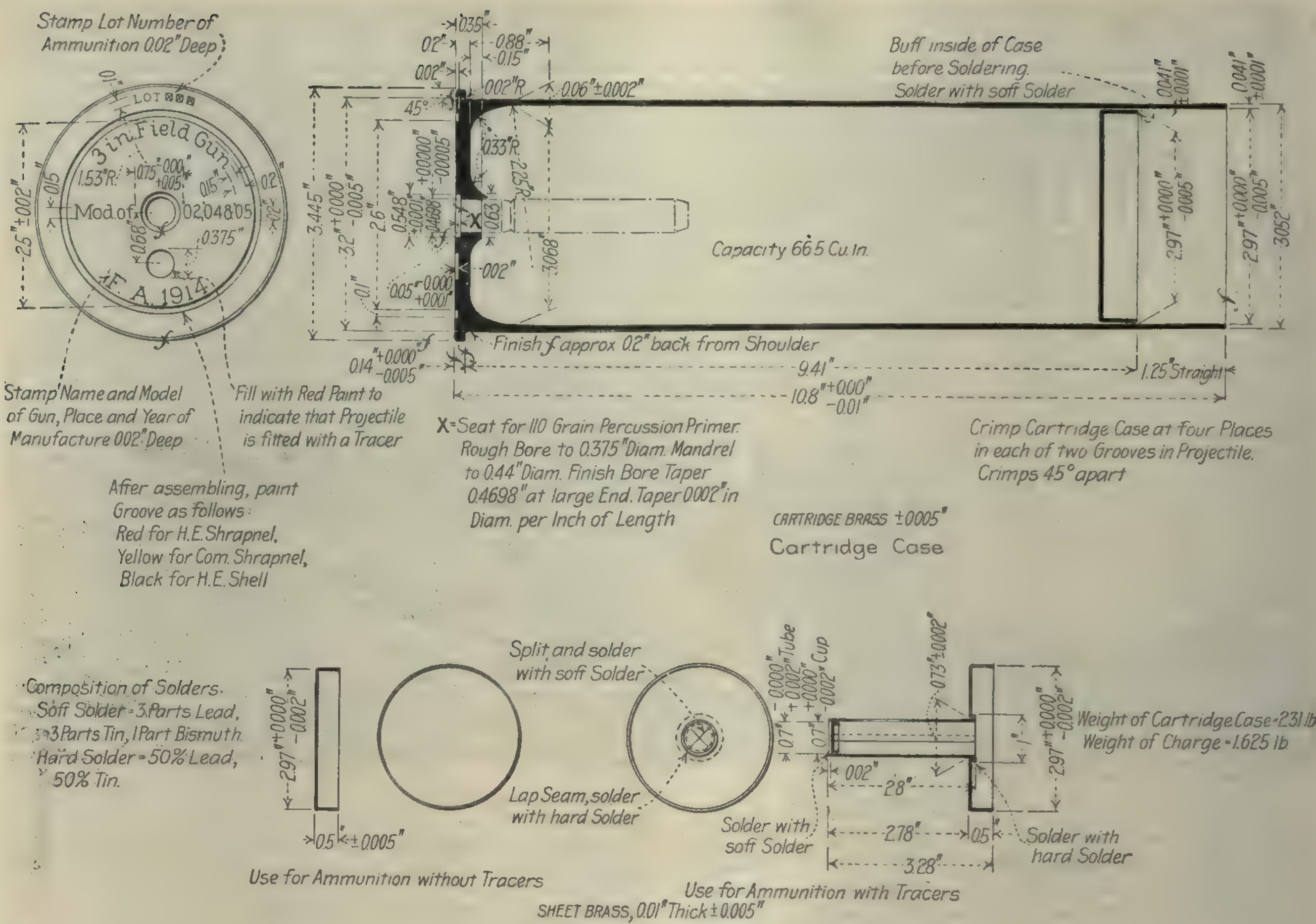
10. Eight cartridge cases will be selected from each lot for microscopic examination and a chemical examination and for ballistic test. Five of these cases will be sectionalized, polished, etched and examined microscopically to determine the crystalline condition of the material. Chemical samples for analysis will also be selected from these five cases. The remaining three cases will be subjected to the same ballistic test as prescribed for the preliminary test in paragraph 6 above.

11. Should any or all of the cases selected fail on the ballistic test, the contractor is entitled to a retest at his own expense. In this event five cases will be selected by the inspector, and the ballistic test as prescribed above will be repeated. If the retest is satisfactory as to all the cases, the lot will be accepted; and if not satisfactory, it will be finally rejected and no further retest allowed.

12. The contractor must have at his works or convenient thereto the necessary apparatus for making the chemical analysis prescribed and must in addition have a satisfactory, modern, metallurgical microscope and the necessary equipment to enable microscopic examination of the metal in the cartridge cases to be made.

13. The manufacturer must have installed the necessary suitable pyrometers to enable the inspector to check at any time the temperature of the annealing operations.

14. The upper portion of the case after the last drawing operation will be annealed at a temperature of from 400 to 450 deg. C. In the annealings between drawings the temperature will in no case exceed 650 deg. C.



Diaphragm FIG. 1

Cartridge Case for 3-In. Field Gun, Models of 1902, 1904 and 1905

OPERATION 1. CUPPING

Transformation—Fig. 2-B. Machine Used—Waterbury-Farrel 450-ton hydraulic press, Fig. 3. Number of Operators per Machine—Two. Punches and Punch Holders—Punch and die, Fig. 9. Pressure Required—40 tons. Lubricant—Drawing and tapering compound, 2 lb. New Era No. 4 to 1 gal. water. Production—4200 in 8 hr. Note—Brass disk: Maximum diameter, 5.805 in.; minimum, 5.800 in.; maximum thickness, 0.313 in.; minimum, 0.308 in.; weight, 2.544 lb.; Fig. 2-A.

OPERATION 2. WASH AND ANNEAL

Number of Operators—Three. Description of Operation—Wash in plain hot water; heat in furnace to 1300 deg. F. for 1 hr. Apparatus and Equipment Used—Tank of hot water, annealing furnace, truck and tray, Fig. 4. Production—5200 in 8 hr.

OPERATION 3. PICKLE AND WASH

Number of Operators—Two. Description of Operation—Dipped in a solution of 6 parts water to 1 of vitriol, then washed in plain hot water. Apparatus and Equipment Used—Dipping baskets and tanks, Fig. 5. Production—4300 per 8 hr.

The various operations on the different sizes of cases are practically alike, the main difference being a few more draws on the gun cases than on those for the howitzers. The punches, dies and gages are all of the same general form, only the dimensions being suited to the several sizes of cases. For this reason detailed descriptions of the operations on all the cartridge cases are unnecessary, since one set of detailed operations will serve as a general guide for all the others.

A detailed drawing of a 3-in. field-gun cartridge case for models of 1902, 1904 and 1905 is given in Fig. 1. It shows not only the case itself, but also the position of the primer and diaphragm, together with details of the two types of diaphragms for use with and without night

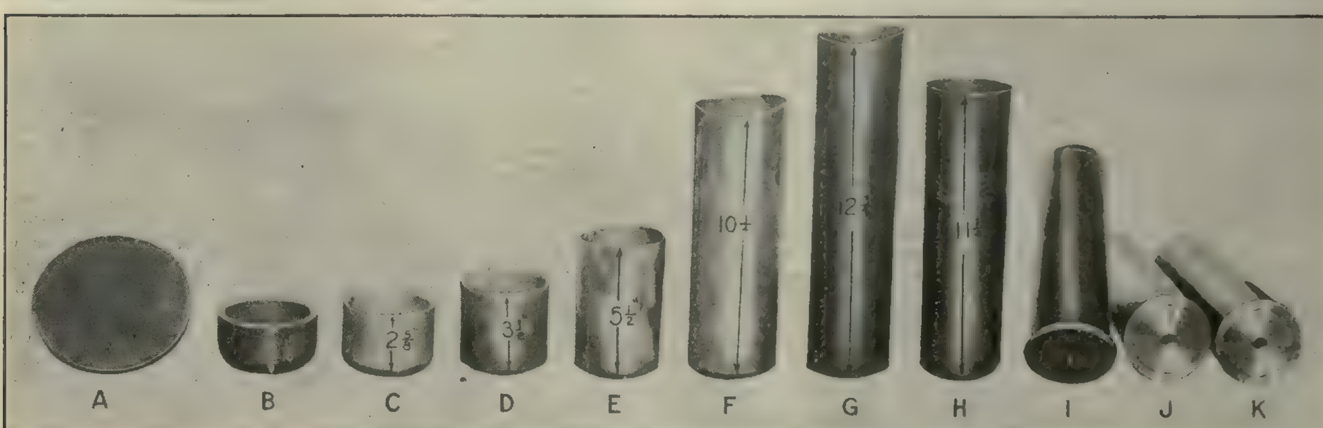
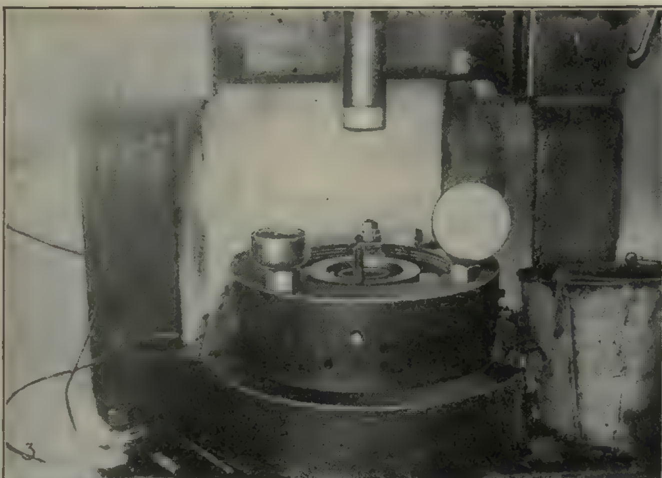


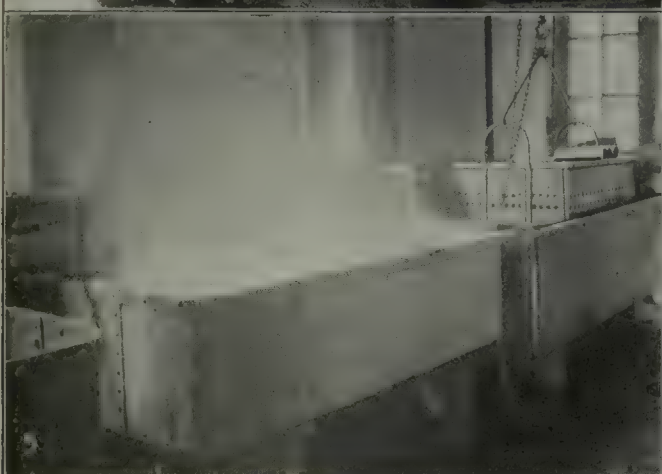
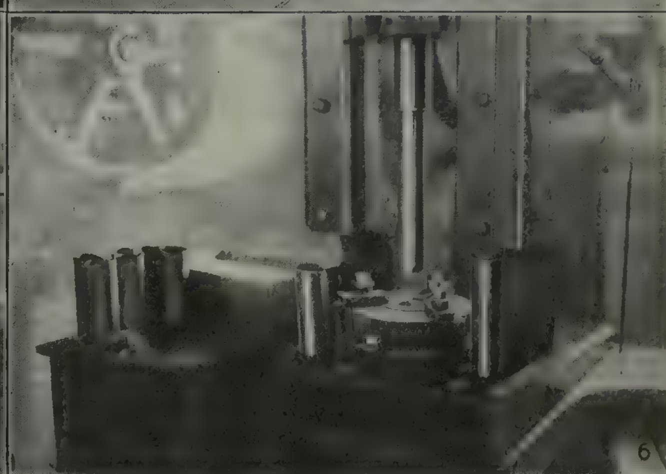
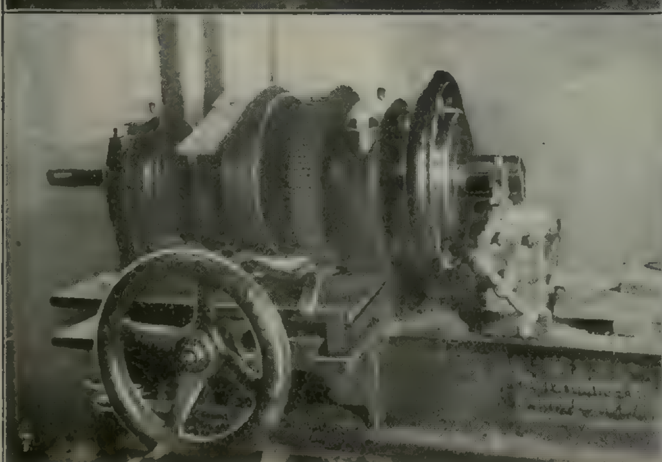
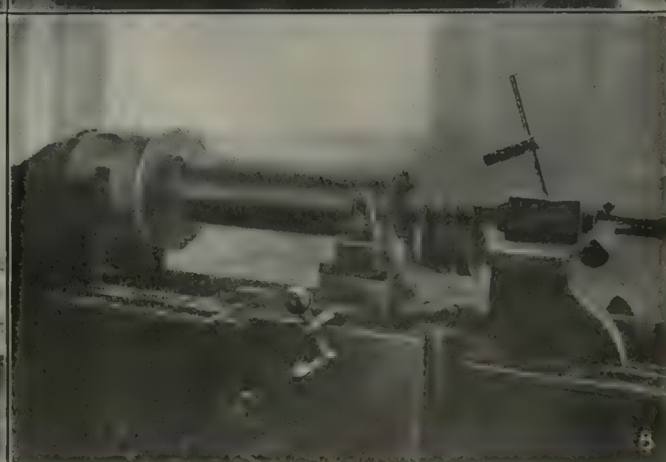
FIG. 2. STEPS IN THE EVOLUTION OF A 3-IN. CARTRIDGE CASE

tracers. The various steps in the evolution of this case are as follows:

1	Cupping
2	Wash and anneal
3	Pickle and wash
4	First draw
5	Wash and anneal
6	Pickle and wash
7	Second draw
8	Wash and anneal
9	Pickle and wash
10	Third draw
11	Wash and anneal
12	Pickle and wash
13	Fourth draw
14	Trim
15	Wash and anneal
16	Pickle and wash
17	Fifth draw
18	Trim
19	Wash for heading
20	Heading
21	Punch primer hole
21-A	Drill primer hole and rough head
22	Broach
22-A	Burr out
23	Point anneal
24	Taper
25	Finish head
26	Stamp
27	Finish trim
28	Inspect

The principal operations are illustrated in Fig. 2. The first step after the blanking of the disk is the cupping, shown in Fig. 3. The operator dips the disk into the bucket of drawing compound, places it in the die and trips the press, forcing the cup down through the die into a receptacle beneath. The details of the punch and die for this cupping operation may be seen in Fig. 9.



FIGS. 3 TO 8. VARIOUS OPERATIONS ON FIELD-GUN CARTRIDGE CASES

Fig. 3—Cupping. Fig. 4—Annealing. Fig. 5—Pickling and washing. Fig. 6—Drawing. Fig. 7—First trimming. Fig. 8—Second trimming

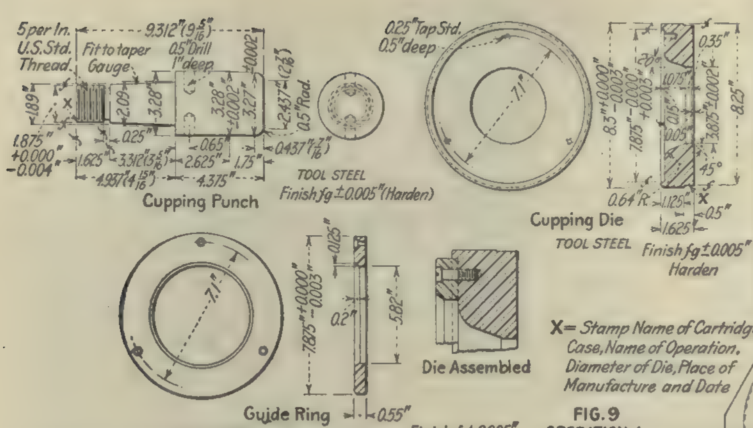


FIG. 9
OPERATION 1

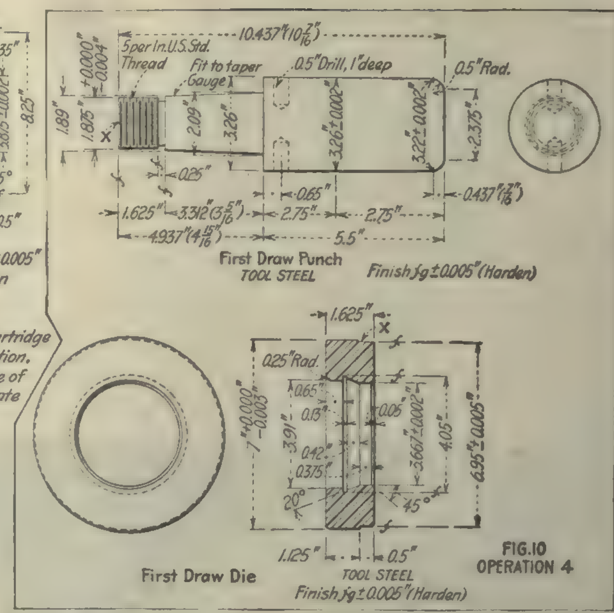


FIG. 10
OPERATION 4

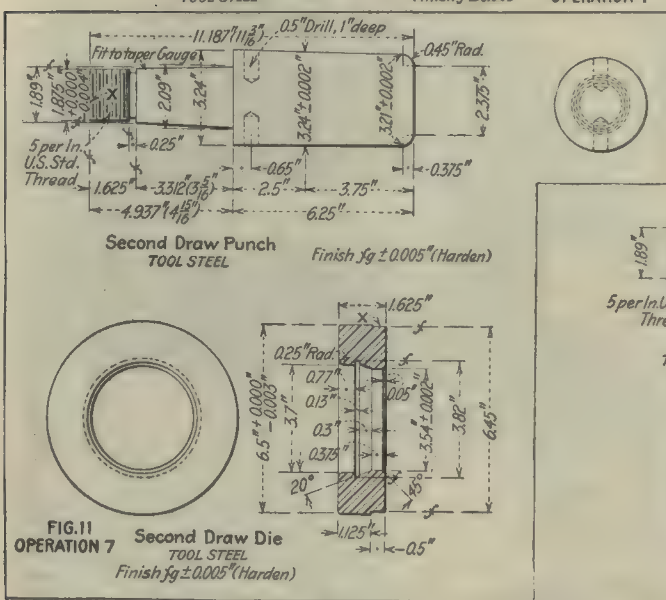


FIG. 11
OPERATION 7

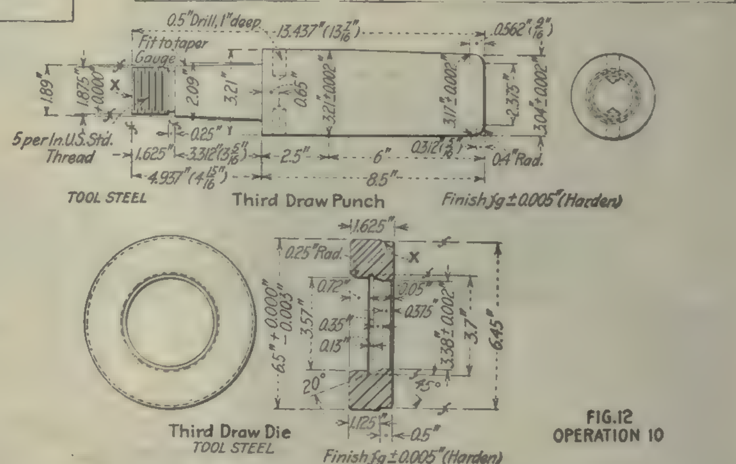


FIG. 12
OPERATION 10

OPERATION 4. FIRST DRAW

Transformation—Fig. 2-C. Machine Used—Waterbury-Farrel rack press. Number of Operators per Machine—Two. Punches and Punch Holders—Punch and die, Fig. 10. Pressure Required—22 tons. Lubricant—New Era No. 4, 2 lb. to 1 gal. water. Production—4300 per 8 hr.

OPERATION 5. WASH AND ANNEAL

Number of Operators—Three. Description of Operation—Same as before. Production—5600 per 8 hr.

OPERATION 6. PICKLE AND WASH

Number of Operators—Two. Description of Operation—Same as before. Production—3500 per 8 hr.

OPERATION 7. SECOND DRAW

Transformation—Fig. 2-D. Number of Operators per Machine—Two. Punches and Punch Holders—Punch and die. Fig. 11. Pressure Required—9 tons. Production—3700 per 8 hr.

OPERATION 8. WASH AND ANNEAL

Number of Operators—Three. Production—6000 per 8 hr.

OPERATION 9. PICKLE AND WASH

Number of Operators—Two. Production—3300 per 8 hr.

OPERATION 10. THIRD DRAW

Transformation—Fig. 2-E. Machine Used—Waterbury-Farrel rack press. Number of Operators per Machine—Two.

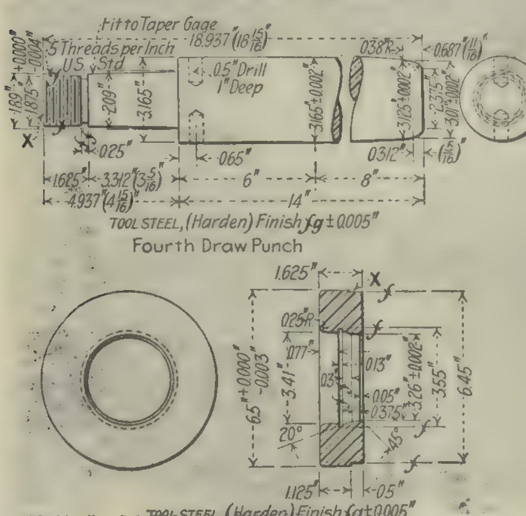


FIG. 13
OPERATION 13

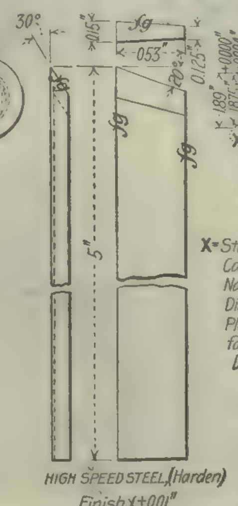


FIG. 14
OPERATION 14

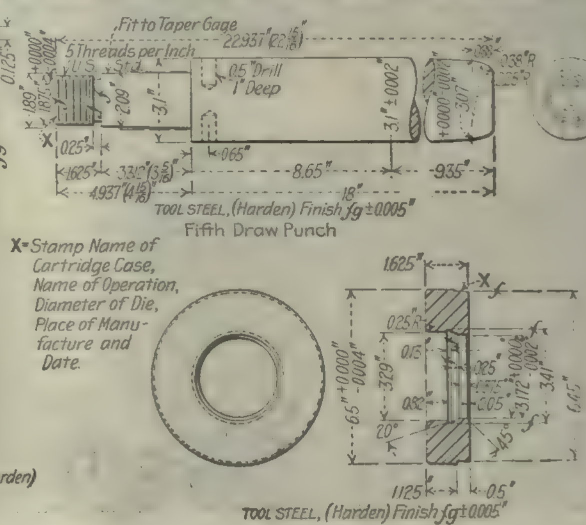


FIG. 15
OPERATION 17

Punches and Punch Holders—Punch and die, Fig. 12. Pressure Required—7 tons. Production—3400 per 8 hr.

OPERATION 11. WASH AND ANNEAL

Description of Operation—Heat to 1300 deg. F. for 50 min. Production—3400 per 8 hr.

OPERATION 12. PICKLE AND WASH

Production—2400 per 8 hr.

OPERATION 13. FOURTH DRAW

Transformation—Fig. 2-F. Machine Used—Rack press, Fig. 6. Number of Operators per Machine—Two. Punches and Punch Holders—Punch and die, Fig. 13. Pressure Required—7 tons. Production—2400 per 8 hr.

OPERATION 14. TRIM

Machine Used—Pratt & Whitney, Fig. 7. Number of Operators per Machine—One. Cutting Tools—Cutoff tool, Fig. 14. Production—1200 per 8 hr. Note—Trim off 20 per cent.

OPERATION 15. WASH AND ANNEAL

Number of Operators—Three. Description of Operation—Heat to 1300 deg. F. for 50 min. Production—3600 per 8 hr.

OPERATION 16. PICKLE AND WASH

Production—1700 per 8 hr.

OPERATION 17. FIFTH DRAW

Transformation—Fig. 2-G. Machine Used—Hydraulic or rack press. Number of Operators per Machine—Two. Punches and Punch Holders—Punch and die, Fig. 15. Pressure Required—3 tons. Production—1900 per 8 hr.

OPERATION 18. TRIM

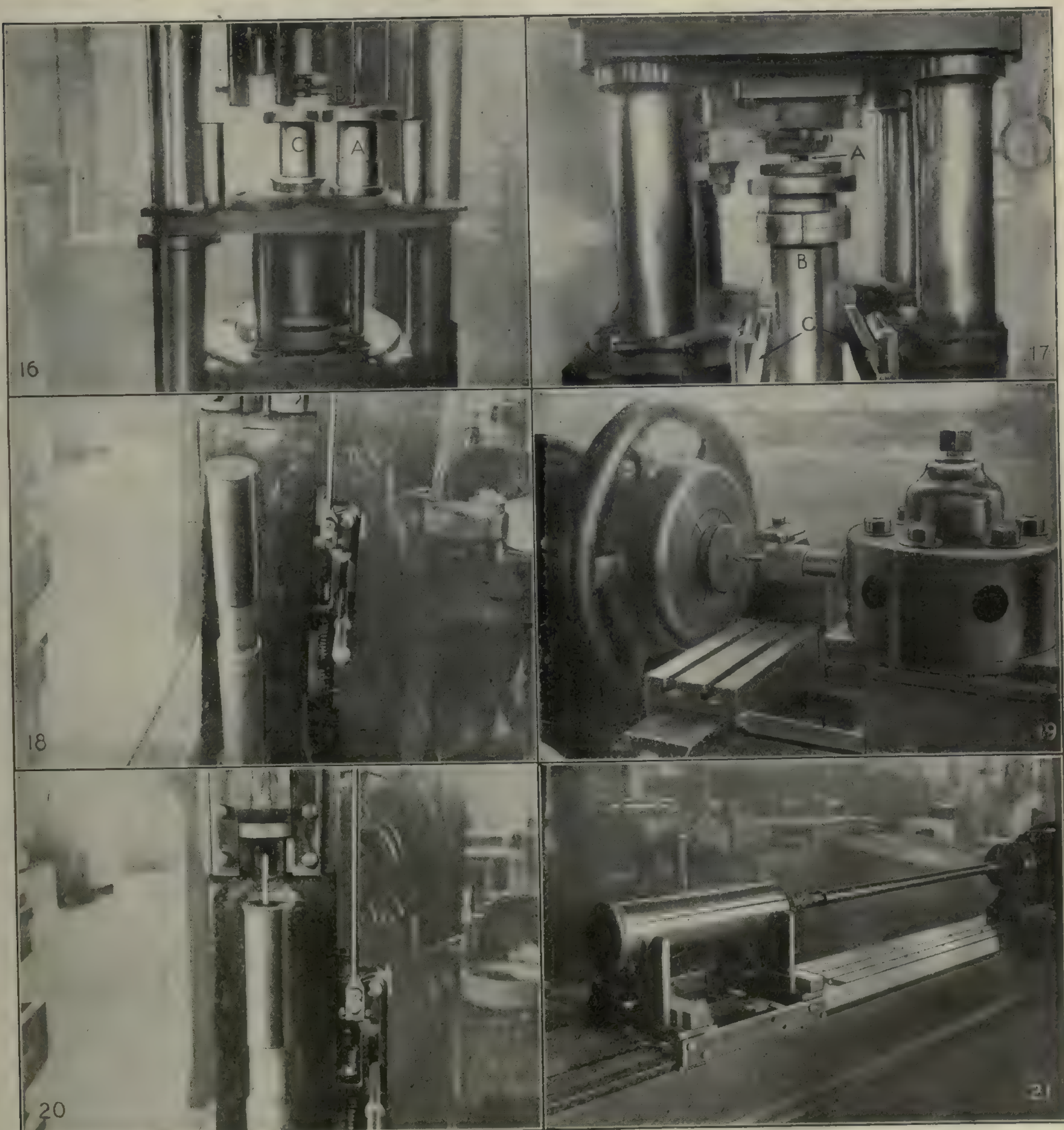
Transformation—Fig. 2-H. Machine Used—Lathe, Fig. 8. Number of Operators per Machine—One. Work-Holding Devices—Three-jaw universal lathe chuck. Cutting Tools—Cutoff tool, Fig. 14. Cut Data—420 r.p.m. Production—1350 per 8 hr.

OPERATION 19. WASH FOR HEADING

Description of Operation—Wash in solution of 25 lb. 6-B washing compound to 75 gal. water. Production—3500 per 8 hr.

OPERATION 20. HEADING

Transformation—Fig. 2-I, minus primer hole. Machine Used—1000-ton hydraulic press, Fig. 16. Number of Operators per



FIGS. 16 TO 21. VARIOUS PRESS AND MACHINING OPERATIONS

Fig. 16—Heading the small-size cases. Fig. 17—Heading large cases. Fig. 18—Punching primer hole. Fig. 19—Drilling and roughing head. Fig. 20—Sizing primer hole. Fig. 21—Burring primer hole

Machine—One. Punches and Punch Holders—Punch, Fig. 22. Dies and Die Holders—Die, Fig. 23. Pressure Required—600 tons. Gages—Snap gage, diameter of head, Fig. 45, operation 25; thickness of head, micrometer gage, Fig. 24. Production—800 per 8 hr.

OPERATION 21. PUNCH PRIMER HOLE

Transformation—Fig. 2-I. Machine Used—Small press, Fig. 18. Number of Operators per Machine—One. Punch and Die—Fig. 25. Production—2800 per 8 hr.

OPERATION 21-A. DRILL PRIMER H[illegible]E AND ROUGH HEAD

Machine Used—Potter & Johnston tur[illegible] [illegible]the, Fig. 19. Cutting Tools—Tool for turning under he[illegible] Fig. 26; drill, reamer. Cut Data—270 r.p.m. Productio[illegible] [illegible] per 8 hr. Note—This is only done when punch press [illegible] ot available.

OPERATION 22. BROACH

Machine Used—Fig. 20. Number of Operators per Machine—One. Tool Used—Sizing drift or broach, F[illegible]g. 27. Special Fixtures—Fig. 28. Production—2800 per 8 hr.

OPERATION 22-A. BURR OUT

Machine Used—Fig. 21. Number of Operators per Machine—One. Cutting Tools—Burring tool, Fig. 29. Cut Data—Tool runs 750 r.p.m. Special Fixtures—Fig. 30.

OPERATION 23. POINT ANNEAL

Number of Operators—One. Description of Operation—A case is placed as shown in the machine, Fig. 31, the gas jets being so regulated as to heat [illegible]e case a low red on the open end with the heat gradually [illegible]ng toward the head; the holding spindle revolves about [illegible] r.p.m., and a case will heat in about 1 min. Production—1200 per 8 hr.

The cups are next washed in plain hot water to remove the soapy drawing solution and are then annealed. This is done by placing the cups in trays, as shown in Fig. 4, and pushing the loaded trays into a furnace. Here they are heated to about 1300 deg. F. for an hour; then the tray is pulled out onto the truck and run out into the open air. The tray shown is filled with fourth-draw cases, but the method of procedure is the same in the other annealing operations.

After annealing, the cups are pickled to remove the scale and are then washed in hot water. The pickling is done as shown in Fig. 5. The parts to be pickled are placed in a large basket, as shown at the right, and immersed in the solution. When the scale has all been cut, the basket is raised and run along to the hot-water tank at the left. After washing, the work is ready for the first draw, the punches and dies for which are illustrated in Fig. 10.

The washing, annealing, pickling and washing follow each drawing operation with but slight variations and need not be further described. Details of the punches and dies for the second draw are given in Fig. 11. Figs. 12 and 13 show those for the third and fourth draw. The latter is also illustrated in Fig. 6. Here a tank for the drawing solution is shown just at the left of the press. The operator dips his work into this tank before he places it in the die. After the fourth draw the case is trimmed as shown in Fig. 7, about 20 per cent. of it being removed.

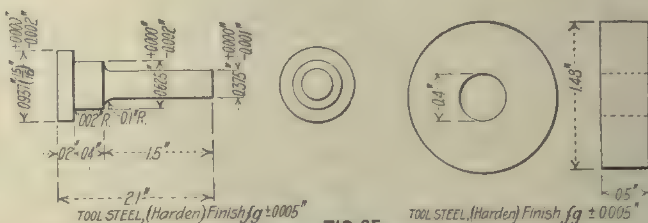


FIG. 25
OPERATION 21

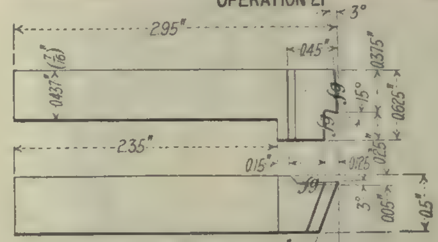


FIG. 26
OPERATION 21A

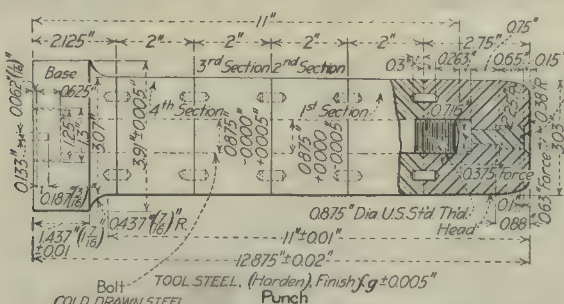


FIG. 22

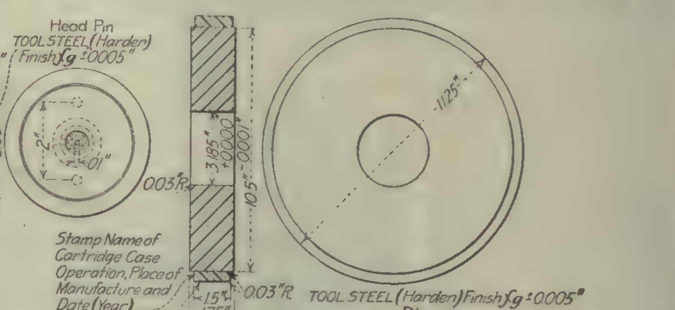


FIG. 23

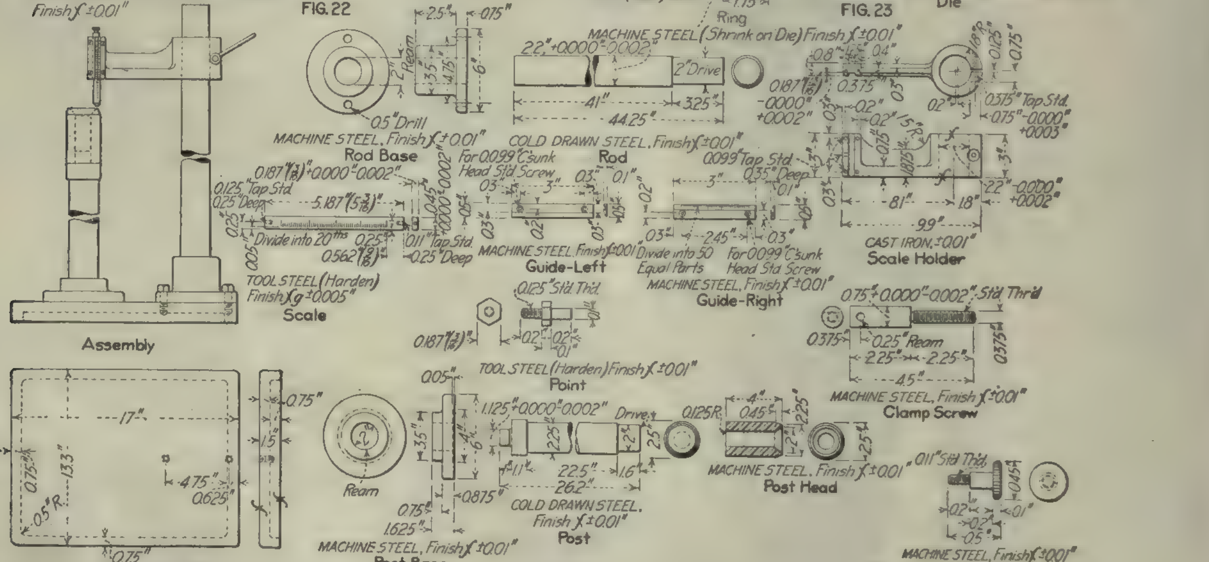
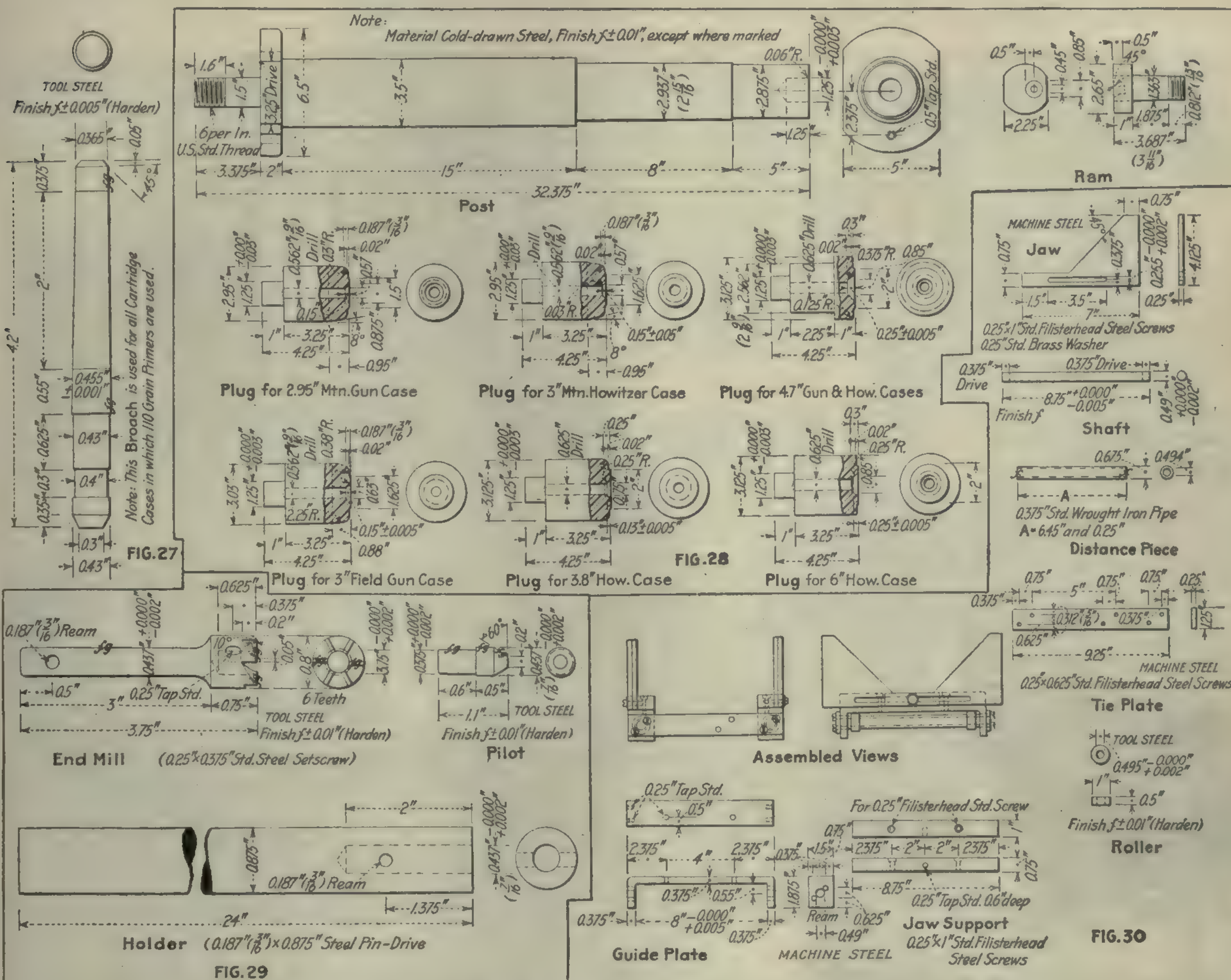


FIG. 24
OPERATION 20

The fifth-draw punches and dies are illustrated in Fig. 15, and the trimming operation, which immediately follows, is shown in Fig. 8. After the case is trimmed, it is washed in a special solution; then it is headed in a hydraulic press, as shown in Fig. 16. Two dies are used in this press, so that the work is practically continuous. A case is placed in one die, as at *A*, while the heading punch *B* is descending on the one at *C*. The die at *C* is then pulled back and the one at *A* pushed into its place, and so on. Details of the die are given in Fig. 23.

A press, Fig. 17, is fitted differently for heading and is used principally on the larger sizes. The case is held in punching operation, and the drift is shown in Fig. 27. Burring of the primer hole is done from the inside on a small lathe fitted as shown in Fig. 21. The burring tool, detailed in Fig. 29, is carried on the end of a long rod chucked as shown. The case is placed on an adjustable carrier that slides along the lathe bed. The adjustment of the V's allows the fixture to be used for all sizes of cases. Details are given in Fig. 30.

Point annealing of the cases is done in special machines, Figs. 31 and 32. The case to be annealed is placed on the revolving table, and the gas jets play on it in such a way as to heat the mouth end to a good red heat. This



NOTE: FIG. 27, 28 OPERATION 22. FIG. 29, 30 OPERATION 22*a*.

the die at *A*. The die is held in a carrier *B*, which slides on the rails *C* and is run in or out by means of a small hydraulic cylinder and piston at the back.

Primer holes are punched in the small press, Fig. 18. The die is carried in a post hinged at the bottom so that the work and the die may be swung in or out under the punch. Details of the punch and die are given in Fig. 25.

Ordinarily, all primer holes in this type of case are punched; but where no press is available, the hole is drilled and the head roughed off in a turret lathe, as shown in Fig. 19. An ordinary twist drill and a turning tool, Fig. 26, are used. Following either the punching or drilling of the primer hole, a broach or drift is forced through, as shown in Fig. 20, to size the hole accurately. The fixture used is made like that for the heating gradually lessens toward the head of the case, so that the case is left hard on the head end, but increasingly soft toward the mouth, so that as the case is forced into the tapering die, as shown in Fig. 33, the head end does not buckle under the pressure and the case is tapered toward the open end. The tapering die is illustrated in Fig. 37. The heads are finished in a semi-automatic, Fig. 34. In this machine the head is faced, chamfered, the paint groove cut and the primer hole reamed and counterbored. The tools used are given in detail in Figs. 38, 39, 40, 41, 42 and 43. The gages are given in Figs. 24, 44 and 45.

Following the finishing of the head, it is stamped in a hydraulic press, Fig. 35, details of the fixture being given in Fig. 46. The final trimming to exact length is done

in a specially fitted turret lathe, Fig. 36. The head is held in a turret chuck *A* and pressed to the revolving tool *B* on the spindle. This chuck and tool are shown in detail in Figs. 47 and 48 respectively. Inspection follows, some of the gages for this purpose being shown in Figs. 50, 51 and 52.

OPERATION 24. TAPERING

Machine Used—Punch press, Fig. 33. Number of Operators per Machine—One. Dies and Die Holders—Die, Fig. 37. Pressure Required—12 tons. Production—1800 per 8 hr.

OPERATION 25. FINISH HEAD

Transformation—Fig. 25. Machine Used—Potter & Johnston automatic, Fig. 34. Number of Machines per Operator—Two. Cutting Tools—Circular form tool, Fig. 38; facing tool, Fig. 39; chamfering tool, Fig. 40; grooving tool, Fig. 41; reamer, Fig. 42; counterbore, Fig. 43. Cut Data—250 r.p.m. Gages—Primer-hole gage, Fig. 44; diameter under head, Fig. 45; primer-hole counterbore, Fig. 44; thickness of head, Figs. 24 and 44; diameter of head, Fig. 45. Production—500 per 8 hr.

OPERATION 26. STAMP

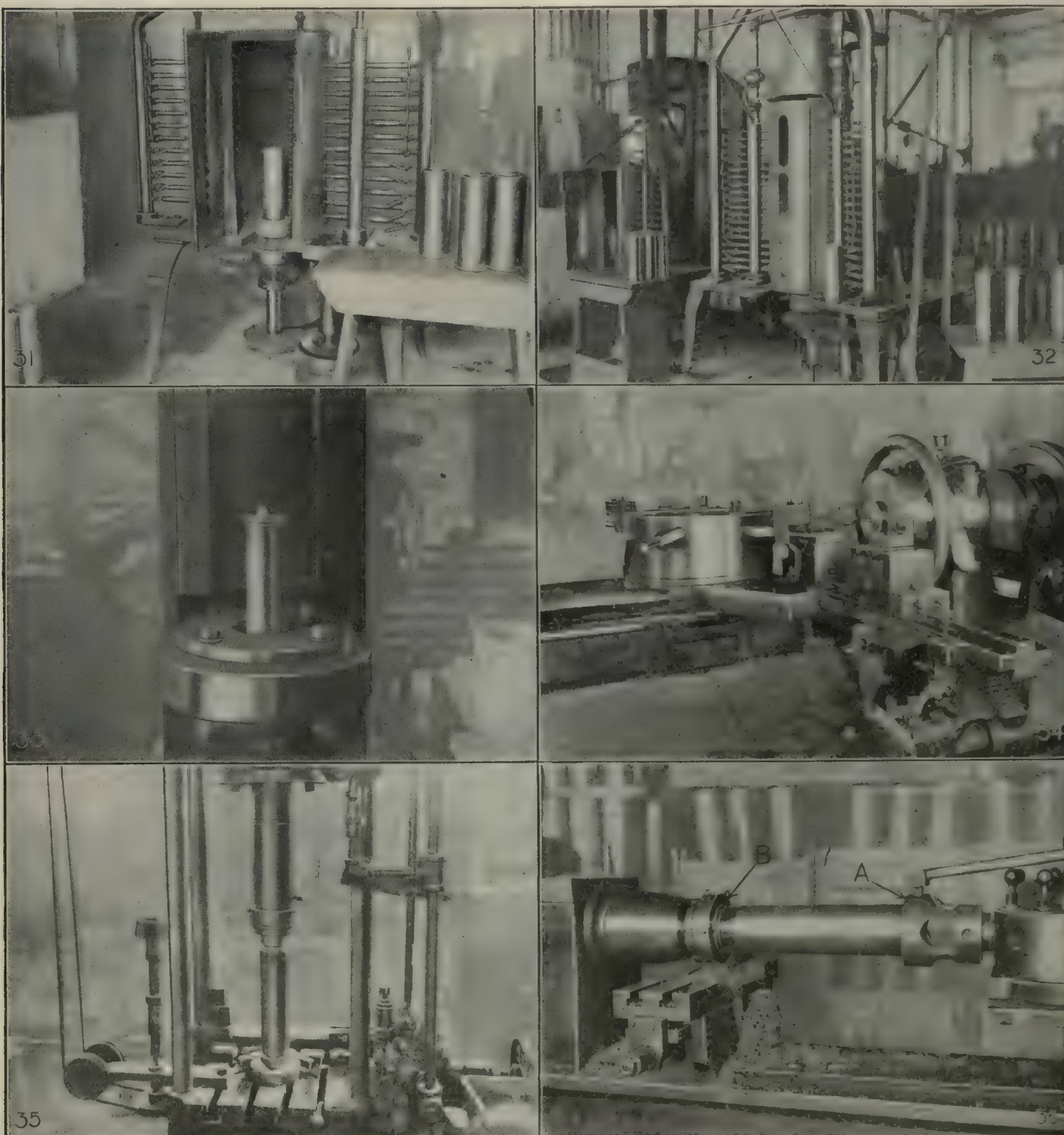
Transformation—Fig. 2-K. Machine Used—30-ton hydraulic press, Fig. 35. Number of Operators per Machine—One. Stamp—See Fig. 1. Pressure Required—13 tons. Special Fixtures—Fig. 46. Production—2500 per 8 hr.

OPERATION 27. FINISH TRIM

Machine Used—Turret lathe, Fig. 36. Number of Operators per Machine—One. Work-Holding Devices—Special chuck, Fig. 47. Tool-Holding Devices—Fixture (tool holder), Fig. 48. Cutting Tools—Inside chamfering, Fig. 48; outside chamfering, Fig. 48; facing, Fig. 48. Cut Data—950 r.p.m. Gages—Length, Fig. 49. Production—1800 per 8 hr.

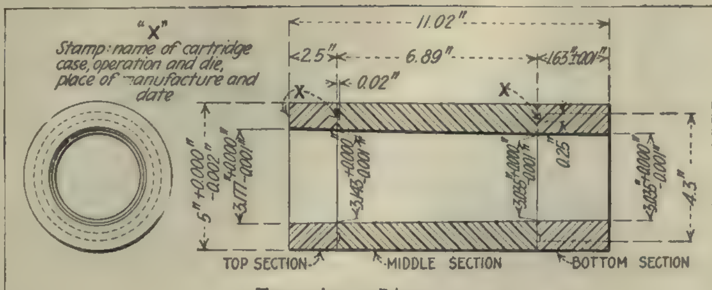
OPERATION 28. INSPECTION

Apparatus and Equipment Used—Fig. 50. Gages—Mouth plug gage, Fig. 51; primer-hole gage, Fig. 44; primer-hole counterbore, Fig. 44; thickness of head, Fig. 44; diameter of head, Fig. 45; diameter under head, Fig. 45; length gage, Fig. 52; cylinder gage, Fig. 50.

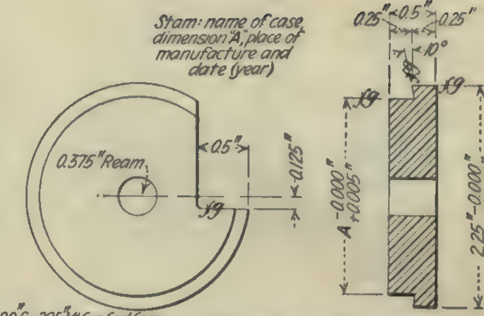


FIGS. 31 TO 36. ANNEALING, PRESSING AND MACHINING WORK

Fig. 31—Point-annealing machine open. Fig. 32—Same machine closed. Fig. 33—Tapering the case. Fig. 34—Machining the head. Fig. 35—Stamping the head. Fig. 36—Finish trimming

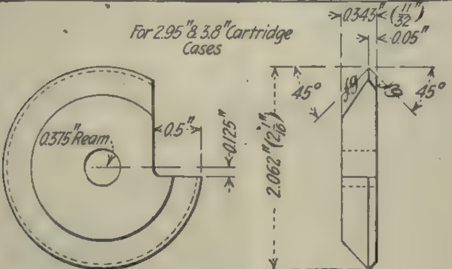


Tapering Die
TOOL STEEL
Finish f ±0.005" Harden
FIG. 37, OP. 24

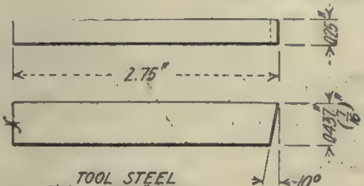


A = 1.980" for 2.95" Mt. Gun Cart. Case
A = 2.007" for 3" Field Gun Mod. 1902, 04 1905 Cart Case
A = 1.987" for 3" Mt. How. Mod. 1907, 11 & 47 How.
A = 2.007" for 3.8" How. Mod. 1908, Cart Case
A = 2.002" For 4.7" Gun Mod. 1906 Cart Case
A = 1.997" For 6" How. Mod. 1906, '08 Cart Case

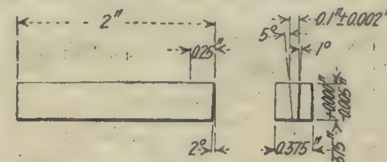
HIGH SPEED STEEL
Finish f ±0.01" Harden
FIG. 38



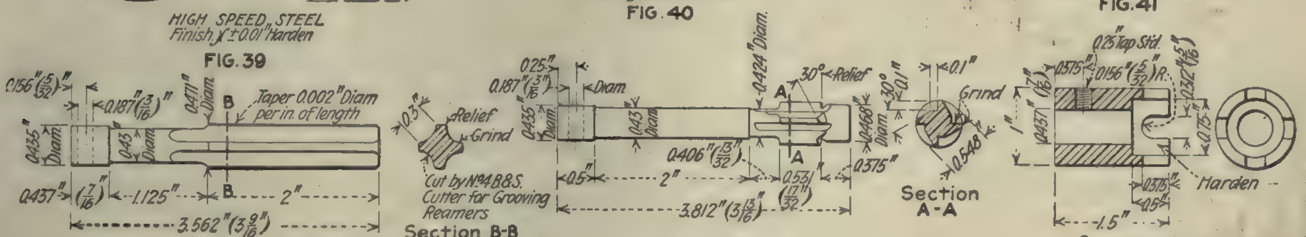
HIGH SPEED STEEL
Finish f ±0.01" Harden
FIG. 39



TOOL STEEL
Finish f g ±0.01" Harden
FIG. 40



TOOL STEEL
Finish f ±0.01" Harden
FIG. 41



Reamer
TOOL STEEL
(Finish, Harden)
FIG. 42

Counterbore
TOOL STEEL
(Finish, Harden)
OPERATION 25

Counterbore Stop
TOOL STEEL
Finish
0.25" x 0.25" Headless Std. Set Screw
FIG 43

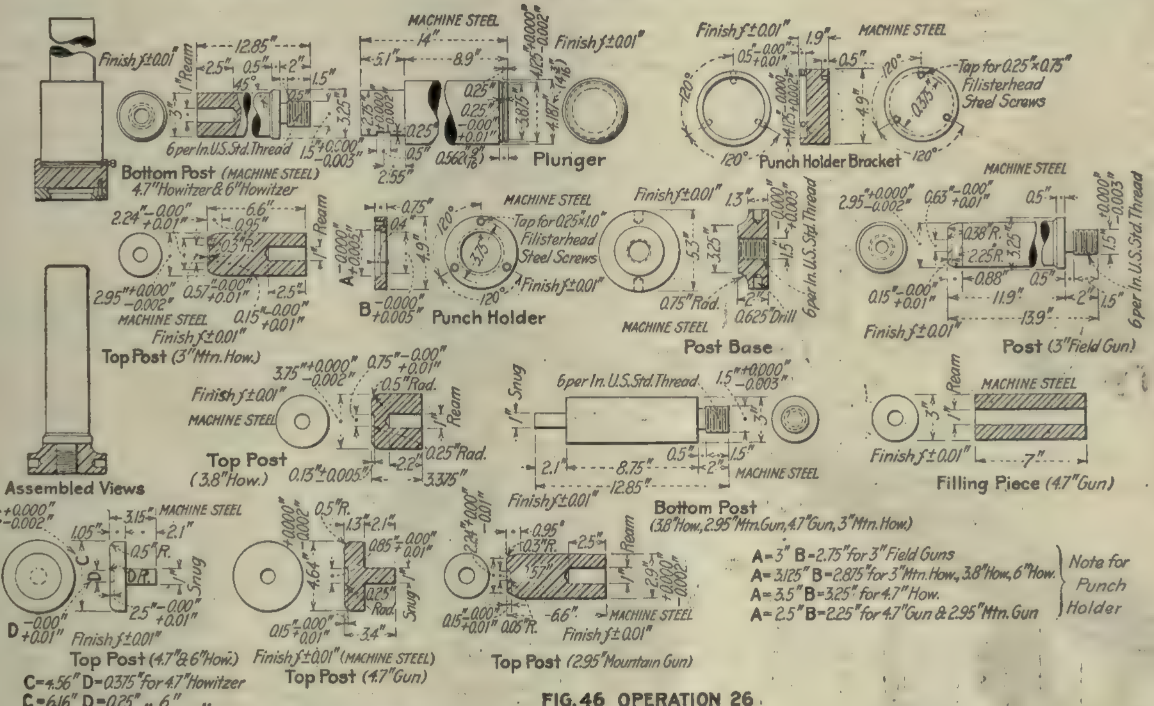
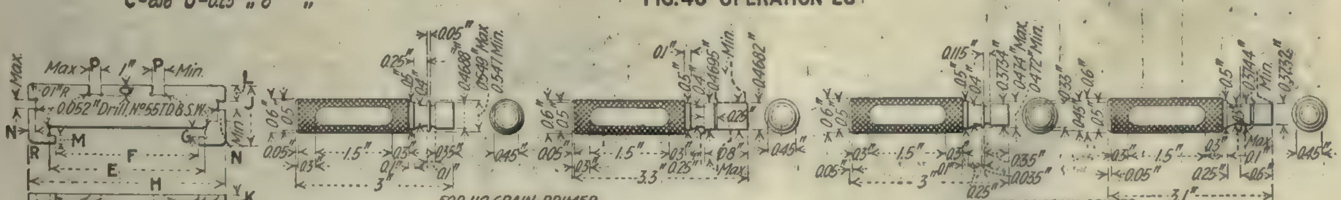


FIG. 46 OPERATION 26



Head Gage
FORGED STEEL No. 3
(Harden & Grind)

Primer Hole Counterbore Gage
FORGED STEEL No. 3
Finish, H. & G.

Primer Hole Gage
FORGED STEEL No. 3
Finish, H. & G.

Primer Hole Counterbore Gage
FORGED STEEL No. 3
Finish, H. & G.

Primer Hole Gage
FORGED STEEL No. 3
Finish H. & G.

FIG. 44, OP. 25

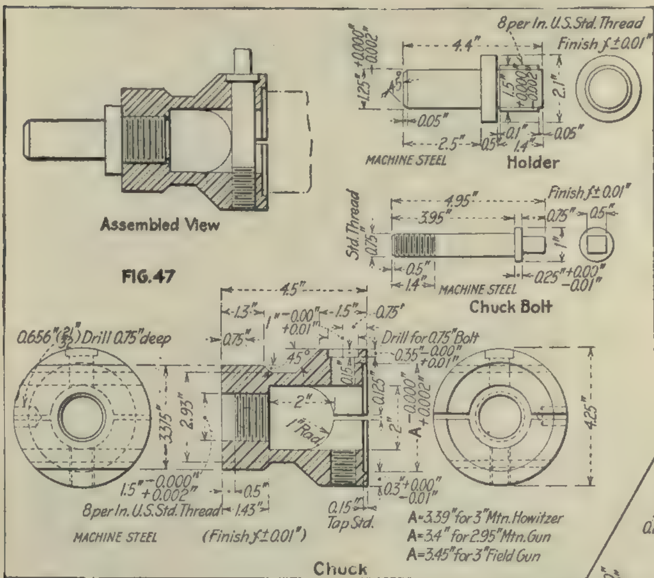
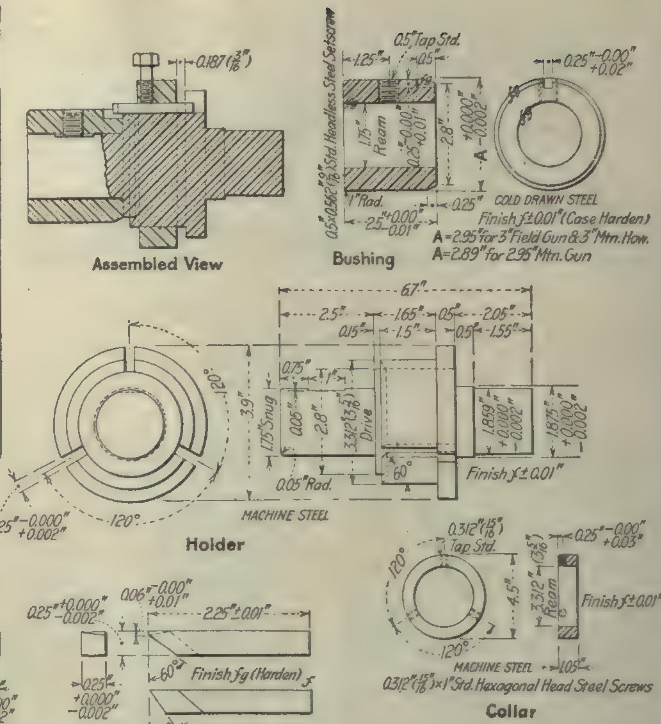


FIG. 47



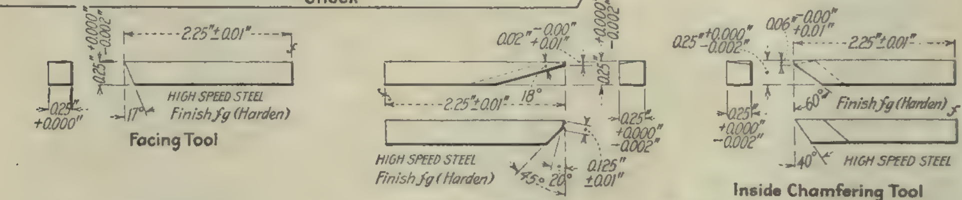


FIG. 48

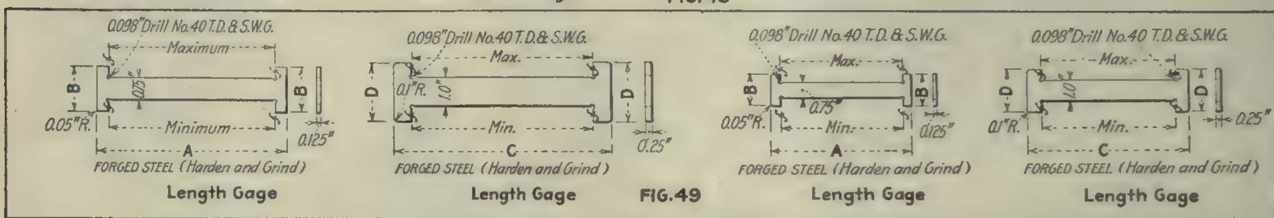


FIG. 49

OPERATION 27

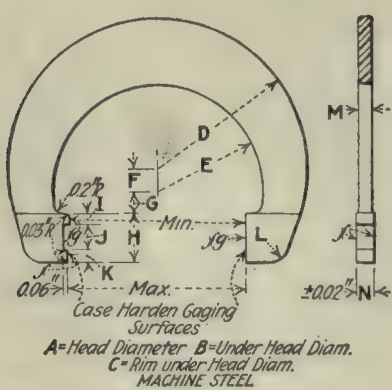


FIG. 45, OP. 25

The Diaphragm and the Tube for Tracers

The diaphragm is made of sheet brass; the operations are:

Operation	
1	Blank and form
2	Pierce for tracer tube

The punches and dies used for the first operation are shown in Fig. 54, but the second is a simple piercing operation.

The tube is set into the diaphragm when a night tracer is used. It is also made of sheet brass and is evolved in the following order:

Operation	
1	Blank and first draw
2	Anneal
3	Pickle and wash

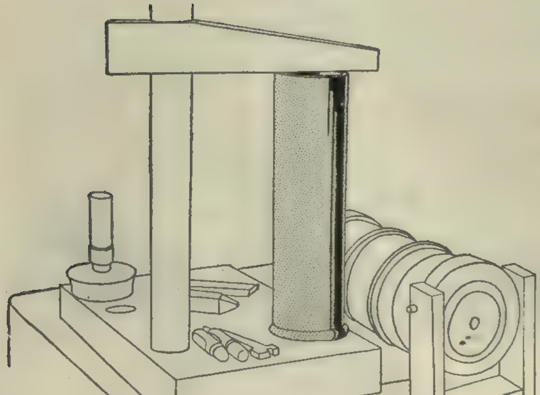


FIG. 50

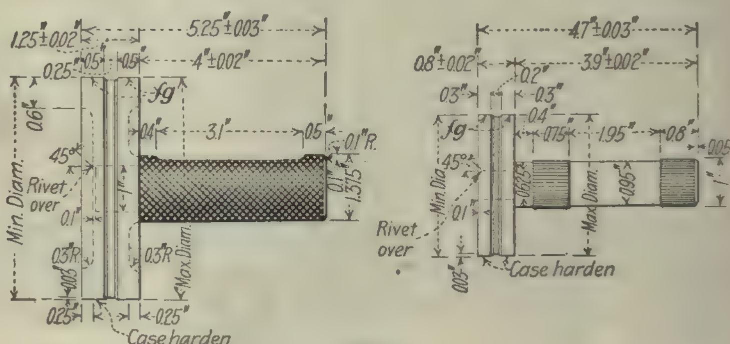


FIG. 51

4 Second draw
5 Anneal
6 Pickle and wash
7 Third draw
8 Anneal
9 Pickle and wash
10 Fourth draw
11 Anneal
12 Pickle and wash
13 Fifth draw
14 Trim
15 Start flange
16 Assemble
17 Solder

The blanking and first drawing die may be seen in Fig. 56. The second- and third-draw dies are shown in Fig. 57 and those for the fourth and fifth draw in Fig. 58. The trimming and flanging fixtures are illustrated in Fig. 59.

OPERATION 7. THIRD DRAW

Transformation—Fig. 57. Punch and Die—Fig. 57. Production—4000 per 8 hr.

OPERATION 8. ANNEAL

Production—10,000 per 8 hr.

OPERATION 10. FOURTH DRAW

Transformation—Fig. 58. Punch and Die—Fig. 58. Production—4000 per 8 hr.

OPERATION 11. ANNEAL

Production—10,000 per 8 hr.

OPERATION 12. PICKLE AND WASH

Production—10,000 per 8 hr.

OPERATION 13. FIFTH DRAW

Transformation—Fig. 58. Punch and Die—Fig. 58. Production—4000 per 8 hr.

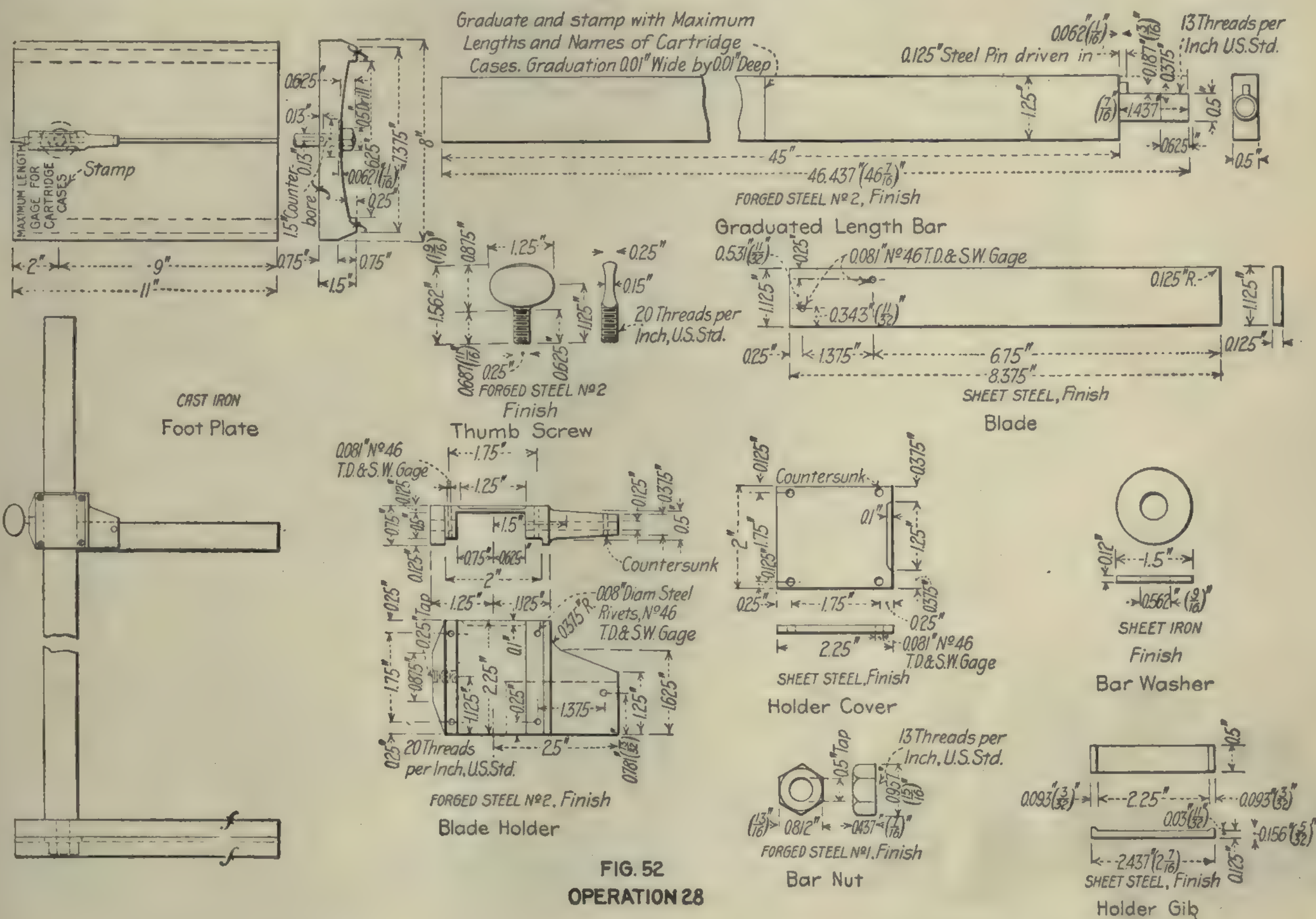


FIG. 52
OPERATION 28

Diaphragm

OPERATION 1. BLANK AND FORM

Punches and Dies—Fig. 54. Production—8000 per 8 hr.

OPERATION 2. PIERCE

Transformation—Fig. 55. Production—8000 per 8 hr. Note—A 1-in. hole is pierced for the tracer tube, with common punch and die.

Tube for Tracer

OPERATION 1. BLANK AND FIRST DRAW

Transformation—Fig. 56. Punch and Die—Fig. 56. Production—8000 per 8 hr.

OPERATION 2. ANNEAL

Production—10,000 per 8 hr.

OPERATION 3. PICKLE AND WASH

Production—10,000 per 8 hr.

OPERATION 4. SECOND DRAW

Transformation—Fig. 57. Punch and Die—Fig. 57. Production—4000 per 8 hr.

OPERATION 5. ANNEAL

Production—10,000 per 8 hr.

OPERATION 6. PICKLE AND ANNEAL

Production—10,000 per 8 hr.

OPERATION 14. TRIM

Machine Used—Small lathe. Special Fixtures—Fig. 59. Production—4000 per 8 hr.

OPERATION 15. START FLANGE

Special Fixtures—Fig. 59. Production—4000 per 8 hr.

OPERATION 16. ASSEMBLE

Production—4000 per 8 hr. Note—Tube is pressed through hole in diaphragm.

OPERATION 17. SOLDER

Production—500 per 8 hr.

Cartridge Case for 3-In. Mountain Howitzer, Models of 1907 and 1911

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 60. Punch and Die—Fig. 61. Pressure Required—18 tons. Production—4200 per 8 hr. Size of Blank—Maximum diameter, 4.905 in.; minimum diameter, 4.900 in.; maximum thickness, 0.317 in.; minimum thickness, 0.312 in.; weight, 1 lb. 13½ oz.

SUCCEEDING OPERATIONS

Operation
2 Wash and anneal; production, 5700
3 Pickle and wash; production, 2700

4 First draw; punch and die, Fig. 62; pressure required, 15 tons; production, 4300
5 Wash and anneal; production, 5700
6 Pickle and wash; production, 3600
7 Second draw; punch and die, Fig. 63; pressure, 12 tons; production, 3700
8 Wash and anneal; production, 6000
9 Pickle and wash; production, 2400
10 Third draw; punch and die, Fig. 64; pressure, 7 tons; production, 3400
11 Wash and anneal; production, 3600
12 Pickle and wash; production, 1800
13 Fourth draw; punch and die, Fig. 65; pressure, 5 tons; production, 2400

DIAPHRAGM

Operation
1 Blank and form; punch and die same as for field gun
2 Shear soldering strip; production, 3000
3 Shear, blank and form clip; production, 6000
4 Form soldering strip; production, 1000
5 Solder soldering strip to diaphragm; production, 300
6 Scrape solder from diaphragm; tools, chuck and scraper; production, 1000
7 Cut cords; production, 12,000
8 Tie and paraffin cords; production, 3500
9 Solder cords to soldering strip and clip; production, 500

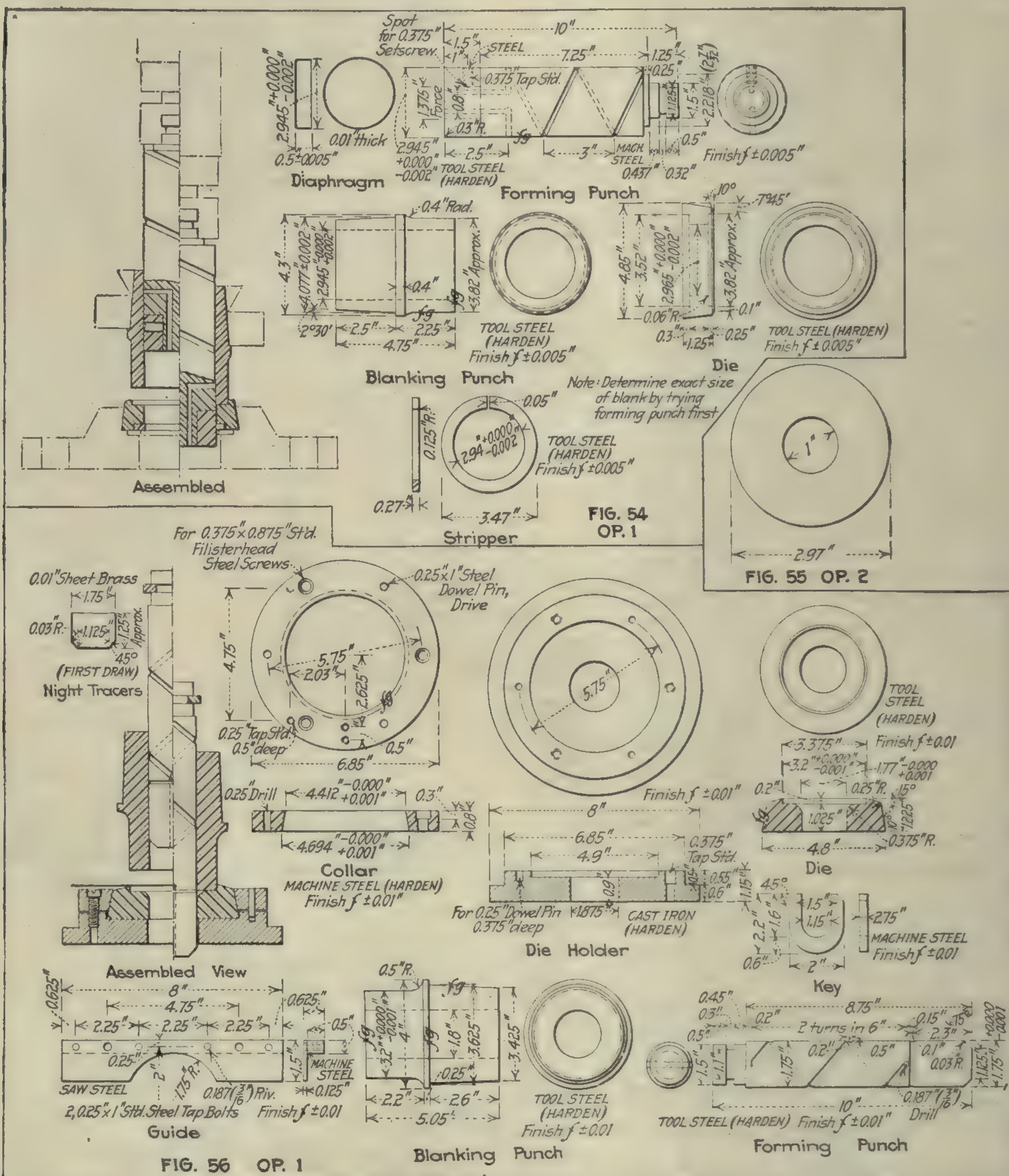


FIG. 54 OP. 1

FIG. 55 OP. 2

FIG. 56 OP. 1

14 Wash and anneal; production, 3800
15 Pickle and wash; production, 2000
16 Fifth draw; punch and die, Fig. 66; pressure, 2 tons; production, 1900
17 Trim; production, 1350
18 Wash for heading; production, 3500
19 Heading; punch and die, Fig. 67; pressure, 600 tons
20 Punch primer hole; production, 2800
20-A Rough head and drill primer hole
21 Broach
22 Burr out
23 Point anneal
24 Tapering; die, Fig. 68; production, 1800
25 Finish head
26 Stamp
27 Finish trim; length gage, Fig. 49
28 Inspection; gages are same as used for field-gun cartridge case except length and cylinder case, Fig. 67

Cartridge Case for 3-In. Gun, 15-Pounder, Model 1898-1902

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 70. Punch and Die—Fig. 71. Pressure Required—73' tons. Size of Blank—Maximum diameter, 8.505 in.; minimum diameter, 8.500 in.; maximum thickness, 0.469 in.; minimum thickness, 0.459 in.; weight, 8.125 lb.

SUCCEEDING OPERATIONS

Operation
2 Wash and anneal
3 Pickle and wash
4 First draw; punch and die, Fig. 72; pressure required, 47 tons
5 Wash and anneal

6 Pickle and wash
7 Second draw; punch and die, Fig. 73; pressure required, 45 tons
8 Wash and anneal
9 Pickle and wash
10 Third draw; punch and die, Fig. 74; pressure required, 42 tons
11 Wash and anneal
12 Pickle and wash
13 Fourth draw; punch and die, Fig. 75; pressure required, 31 tons
14 Wash and anneal
15 Pickle and wash
16 Fifth draw; punch and die, Fig. 76; pressure required, 26 tons
17 Wash and anneal
18 Pickle and wash
19 Sixth draw; punch and die, Fig. 77; pressure required, 15 tons

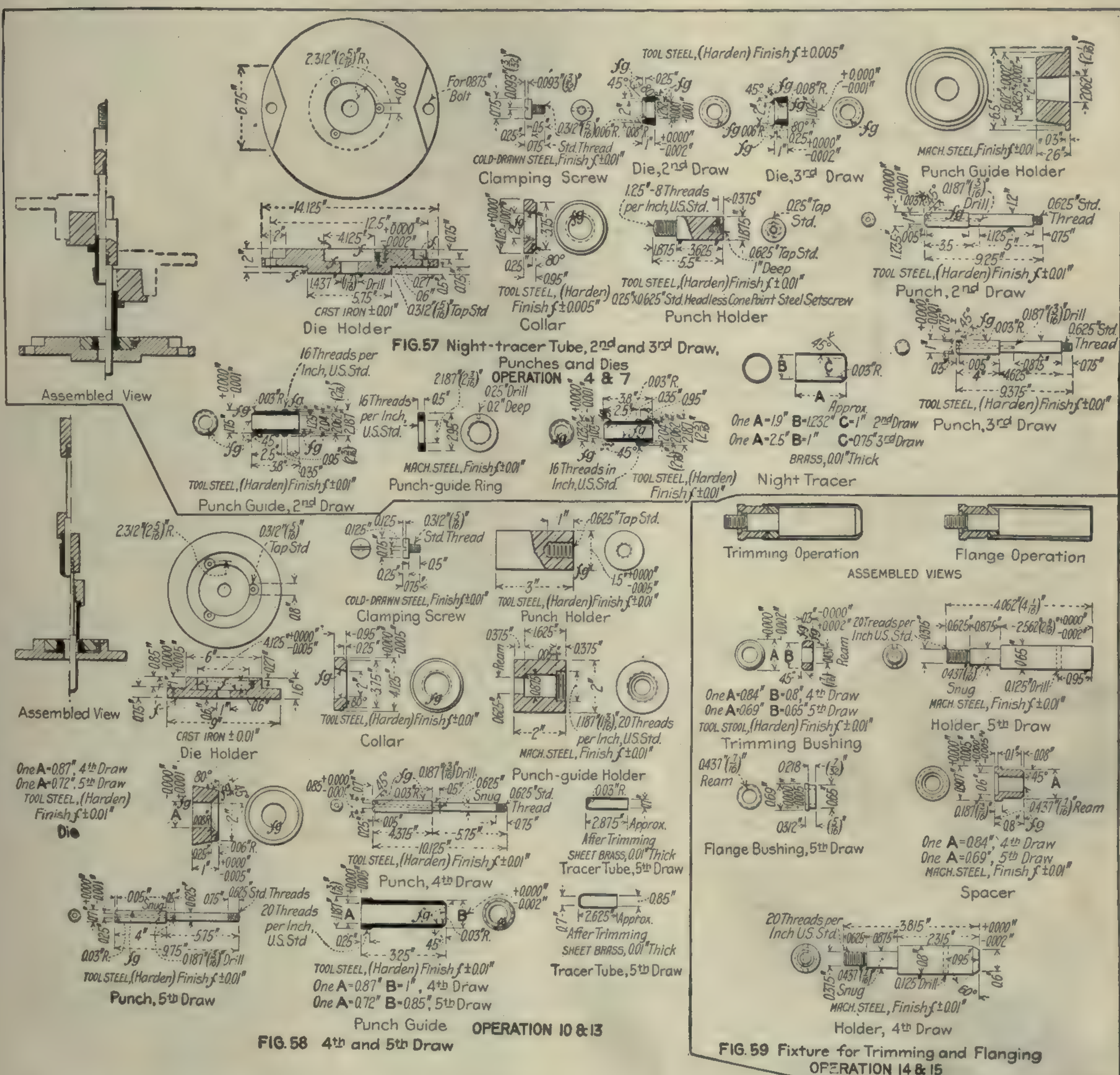


FIG. 57 Night-tracer Tube, 2nd and 3rd Draw, Punches and Dies OPERATION 4 & 7

FIG. 58 4th and 5th Draw OPERATION 10 & 13

FIG. 59 Fixture for Trimming and Flanging OPERATION 14 & 15

20 Sixth-draw trim; trim off 20 per cent.
21 Wash and anneal
22 Pickle and wash
23 Seventh draw; punch and die, Fig. 78; pressure required, 10 tons
24 Seventh-draw trim
25 Wash and anneal
26 Pickle and wash
27 Eighth draw; punch and die, Fig. 79; pressure required, 7 tons
28 Eighth-draw trim
29 Wash for heading
30 Heading; punch and die, Fig. 80; pressure required, 850 tons
31 Rough-turn heads and drill primer hole
32 Broach primer hole
33 Burr out
34 First point anneal; approximate heat, 1300 deg. F.: 6 min.
35 First tapering; die, Fig. 81; pressure, 45 tons
36 Second point anneal
37 Second tapering; die, Fig. 82; pressure, 45 tons
38 Final trim
39 Finish-turn head
40 Stamp head; pressure required, 15 tons
41 Final anneal
42 Inspect

Cartridge Case for 3-In. Gun, 15-Pounder, Model 1903

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 83. Punch and Die—Fig. 84. Pressure—60 tons. Disk—Maximum diameter, 9.380 in.; minimum diameter, 9.375 in.; maximum thickness, 0.438 in.; minimum thickness, 0.428 in.; weight, 9.25 lb.

SUCCEEDING OPERATIONS

Operation
2 Wash and anneal
3 Pickle and wash
4 First draw; punch and die, Fig. 85; pressure required, 45 tons
5 Wash and anneal
6 Pickle and wash
7 Second draw; punch and die, Fig. 86; pressure, 40 tons
8 Wash and anneal
9 Pickle and wash
10 Third draw; punch and die, Fig. 87; pressure, 35 tons
11 Wash and anneal

12 Pickle and wash
13 Fourth draw; punch and die, Fig. 88; pressure, 30 tons
14 Wash and anneal
15 Pickle and wash
16 Fifth draw; punch and die, Fig. 89; pressure, 20 tons
17 Wash and anneal
18 Pickle and wash
19 Sixth draw; punch and die, Fig. 90; pressure required, 10 tons
20 Sixth-draw trim; trim off 20 per cent.
21 Wash and anneal
22 Pickle and wash
23 Seventh draw; punch and die, Fig. 91; pressure required, 8 tons
24 Seventh-draw trim
25 Wash and anneal
26 Pickle and wash
27 Eighth draw; punch and die, Fig. 92; pressure, [illegible] tons
28 Eighth-draw trim
29 Wash for heading
30 Heading; punch and die, Fig. 93; pressure, 1050 tons
31 Rough-turn head and drill primer hole
32 Broach
33 Burr out
34 First point anneal
35 First taper; die, Fig. 94; pressure, 50 tons
36 Second point anneal
37 Second taper; die, Fig. 95; pressure, 50 tons
38 Final trim
39 Finish-turn head
40 Stamp
41 Final anneal
42 Inspect

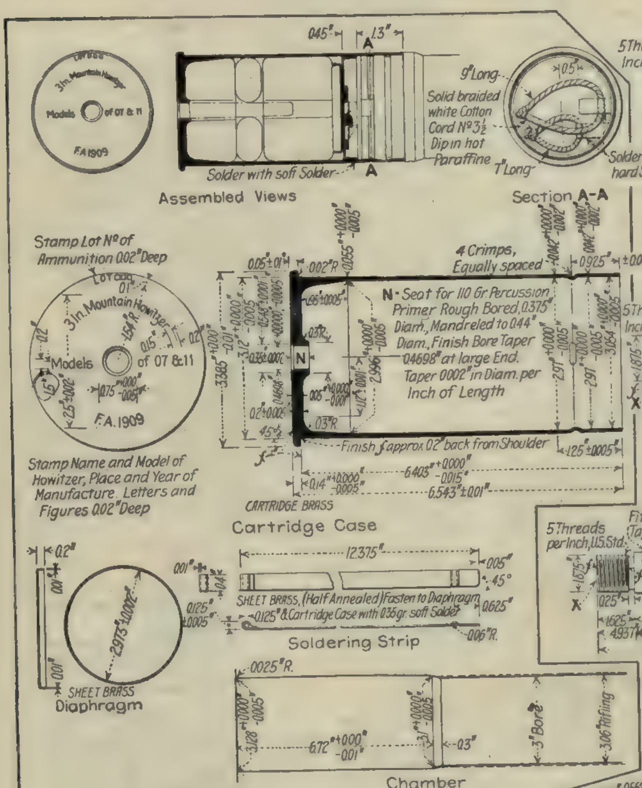


FIG. 60

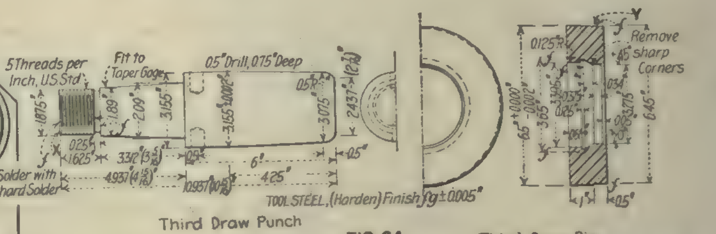


FIG. 64
OPERATION 10

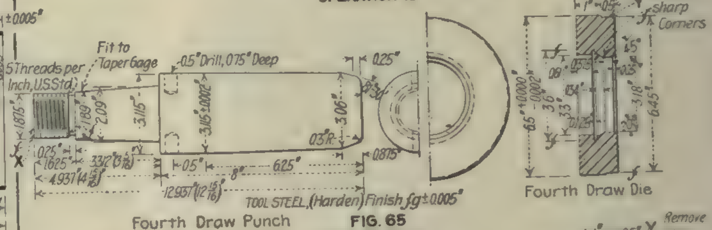


FIG. 65
OPERATION 13

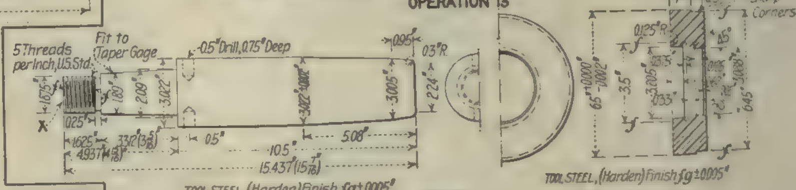


FIG. 66
OPERATION 16

X - Stamp Name of Cartridge Case, Operation, Place of Manufacture and Date (Year)
Y - Stamp Name of Cartridge Case, Operation, Diameter of Die, Place of Manufacture and Date (Year)

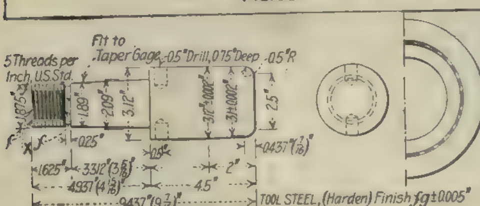


FIG. 61
OPERATION 1

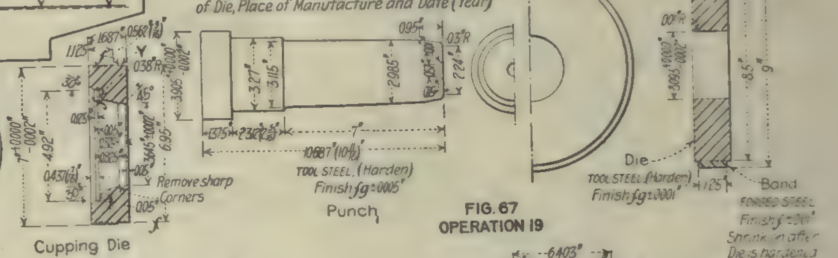


FIG. 67
OPERATION 19

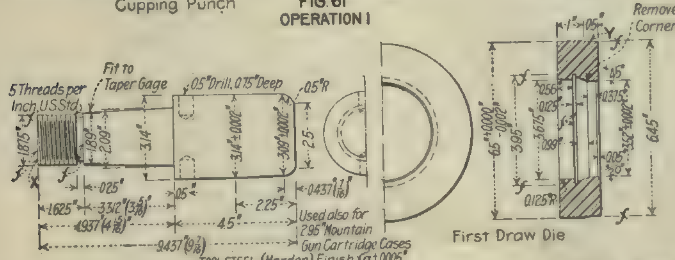


FIG. 62
OPERATION 4

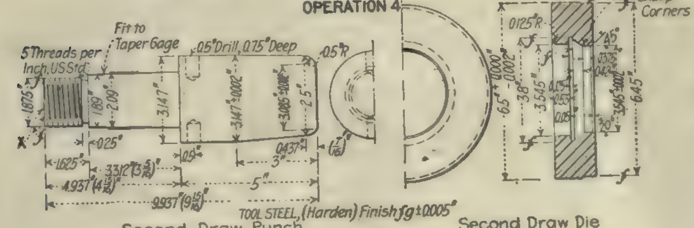


FIG. 63
OPERATION 7

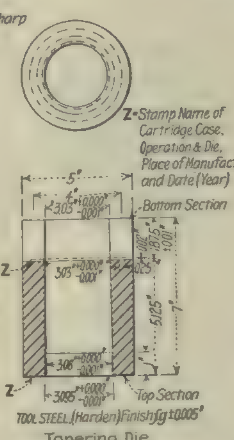


FIG. 68
OPERATION 24

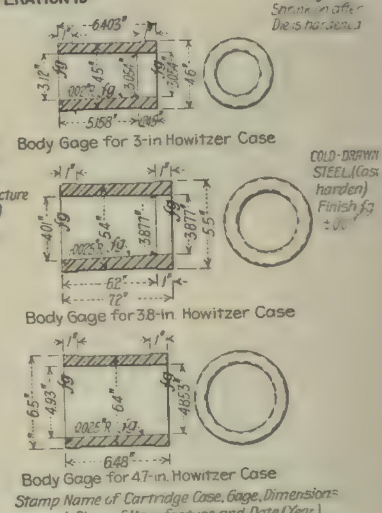


FIG. 69
OPERATION 28

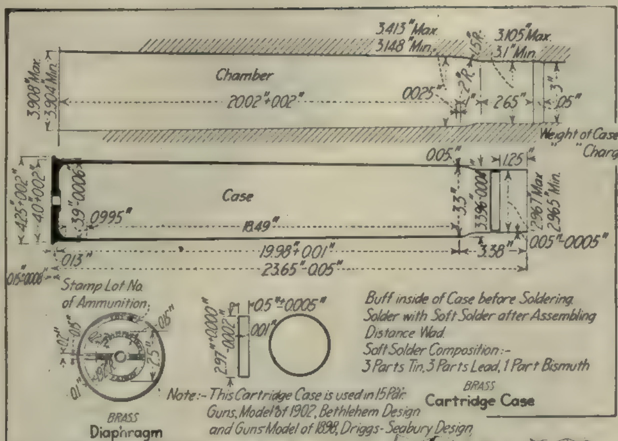


FIG. 70

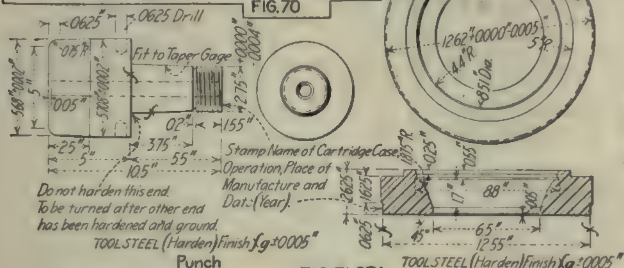


FIG. 71, OP. 1

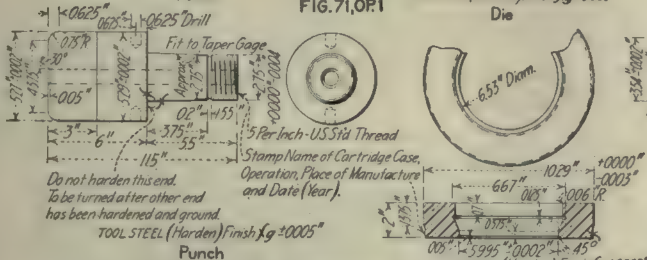


FIG. 72, OP. 4

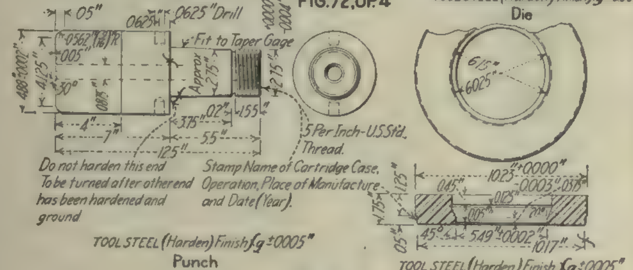


FIG. 73, OP. 7

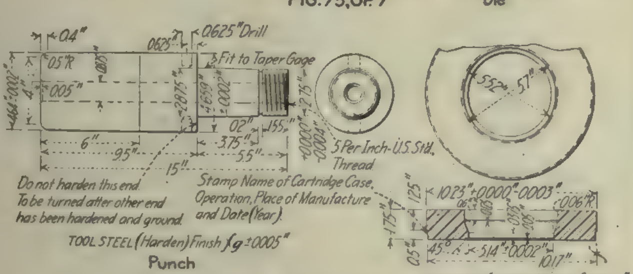


FIG. 74, OP. 10

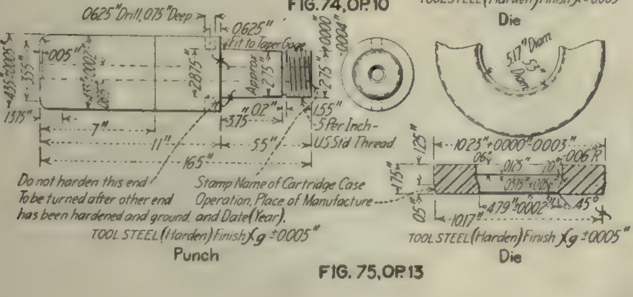


FIG. 75, OP. 13

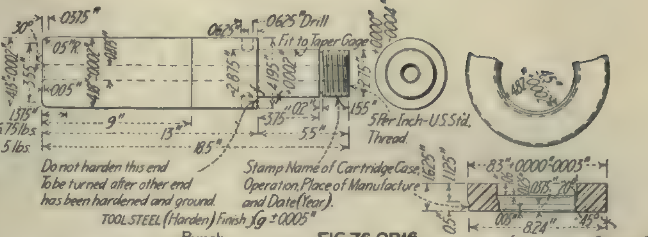


FIG. 76, OP. 16

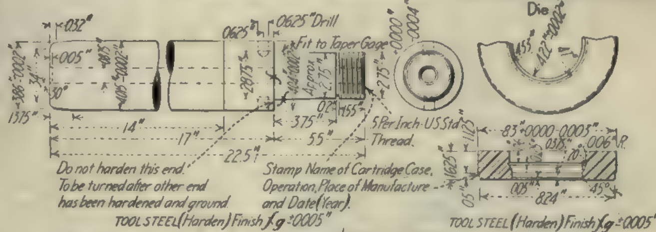


FIG. 77, OP. 19

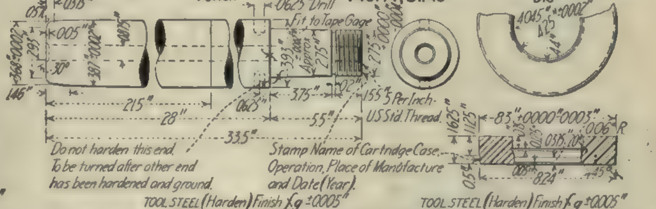


FIG. 78, OP. 23

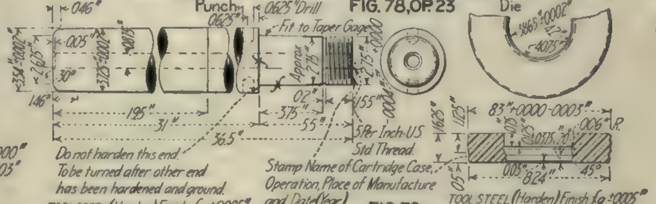
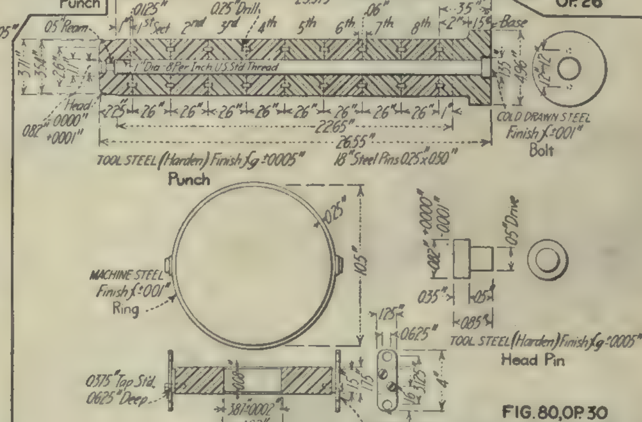


FIG. 79



OP. 26

FIG. 80, OP. 30

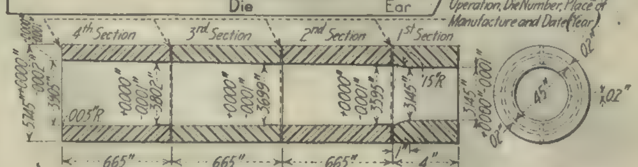


FIG. 81, OP. 35

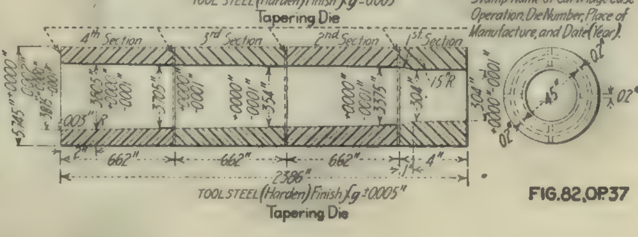


FIG. 82, OP. 37

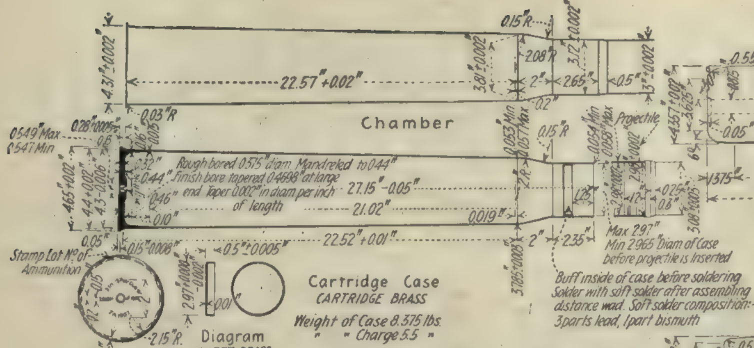


FIG. 83

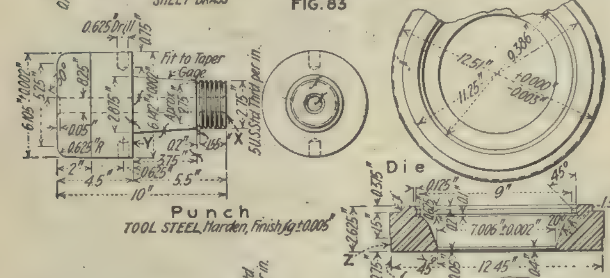


FIG. 84, OP. 1

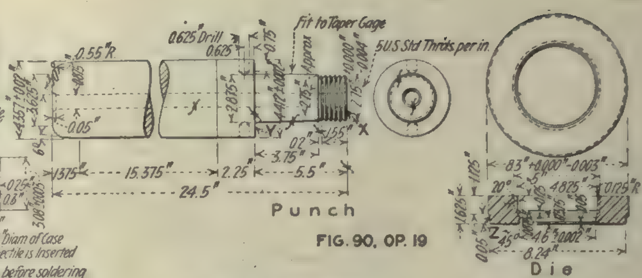


FIG. 90, OP. 19

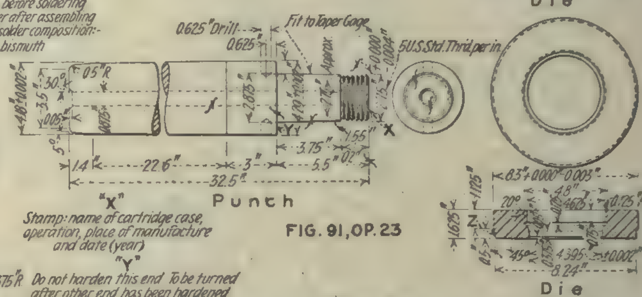


FIG. 91, OP. 23

"X"
Stamp: name of cartridge case, operation, place of manufacture and date (year)

"Y"
Do not harden this end. To be turned after other end has been hardened and ground

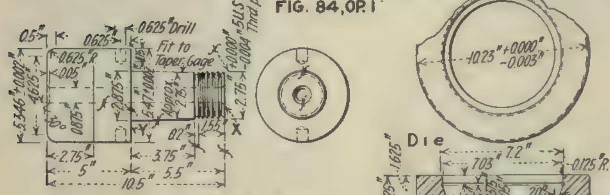


FIG. 85, OP. 4

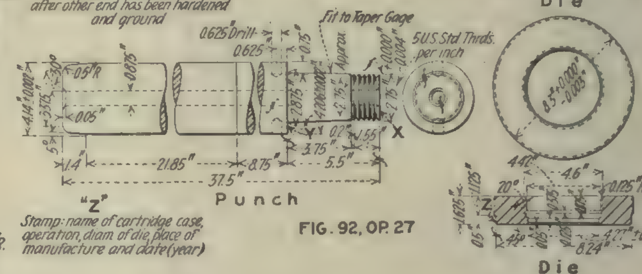


FIG. 92, OP. 27

"Z"
Stamp: name of cartridge case, operation, diam. of die, place of manufacture and date (year)

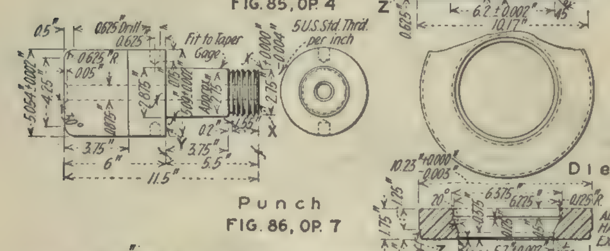


FIG. 86, OP. 7

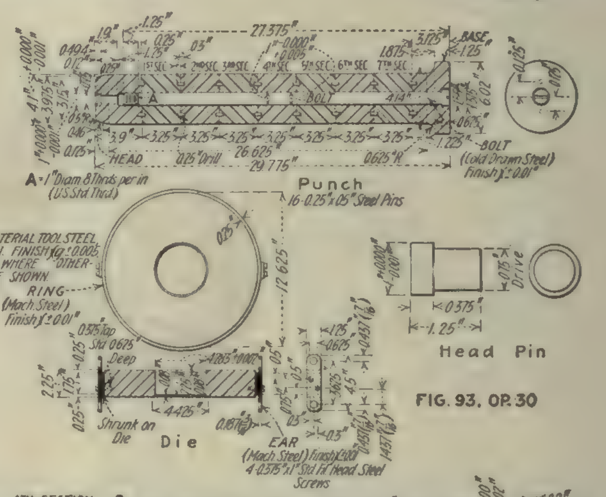


FIG. 93, OP. 30

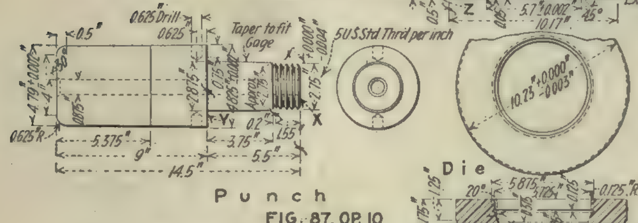


FIG. 87, OP. 10

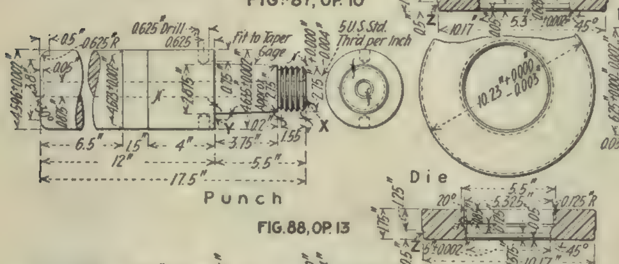
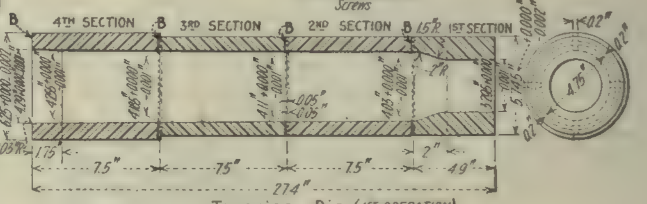


FIG. 88, OP. 13



Tapering Die (1ST OPERATION)
FIG. 94, OP. 35

"B"
Stamp: name of cartridge case, operation and die number, place of manufacture and date (year)

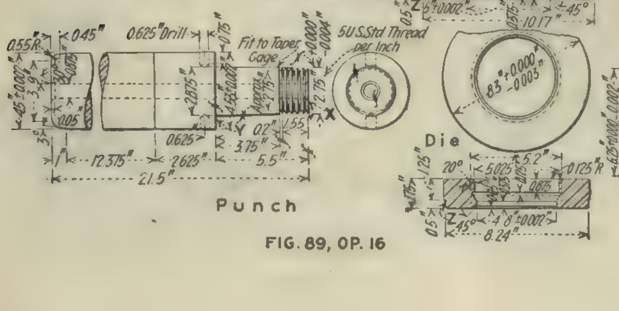
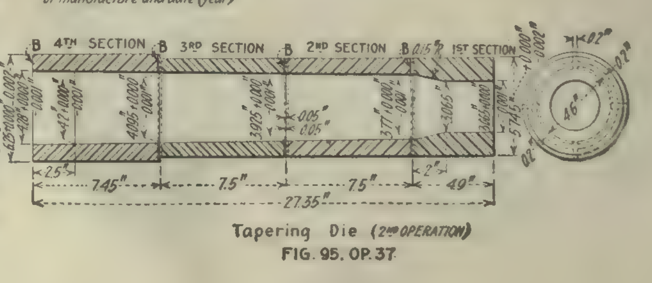


FIG. 89, OP. 16



Tapering Die (2ND OPERATION)
FIG. 95, OP. 37

The operation lists, dimensions, dies and other information on the other cartridge cases up to 6 in. in both the gun and howitzer types are as follows:

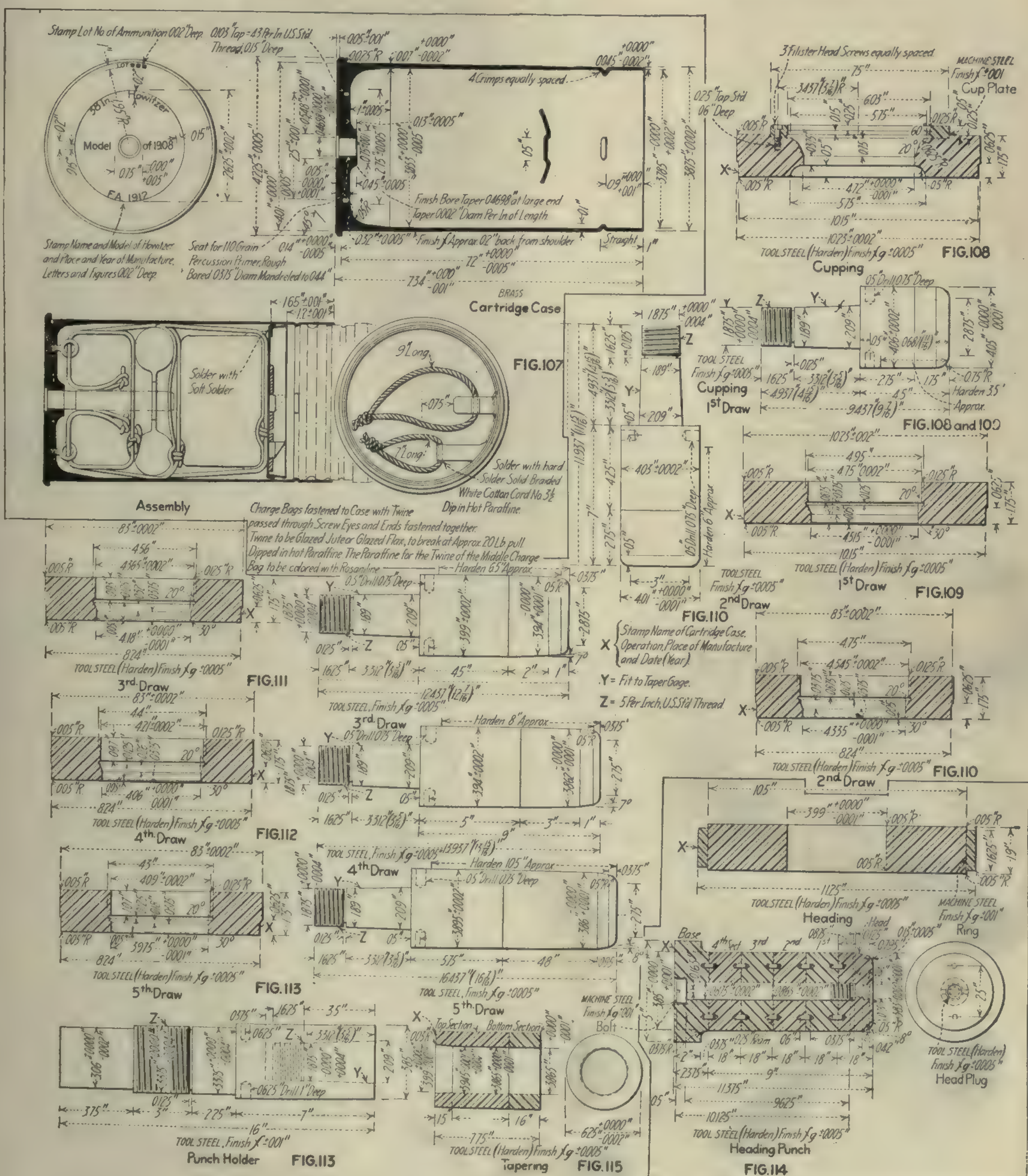
CARTRIDGE CASE FOR 3.8-IN. HOWITZER, MODEL 1908

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 107. Punch and Die—Fig. 108. Pressure Required—50 tons. Dimensions of Disk—Maximum diameter, 6.005 in.; minimum diameter, 6 in.; maximum thickness, 0.431 in.; minimum thickness, 0.421 in.; weight, 3.739 lb.

SUCCEEDING OPERATIONS

Operation	
2	Wash and anneal
3	Pickle and wash
4	First draw; punch and die, Fig. 109; pressure required, 30 tons
5	Wash and anneal
6	Pickle and wash
7	Second draw; punch and die, Fig. 110; pressure, 20 tons
8	Wash and anneal
9	Pickle and wash
10	Third draw; punch and die, Fig. 111; pressure, 15 tons
11	Wash and anneal
12	Pickle and wash
13	Fourth draw; punch and die, Fig. 112; pressure, 13 tons
14	Wash and anneal
15	Pickle and wash
16	Fifth draw; punch and die, Fig. 113; pressure, 10 tons
17	Fifth-draw trim
18	Wash for heading
19	Heading; die, Fig. 114; pressure, 1000 tons
20	Rough-turn head and drill primer hole
21	Broach
22	Burr out
23	Point anneal
24	Taper; die, Fig. 115; pressure, 20 tons



25 Finish-turn heads
26 Drill for screw-eyes
27 Tap for screw-eyes
28 Stamp
29 Final trim
30 Inspect

Cartridge Case for 4.7-In. Gun, Model 1906

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 116. Punch and Die—Fig. 117. Pressure—65 tons. Dimensions of Disk—Maximum diameter, 8.630 in.; minimum diameter, 8.625 in.; maximum thickness, 0.505 in.; minimum thickness, 0.495 in.; weight, 8.987 lb.

SUCCEEDING OPERATIONS

Operation

2 Wash and anneal
3 Pickle and wash
4 First draw; punch and die, Fig. 118; pressure, 60 tons
5 Wash and anneal
6 Pickle and wash
7 Second draw; punch and die, Fig. 119; pressure, 45 tons
8 Wash and anneal
9 Pickle and wash
10 Third draw; punch and die, Fig. 120; pressure, 40 tons
11 Wash and anneal
12 Pickle and wash
13 Fourth draw; punch and die, Fig. 121; pressure, 30 tons
14 Wash and anneal
15 Pickle and wash
16 Fifth draw; punch and die, Fig. 122; pressure, 25 tons
17 Wash and anneal
18 Pickle and wash
19 Sixth draw; punch and die, Fig. 123; pressure, 20 tons
20 Sixth-draw trim; remove 20 per cent.
21 Wash and anneal
22 Pickle and wash
23 Seventh draw; punch and die, Fig. 124; pressure, 15 tons
24 Seventh-draw trim
25 Wash for heading
26 Heading; die, Fig. 125; pressure, 1400 tons
27 Rough-turn head and drill primer hole
28 Broach
29 Burr out
30 Point anneal
31 Taper; die, Fig. 126; pressure, 45 tons
32 Finish-turn head
33 Stamp; pressure, 15 tons
34 Final trim
35 Inspect

Cartridge Case for 4.7-In. Howitzer, Models of 1907, 1908 and 1912

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 127. Punch and Die—Fig. 128. Pressure—90 tons. Dimensions of Disk—Maximum diameter, 7.105 in.; minimum diameter, 7.100 in.; maximum thickness, 0.465 in.; minimum thickness, 0.455 in.; weight, 6 lb 9 oz.

SUCCEEDING OPERATIONS

Operation

2 Wash and anneal
3 Pickle and wash
4 First draw; punch and die, Fig. 129; pressure, 50 tons
5 Wash and anneal
6 Pickle and wash
7 Second draw; punch and die, Fig. 130; pressure, 45 tons

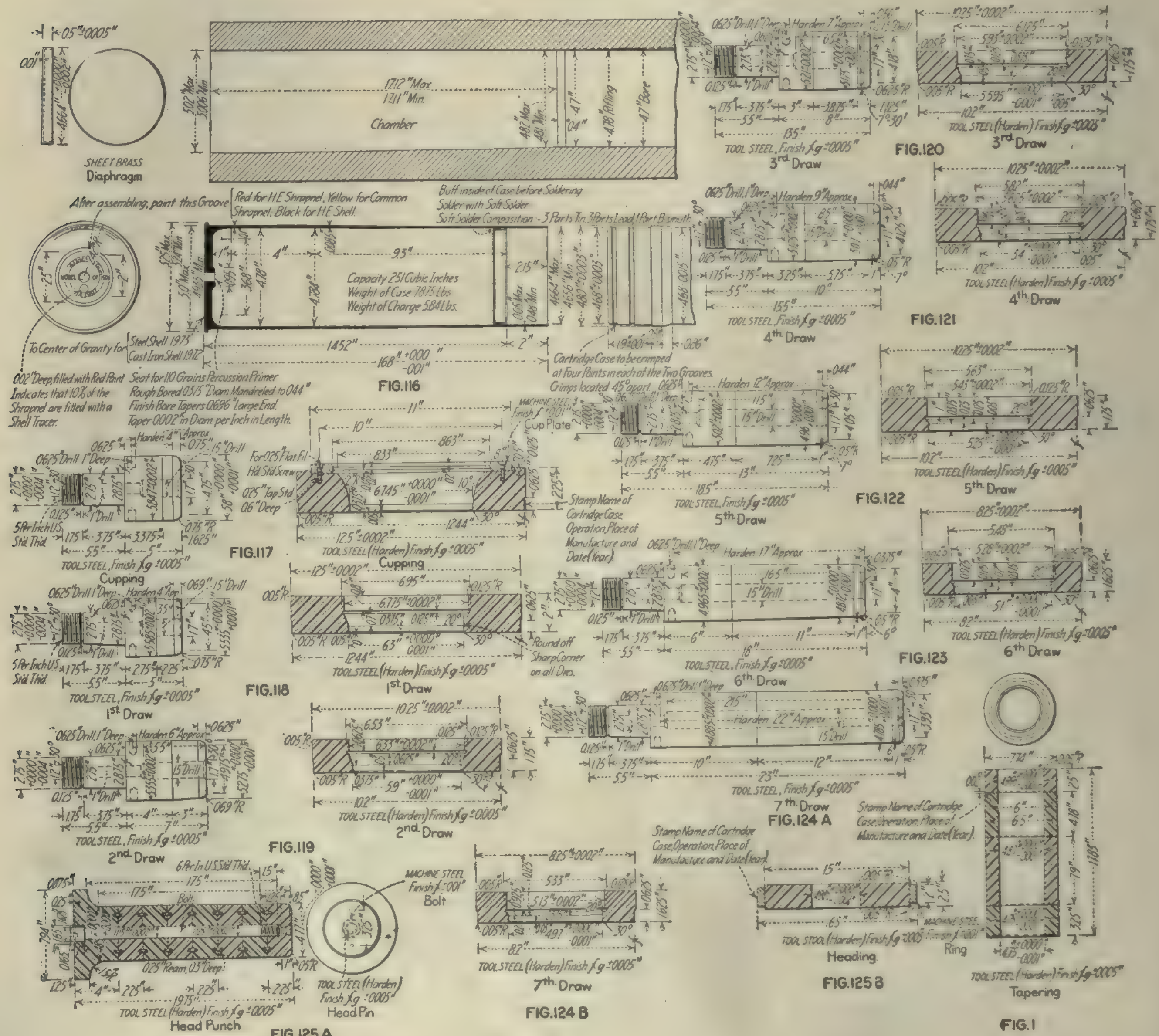


FIG.116 FIG.117 FIG.118 FIG.119 FIG.120 FIG.121 FIG.122 FIG.123 FIG.124 A FIG.124 B FIG.125 A FIG.125 B FIG.1

8 Wash and anneal
9 Pickle and wash
10 Third draw; punch and die, Fig. 131; pressure, 30 tons
11 Wash and anneal
12 Pickle and wash
13 Fourth draw; punch and die, Fig. 132; pressure, 20 tons
14 Wash and anneal
15 Pickle and wash
16 Fifth draw; punch and die, Fig. 133; pressure, 15 tons
17 Fifth-draw trim
18 Wash for heading
19 Heading; die, Fig. 134; pressure, 1350 tons
20 Rough-turn head and drill primer hole
21 Broach
22 Burr out
23 Point anneal
24 Taper; die, Fig. 135; pressure, 30 tons
25 Finish-turn head
26 Drill for screw-eyes
27 Tap for screw-eyes
28 Stamp; pressure, 15 tons
29 Final trim
30 Inspect

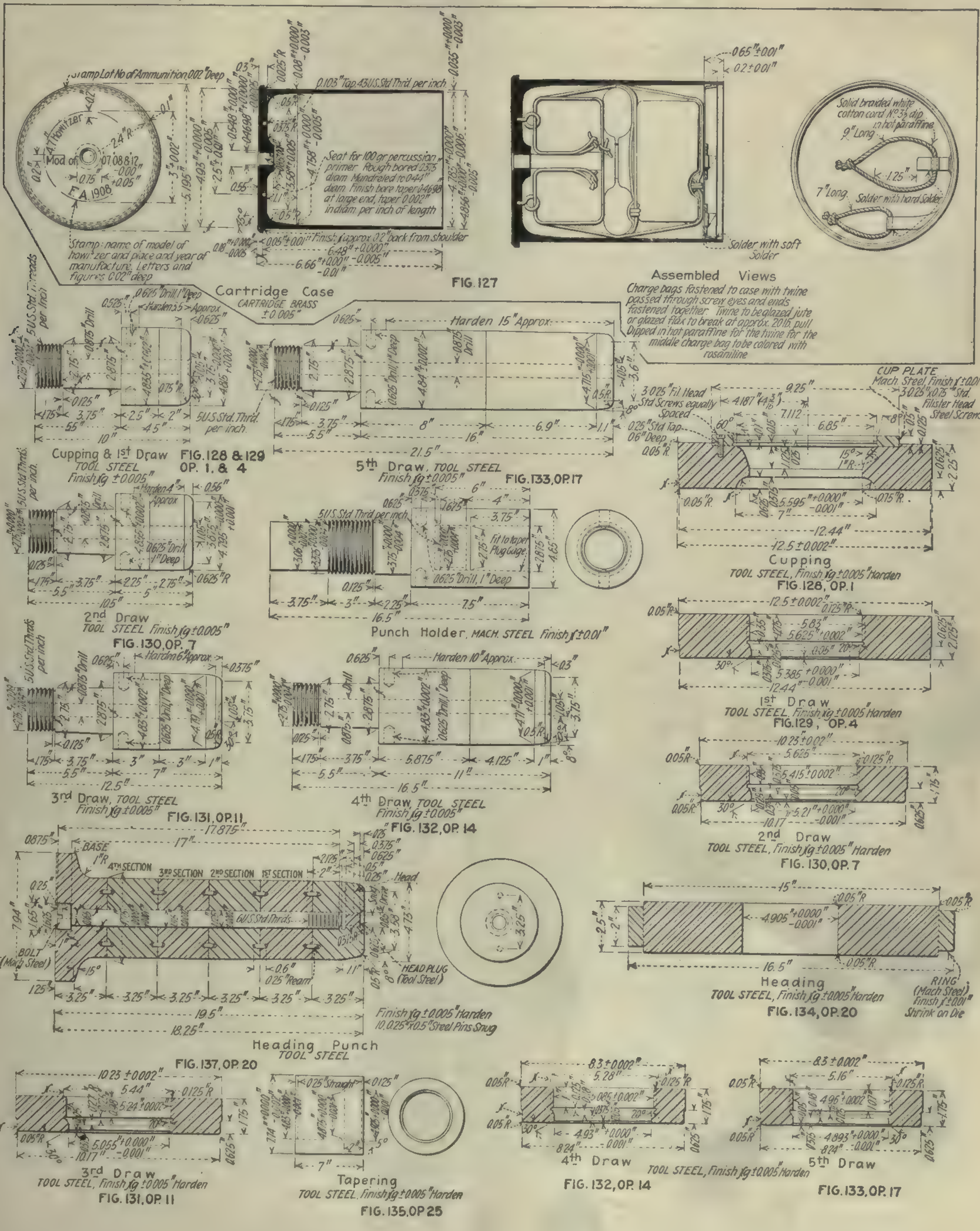


FIG. 127

FIG. 128 & 129, OP. 1 & 4

FIG. 133, OP. 17

FIG. 128, OP. 1

FIG. 129, OP. 4

FIG. 130, OP. 7

FIG. 131, OP. 11

FIG. 132, OP. 14

FIG. 130, OP. 7

FIG. 137, OP. 20

FIG. 134, OP. 20

FIG. 131, OP. 11

FIG. 135, OP 25

FIG. 132, OP. 14

FIG. 133, OP. 17

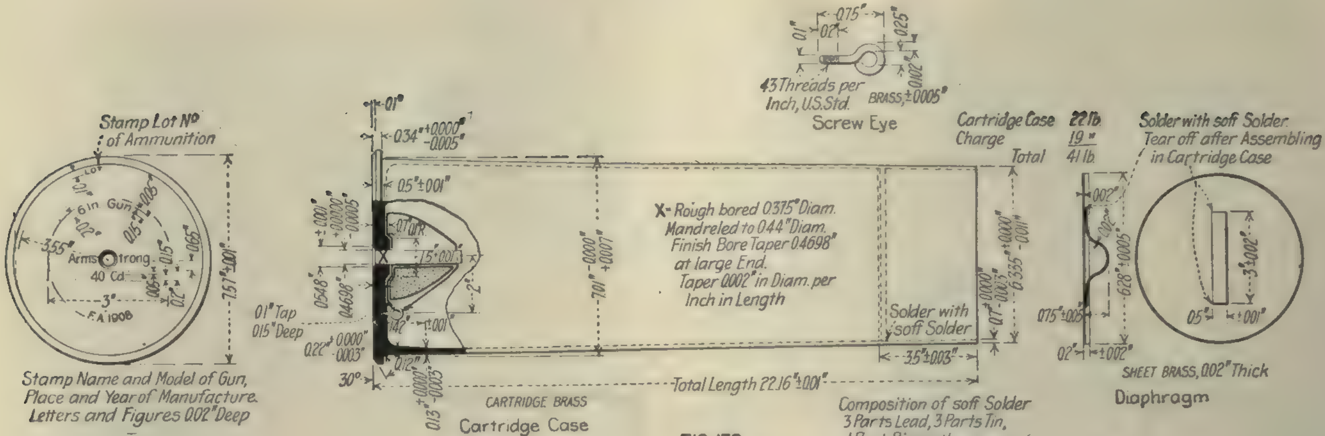


FIG. 136

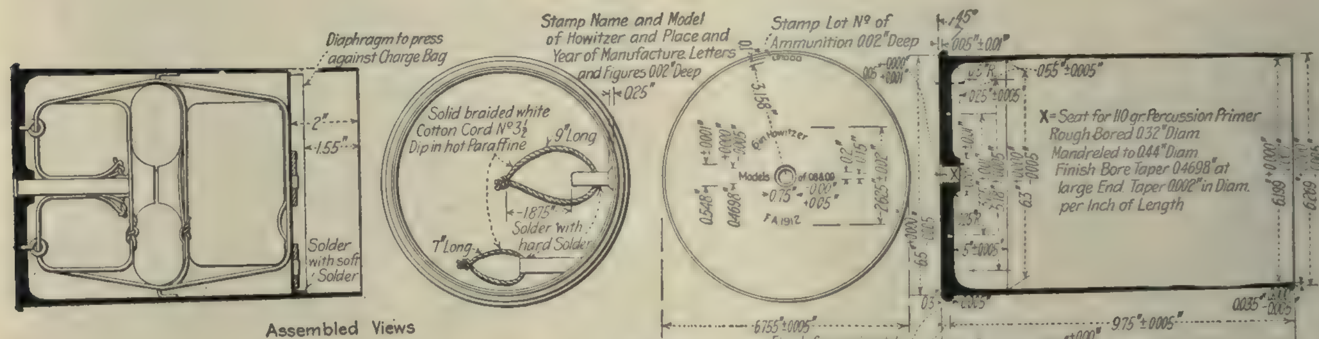
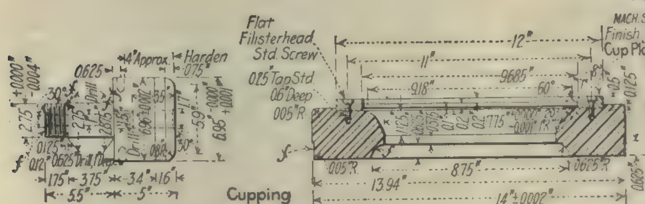
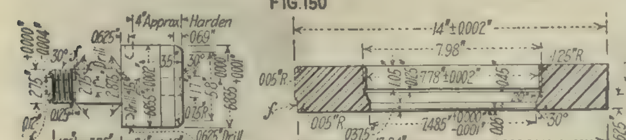


FIG. 149



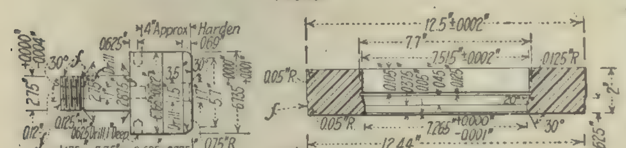
Cupping

FIG. 150



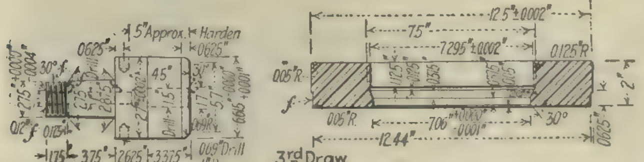
1st Draw

FIG. 151



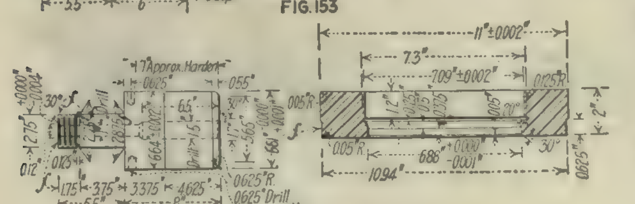
2nd Draw

FIG. 152



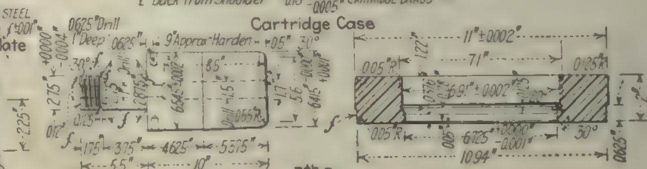
3rd Draw

FIG. 153



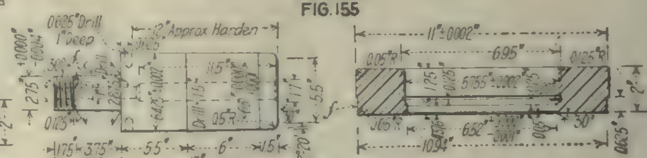
4th Draw

FIG. 154



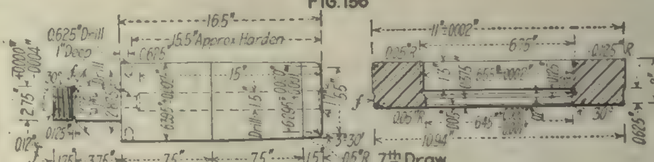
5th Draw

FIG. 155



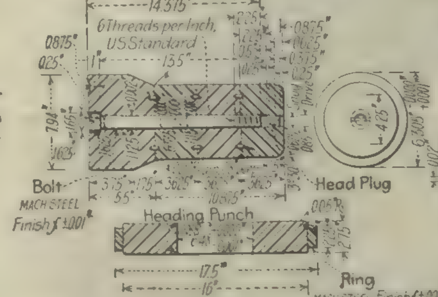
6th Draw

FIG. 156



7th Draw

FIG. 157



Heading

FIG. 158

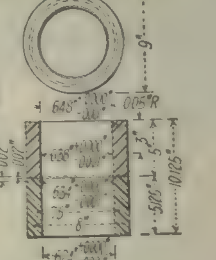


FIG. 159

Tapering

Stamp Name of Cartridge Case, Operation, Place of Manufacture and Date (Year) on each Punch and Die. Fit all Shanks to Taper Gage. All Threads 5 per Inch, U.S. Std. Round off sharp Corner on all Dies.

Cartridge Case for 6-In. Howitzer, Models of 1906 and 1908

OPERATION 1. CUPPING

Details of Cartridge Case—Fig. 149. Punch and Die—Fig. 150. Pressure—75 tons. Dimensions of Disk—Maximum diameter, 9.680 in.; minimum diameter, 9.675 in.; maximum thickness, 0.405 in.; minimum thickness, 0.395 in.; weight, 9.0524 lb.

SUCCEEDING OPERATIONS

Operation	
2	Wash and anneal
3	Pickle and wash
4	First draw; punch and die, Fig. 151; pressure, 50 tons
5	Wash and anneal
6	Pickle and wash
7	Second draw; punch and die, Fig. 152; pressure, 45 tons
8	Wash and anneal
9	Pickle and wash
10	Third draw; punch and die, Fig. 153; pressure, 35 tons
11	Wash and anneal
12	Pickle and wash
13	Fourth draw; punch and die, Fig. 154; pressure, 30 tons
14	Wash and anneal
15	Pickle and wash
16	Fifth draw; punch and die, Fig. 155; pressure, 25 tons
17	Fifth-draw trim; trim 50 per cent.
18	Wash and anneal
19	Pickle and wash
20	Sixth draw; punch and die, Fig. 156; pressure, 25 tons
21	Sixth-draw trim
22	Wash and anneal
23	Pickle and wash
24	Seventh draw; punch and die, Fig. 157; pressure, 15 tons
25	Seventh-draw trim
26	Wash for heading
27	Heading; die, Fig. 158; pressure, 1800 tons

FIGS. 160 TO 165. PREPARING FOR THE LOADING OF THE PROPELLING CHARGE

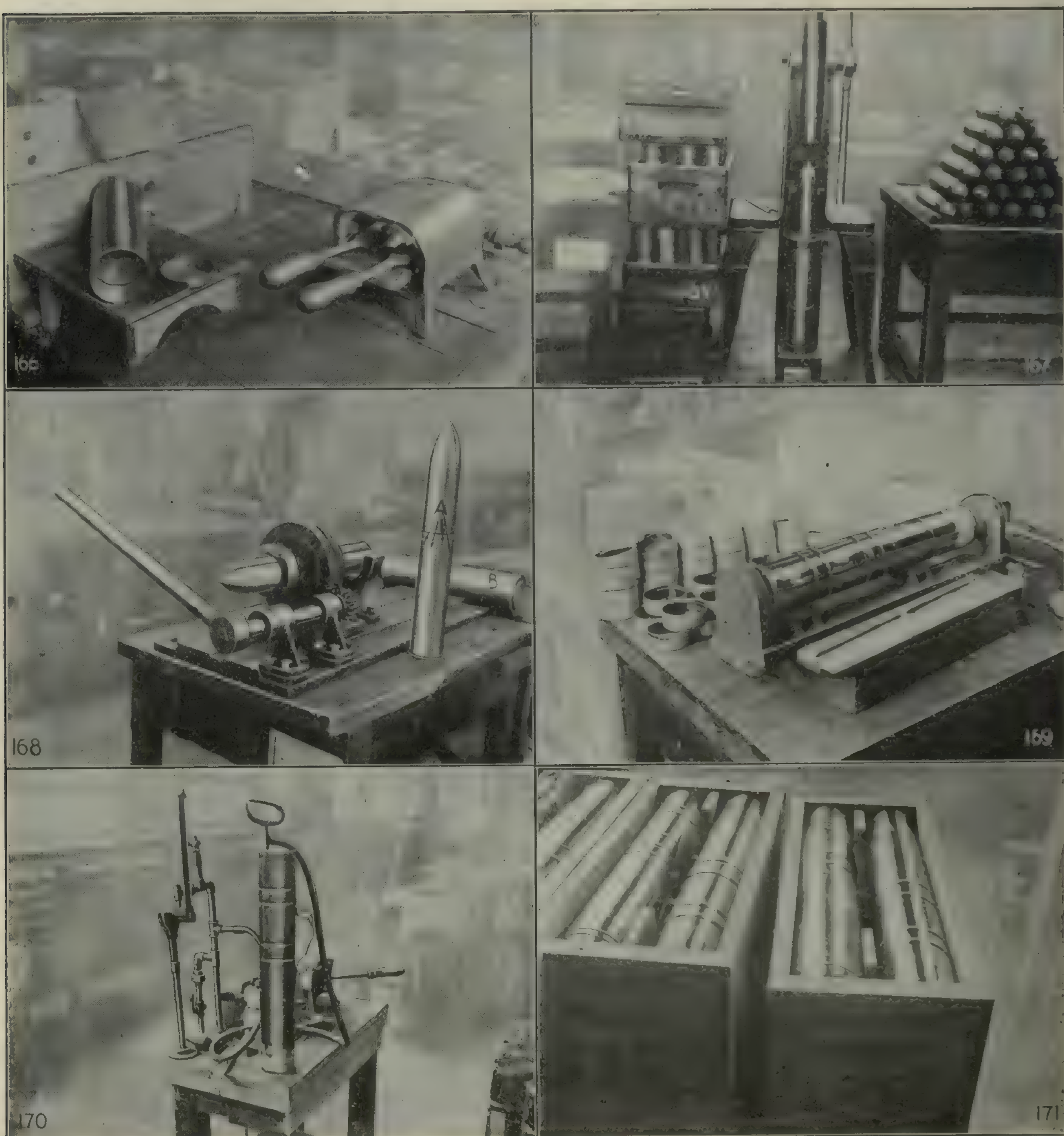
Fig. 160—Polishing the mouth. Fig. 161—Inserting primer. Fig. 162—Spot drilling for tracer mark. Fig. 163—Stamping lot number. Fig. 164—Weighing and putting in the powder. Fig. 165—Inserting the diaphragm

28 Rough-turn head and drill primer hole
29 Broach
30 Burr out
31 Point anneal
32 Taper; die, Fig. 159; pressure, 40 tons
33 Finish-turn head
34 Drill for screw-eyes
35 Tap for screw-eyes
36 Stamp; pressure, 13 tons
37 Final trim
38 Inspect

Loading the Propelling Charge and Assembling to Projectile

Like the various drawing and other operations on the cartridge cases, the loading of the propelling charge follows pretty closely along the same general lines, so that only one size will be followed through. In this particular case the powder is put loose into the case, but in others, especially in the howitzer types, the powder is placed in one or more bags. In the howitzer these bags are tied in by means of cords run through screw-eyes placed inside of the head. In a large number of cases the assembling is done in the field or just previous to actual use. This, however, has nothing directly to do with the manufacturing or machining processes, so will not be expanded upon here. The example chosen to illustrate the loading process is the case and projectile for the 3-in. field gun, models of 1902, 1904 and 1905, and the operations are:

1. Polish mouth
2. Insert primer
3. Fill color groove
3½. Spot for tracer paint mark



FIGS. 166 TO 171. VARIOUS ASSEMBLING, SOLDERING AND TESTING OPERATIONS
Fig. 166—Soldering in the diaphragm. Fig. 167—Pressing in the projectile. Fig. 168—Creasing machine. Fig. 169—Soldering on the can lid. Fig. 170—Testing for leaks. Fig. 171—Packed in boxes

4. Stamp lot number
5. Put in propelling charge
6. Insert diaphragm
7. Solder in diaphragm
8. Fill crimping grooves
9. Press in projectile
10. Crimp and drop in can
11. Solder on can top
12. Test and solder small hole
13. Varnish and box

The mouth of the case is polished to provide a clean bright surface for the soldering in of the retaining diaphragm. The case is chucked as shown in Fig. 160. As it turns, the operator holds emery cloth so as to polish out the mouth back for several inches. Waste on the end of a stick is also used to wipe the surface clean. Primers are inserted by means of a small hand press, as shown in Fig. 161. They are carried to the bench on board trays holding 200 primers.

All cartridge cases intended for use with projectiles having night tracers must be spotted with a blunt-end drill and the spot filled with red paint, as a distinguishing mark. The spotting of the head is done as shown in Fig. 162. The case is held in a guiding fixture and fed forward onto the drill by means of the tailstock spindle. A stop bolted to the top of the front lathe bearing is used to gage the depth of the spot.

The lot number is stamped in a hand press, as shown in Fig. 163. The order of some of these minor operations is occasionally varied according to changing shop conditions, but this is not important. In loading the propelling charge into this case, the required amount of powder is weighed out and poured into it, the outfit used being shown in Fig.164. The next operation after pouring in the powder is the pressing in of the diaphragm, which is done with the handled gaging plug illustrated in Fig. 165.

In getting ready to solder in the diaphragm the operator first polishes the inside edges of the diaphragm slightly with emery cloth and then proceeds to solder the edges to the case, using ordinary soldering coppers heated in a bench furnace as shown in Fig. 166.

Following the work on the diaphragm, the projectile is pressed in, as shown in Fig. 167, and then the case is crimped into the grooves at the base of the projectile, using the machine shown in Fig. 168. Continuous creases all around are not produced, but indentations like those at *A* are made. After crimping, the assembly is thrust into the gaging chamber *B* and then dropped into a tin can.

The can cover is next put on and soldered in place in the bench fixture, Fig. 169. The can is tested for leaks with the device illustrated in Fig. 170; and after varnish has been applied wherever the can has not been coated, it is ready for packing in boxes, shown in Fig. 171. Of this size, four cans are packed in each box. The boxes are then covered and nailed ready for shipment.

Loading 3-In. Cartridge Case and Assembling to Projectile for Field Gun

OPERATION 1. POLISH MOUTH

Machine Used—Lathe, Fig. 160. Number of Operators per Machine—One. Work-Holding Devices—Chuck; work runs at 475 ft. surface speed. Production—800 per day. Note—No. 2 emery cloth is used, and workman presses it inside of mouth to polish for soldering in diaphragm.

OPERATION 2. INSERT PRIMER

Machine Used—Small hand press, Fig. 161. Number of Operators per Machine—One. Production—1850 per day.

OPERATION 3. FILL COLOR GROOVE

Number of Operators—One. Description of Operation—Operator sets case on end and applies paint to the circular groove in the head. Apparatus and Equipment Used—Small round brush and can of paint. Production—2000 per day. Note—Colors: Red for high explosives, yellow for shrapnel and black for shell.

OPERATION 3½. SPOT FOR TRACER PAINT MARK

Machine Used—Lathe, Fig. 162. Cutting Tools—Blunt-point ⅜-in. gun drill. Cut Data—Spindle runs 600 r.p.m. Production—200 per hr. Note—Ten per cent. of the cases are drilled just enough to hold a dab of red paint to identify those carrying night tracers.

OPERATION 4. STAMP LOT NUMBER

Machine Used—Hand press, Fig. 163. Production—1700 per day.

OPERATION 5. PUT IN PROPELLING CHARGE

Number of Operators—One. Description of Operation—Operator weighs and pours charge of smokeless powder into each cartridge case, the amounts being 10,336 gr. for 3-in. shrapnel and 10,910 gr. for 3-in. common shell for field guns. Apparatus and Equipment Used—Scale, measure and funnel, Fig. 164. Production—950 per day.

OPERATION 6. INSERT DIAPHRAGM

Number of Operators—One. Apparatus and Equipment Used—Wooden plug inserting tool, Fig. 165. Production—110 per hr. Note—The shoulder on tool is 1⅞ in. back from the end of the plug.

OPERATION 7. SOLDER IN DIAPHRAGM

Description of Operation—Operator solders edges of diaphragm to the inside of the cartridge case, as shown in Fig. 166. Production—550 to 575 per day.

OPERATION 8. FILLING CRIMPING GROOVES OF PROJECTILE

Description of Operation—Operator brushes a mixture of 1 lb. beeswax to 3 lb. of tallow into the crimping grooves at the base of the projectile; this forms an air- and moisture-proof seal as the projectile is pressed into the cartridge case. Note—Operations 8, 9 and 10 are done by two men, with an output of 875 per day.

OPERATION 9. PRESSING IN PROJECTILE

Description of Operation—Operator places case in the holding fixture, sets a projectile in place and presses it down until the end of the case contacts with the copper band, as shown in Fig. 167. Note—This is the same for both the 3-in. common and the 3-in. shrapnel shell.

OPERATION 10. CRIMP AND DROP IN CAN

Description of Operation—The crimping machine, Fig. 168, does not crimp continuous grooves all around the case, but makes eight indentations, staggered as shown at A; after crimping, the shell is thrust into the cylinder gage B, which is the same size as the chamber of the gun; the operator next drops the shell into a tin can.

OPERATION 11. SOLDER ON CAN TOP

Description of Operation—Operator puts lid on top of can and places it on the rollers of the fixture shown in Fig. 169; he then securely solders the edges of the top to the can. Production—350 per day.

OPERATION 12. TEST AND SOLDER SMALL HOLE

Description of Operation—A small open air hole has been left in the bottom of the can; the operator places the can bottom up and thrusts the nozzle of an air hose into the air hole, as shown in Fig. 170; about 5 lb. air pressure is carried, and the air valve automatically opens as the nozzle is pressed to the can; as the operator presses down the nozzle, he watches the air gage; if it remains stationary the can is tight, the nozzle is removed and the air hole soldered up; if the can leaks, the place is located and soldered. Production—800 to 900 per day.

OPERATION 13. VARNISHING AND BOXING

Description of Operation—After being soldered, the can is varnished wherever it has not been previously coated, and then the cans are placed four in a box, as shown in Fig. 171. Production—1500 per day.

What the Munitions Board Has To Do

The Munitions Standards Board has been created by the United States Government to insure the speedy and efficient quantity production of munitions. But it should be said at the outset that its existence has a perhaps broader significance—namely, that it represents the first official link between manufacturers and the Government. The members of the Munitions Standards Board are appointed by the Secretary of War, acting in his capacity as chairman of the Council of National Defense. The council in turn is composed of six cabinet officers responsible to no one but the President. This recently organized council, the powers of which are just beginning to seize upon the imagination of the country, has as its cardinal duty, in the broad and sweeping terms creating it, "the immediate concentration and utilization of the resources of the nation." The council is also authorized to organize subordinate bodies of experts, and it is from this authority that the new Munitions Standards Board springs. The board, it should be said, was nominated to

the council by the Advisory Commission of seven civilians, headed by Daniel Willard, president of the Baltimore & Ohio Railroad.

Those familiar with the early days of the production of munitions for the allied governments in the present war know that in some instances concerns, for lack of proper specifications, had to turn out their product from samples and without drawings. The establishment of correct blueprints and specifications to make impossible in the future such a condition in the United States is one of the things that the Munitions Standards Board intends to bring about.

Battles Are Won by Fighting Industries

All this comes in great measure, of course, from the growing realization, even on the part of the layman, that war is now a business proposition and that battles are won not only by fighting men, but by fighting industries. As Howard Coffin has said, "In modern warfare the blood of the soldier must be mingled with three parts of the sweat of the man in the mills." There is coming the realization, to carry the thought further, that preparedness no longer is a glorious melodramatic thing of vast bodies of uniformed men and waving flags, but rather an organization and coördination of sources from which these things spring.

To go from the abstract to the concrete, it has been said by qualified authorities that, if we can measure an article, we can make it. To meet the demand of the present age we must have progressive manufacturing, where each man has only a small part of the work and that part must be done by an ordinary workman. All this calls for a definite method of measurement from that formerly used. In other days we wanted only one piece; now we want thousands of pieces all alike—each one an exact duplicate of the other. If organization is carried out along this line in all necessary channels, we can start a large number of factories making war materials that will be 100 per cent. good, at the same time standardizing the cost of production. Improperly designed gages with improper tolerance have cost the manufacturers in this country, as well as the Allies, many millions of dollars. It is equally true that in vast contracts growing out of the European War it was, due to various causes, utterly impossible for manufacturers, after the contracts were closed, to obtain from foreign governments drawings and specifications that any man could understand.

Standardization of Operations and Tolerances

The Government should have, first of all, its blueprints prepared with the proper tolerance perfected by tests and careful practice. The sequence of operations and the time taken to do the work should also be perfected and put in printed form with the necessary cuts showing the set-up, as well as the best way to handle the work, both in operation and in gaging. This would enable all factories to standardize their productions.

To illustrate what all this means, it is said that the production of the munitions manufacturers of Canada was curtailed 50 per cent. by one inspector. This experience has been duplicated many times in this country. All this trouble could have been largely eliminated if the methods employed had been properly standardized.

It is a well-known fact that Germany was the only country that had all these methods carefully worked out in detail. It has been stated that, if the Allies had been as well equipped with standardized gages, small tools, fixtures and methods, this terrible world war would never have come about.

The Munitions Standards Board is of course fully aware how efficiently the technical work of the Government bureaus has been and is performed. On this side probably the chief service that the board can render to the Government is to suggest ways and means of adapting peace-time standards to war-time conditions, together with the possibility of so modifying our designs that they shall become more practicable as manufacturing propositions.

Also, through the activities of the board, there may be drawn into the military departments of the Government the experience that has been developed through two and one-half years' of making war materials for foreign governments. Previous to the creation of this board there seemed to be no duly constituted channel through which this result could be brought about. This is particularly true since war has ceased to be a profession to the successful conduct of which are called military men alone. Modern war enlists every science, industry and special knowledge of the nation in arms.

Work of the Board is Equally Vital for Either Peace or War

It should be borne strongly in mind that the work of the board is equally as vital for peace as for war. It is essential that we should give to manufacturers and that manufacturers should have such information as will enable them to fit themselves for proper production in an emergency—and for proper production one should read quantity production.

In many ways the work stretching before the Munitions Standards Board is obviously of great, immediate and potential value to the people, to the Government of the United States and to the efficient maintenance of their armed forces.

Machinery Club of Chicago Equips Clubrooms

The Machinery Club of Chicago, with a present membership of 300 and applications for membership coming in at a rapid rate, is taking steps to establish a centrally located home for its members, for the purpose of promoting business relations, coöperation and acquaintanceship among machinery builders and patrons in the Chicago territory.

This club will be provided with a first-class dining room, lounging rooms, library of trade publications and catalogs, and in fact every possible convenience for its members.

Cost of furnishing the club will approximate $7500, of which $4000 has already been pledged. Amounts from $25 to $250 have been contributed by a number of business houses, and it is desired to raise the balance similarly during the next 30 days. Membership dues, while low, will make the club self-supporting after it is once equipped. Those desiring to contribute should make out checks payable to Machinery Club of Chicago and mail them to Arthur L. Beardsley, treasurer, 9 N. Jefferson St., Chicago.

Series for Draftsmen and Designers

Making Changes on Drawings

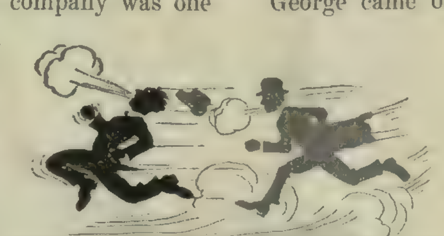
By Charles M. Horton

AS A general thing in drafting-room practice, this matter of making changes on drawings should come under the head of Don't's. A drawing that has been traced and signed and sealed and blueprinted—aye, blueprinted, that's the rub—should never be tampered with. Of course, there are times when it must be done, but the reason for it should be unassailable and the change absolutely imperative. To tamper with a finished drawing, as everybody knows, is like inviting trouble with both hands; and as everybody knows also, trouble never requires a second invitation to the table, and especially to the feast of reason and flow of soul that as a rule accompany the average daily run of events in drafting rooms.

Drafting rooms have enough troubles without bidding for more with an erasing rubber, since it has long been established that the more one rubs out of a tracing in the matter of figures and lines the more one rubs into the scheme of things a defiant challenge to the gods of difficulty and angry explanation. Cats, but I'm glad that's out of my system!

"George," trilled the chief, one morning, after arriving thirty-five minutes late—the chief, not the draftsman, understand—as he stepped into the drafting room, folded handkerchief in hand, from some kind of session with the president and general manager in the front office; "George," he repeated a little nervously, "get out a blueprint of that tower and send it to the St. Louis plant. They're well along on that job now and waiting for this drawing. I guess I kind of forgot it, myself. Better shoot it right into the mail now."

George was the sole surviving draftsman in this drafting room. Up to a week or so before, there had been one other draftsman, who had quit to better himself; and so George was doing it alone now. The company was one manufacturing a form of gas, and it was erecting, one after another, plants around the country for this purpose. One plant was very much like another, and the general mechanical features were absolutely similar and made from a single set of drawings. As a process it had been worked up by a hired staff of chemical and mechanical engineers—the former answering to the *nom de guerre* of "doctors," the latter responding to "Here, you!" calls from their superiors. The chemists always did have us mechanical fellows on the run—have us on the run now harder than ever, since the war. But that's an aside. The point I'm trying to bring out is that these plants were all being erected from one set of drawings, blueprints being made from them and supplied to men in the field as each new site was chosen and another factory started. They only needed one draftsman.



George did it. He fished out a blueprint of the tower and sent it on. Then he went back to his board to dream of the foot-loose field guys out there in the country sitting around on boxes smoking pipes and overseeing things and giving orders. It was a sad sort of dream for George. But he liked it, nevertheless; and he dreamed on, perhaps a day, perhaps a week, until he was jolted out of it one morning by the chief. The chief steamed in upon him that morning with fire in his eye and blood on the moon. There was a blueprint in his hand, and he was plainly in a state of impatient exasperation.

"George," he snapped, "let's see the drawing of this tower. The steel is out there, and they're all kicking about something. Say things don't go together according to drawing. What do you suppose is the matter?"

The chief was like that. He would start out with a lot of pep in his voice, but wind up asking a mild question. A good likable scout, only the job had him worried.

George came out of his dream. It did not look so attractive to him now, now that trouble was in the air for the field guys, and he walked lightly to the cabinet where the drawings were filed and dug out the tracing of the tower. The chief stood beside him, blueprint in hand, and both bent over and gave tracing and blueprint

the once over. To be truthful, they gave the tracing and blueprint the five and six times over, because the kick, registered from the men in the field, fell on ground difficult to locate on the tracing. But at last they discovered the source of the trouble. A fiend in human form had made a change on the tracing, and it evidently had been made since the last plant was erected. Humph!

The buzzer rang. The chief answered. It was an irate call from the general manager. The chief was gone. He returned directly, face red and once more full of pep.

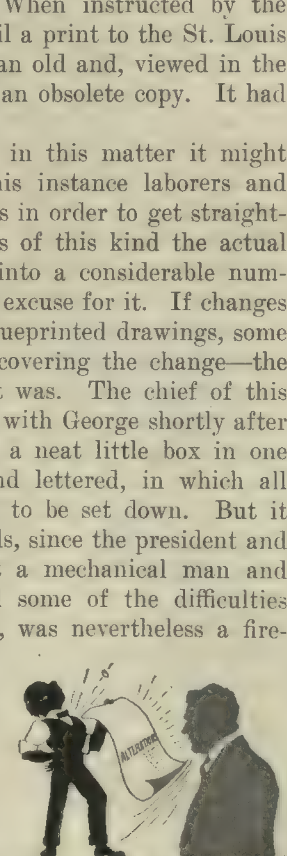
"Who made that change, George?" he demanded. "And when was it made? I don't understand why that change was made without my knowing something about it." His manner was tapering off, as usual. "You didn't make it; did you, George?"

George shook his head. Also he grew thoughtful. Then suddenly he brightened up.

"Oscar must have done that," he declared—Oscar was the draftsman who had recently quit. "I seem to recall his being in conversation with one of the erecting men who was in here some time ago—the man on that Milwaukee job now. He probably made the suggestion and Oscar embodied it on the tracing. Let's see the rest of the blueprints."

The blueprints, with one exception, tallied. This one exception evidently had been made, through force of habit, from the tracing after it had been changed—as a matter of record, you know. When instructed by the chief, a week or so before, to mail a print to the St. Louis plant, George had landed upon an old and, viewed in the light of this mysterious change, an obsolete copy. It had brought about trouble.

And there you are, although in this matter it might have been much worse. In this instance laborers and fieldmen were held up a few days in order to get straightened out, whereas in some cases of this kind the actual money loss mounts frequently into a considerable number of dollars. Nor is there any excuse for it. If changes must be made on finished and blueprinted drawings, some form of record should be kept covering the change—the date, who made it, and what it was. The chief of this organization took the matter up with George shortly after this séance, and the result was a neat little box in one corner of the tracing, lined and lettered, in which all such information was in future to be set down. But it was a narrow escape for all hands, since the president and general manager, who was not a mechanical man and therefore could not understand some of the difficulties that arise in construction work, was nevertheless a fire-eater when it came to mistakes. In this case it was not a mistake. The alteration was essential in order to have the drawing meet with a change believed necessary by the steel people, for better purposes of construction, and



the drawing had to be brought up to date. Where the error lay was in George's—or rather, Oscar's—neglect in failing to destroy every last blueprint in field and drawing room (in the former by letter), to the end that only correct blueprints would be in service.

And let me bear on hard on that. Records are records, to be sure; and for their own security all drafting rooms like to have something to flash under the noses of the management when trouble comes. But there is such a thing as having too many different blueprints of a single design lying about. Unless the greatest care is exercised in the matter, even though the sheets bear a tabulated form containing date and character of changes, something of a troublesome nature is bound to occur. "Safety first" should be the drawing-room motto, and true security lies in destroying all obsolete blueprints of a fixed design.

Of course, where a change has been made after one or more plants or machines have been erected or built from a set of drawings, copies of those old, and now obsolete, drawings should be kept. But they should be kept out of the regular places for storing blueprints and drawings, and thus clear of hands and brains bent upon digging up in a rush a blueprint of the design, regardless of whether or no the design has suffered any change. Draftsmen on a still hunt for a drawing under the eagle eye of an executive fuming and fussing over the delay are men not rightly themselves for the moment. As a result, they are blinded to but one thing—namely, to get what's wanted in as brief a time as possible and get the executive out. Afterward, when the draftsman returns to consciousness, he may remember that there has been a change made in that drawing—and begin to pack up his tools, this depending on the draftsman, the nature of the organization and to what use the particular blueprint has been, or is to be, put. Draftsmen sure do have troubles not dreamed of by men in the shop.

Changes are frequently made without just cause, too. Where doctors disagree once, designers disagree many times.

"Steve," said the chief engineer of a small company building a line of gas engines, addressing himself to our old friend Steve Winthrop, one day, the chief having just stepped into the drafting room casually; "Steve, I've been looking over that new type of ours down on the testing floor. It strikes me the bearings are too small."

Steve lifted his head slowly from another design he was working upon. Also, having lifted his head, he reached a deliberate hand toward his handbooks.

"Kent was my authority in that," he declared quietly, beginning to turn the pages of this justly famous handbook. "They're big enough, according to him."

"Big enough for pressure, no doubt—yes," agreed the chief; "but I hardly think they're big enough for wear. Suppose we boost the area and lower the pressure a little—make the shaft seven inches instead of five. That'll add a good many years to their service." The chief turned, only to pause again suddenly. "And follow up the necessary alterations in the drawings, Steve. Call in all the old blueprints and issue new ones."

Stephen did as he was told. He made the required changes in the drawings, called in all the old blueprints and issued new ones to the shop. Then he rested. The second finger on his right hand was swollen with a nice fat callus from holding the eraser, and the muscles of his right arm ached in sudden and strange places from the unwonted and day-long exercise of rubbing out ink on tracing-cloth. So he rested.

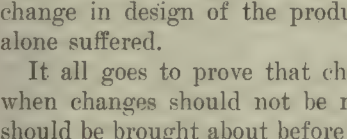
But not for long. The superintendent, getting his orders and seeing the new blueprints, lifted a long wail

from his corner. It was all —— nonsense, seemed to be the gist of his lamentation, and he'd see the president and the vice president about it. He did. Precisely what took place was never revealed to Steve, but he did know that the chief's orders were rescinded, with the result that Steve wore out his arm and fingers again, changing the drawings back to their original status. Nor was this all of trouble that came to him. In changing the tracings a second time he rubbed nice large holes in the cloth; and when he came to reëmbody in the drawings the information they originally held, he found that he had no surface upon which to work. His first thought was to paste a patch over the holes from the back side of the drawing; but upon recalling from experience that this made for faulty blueprints, he changed his mind and, in the language of the élite, passed the buck along to his assistant, by giving orders to trace the drawings over again.

This was one actual case that came under my observation. Merely because of a difference of opinion among the doctors as to what constituted correct design, this establishment got itself into a petty jangle, the burden of which descended, as it should, upon the drafting room. What are drafting rooms for, anyway, if not to relieve the organization as a whole of all distressing toil? There was no sense, really, in this distressing affair. The chief was right, and no doubt the superintendent, considering manufacturing difficulties as necessitated by any change in design of the product, was right. But Steve alone suffered.

It all goes to prove that changes are made sometimes when changes should not be made; or if made, at least should be brought about before and not after the tools and jigs for machining the parts are fixtures of the shop equipment. Still, there are times when changes are for the good of the concern, as we all will agree. It only remains for the drafting room to maintain a proper record of those changes, to the end that a minimum of costly mistakes be made, for the good of both the shop and the drafting room.

In one of the large electrical manufacturing companies in the East—and I blush to tell this, my brothers—there are fair young ladies seated at drawing boards earning their daily bread with a tracing pen. They make the more simple—and, yea, sometimes the more complex—tracings. The drawings, thank my—and your—stars, are made by real human menfolks. Still, the girls make excellent tracings, once they get their hands in; and the innovation evidently pays, because this has been going on for years and years and years, the staff changing as often as some male draftsman in one or another of the adjoining rooms decides he wants a tracer for his wife. They get married, too—you betcha! But the point is this: Womenfolks have a type of mind peculiarly well adapted to the kind of work that comes under the general heading of changes on drawings. The girls erase easily and carefully, are strong on finding out the whys and wherefores of the change and are infinitely painstaking in their work of setting down this information on the tracings in the space allotted for this sort of information on the sheet. They like it. The work to them is a mixture of needle decoration and the darning of socks, with a little touch of art on the side, and they bend their pretty little heads to the task with a patience that is beautiful, and never seen in a draftsman of experience engaged on the same sort of work.



This in itself proves nothing, save that your stenographer or possibly your office boy or blueprint devil, ought to be assigned this work in your drafting room. I seem to hear the stenographer raising a kick. Nevertheless, stenographers are not *all* worked to death, especially in engineering establishments, and the making of changes on drawings would be a good job for them, to have and to hold for all time and to keep track of, time without end. Any change that came up for discussion would be apt to be set forth clearly with a young woman doing the explaining—draftsmen generally have a puzzled look when you ask them about a certain change that has been made sometime in the past on a drawing, owing to the fact that a good many drawings have come and gone under their observation—and the girl, in no wise puzzled in this fashion, would prove as big a help to the chief in this matter as she is in her stenography work. Although I am a mere male, it strikes me that girls like this kind of work. Still, you never can tell—can you?

But to sum up: Don't make changes on tracings unless you absolutely have to make them. When such an occasion arises, be sure to note on the tracing itself, in a conspicuous place—not in tiny letters outside the border line, letters that an outside man might mistake for scribbled calculations of a draftsman—the date of the change, who made the change, and what the change was. Put the notation in a big box. Put it where a casual glance at the drawing will establish it in a man's brain. He may not be—and generally is not—looking for changes; all that he is concerned with is the design. When he sees this formidable box in one corner and bends to read what the box contains, he will be as deeply impressed with its importance as he is with the design as a whole. Then, if the nature of the change puzzles him, he will raise the point with the home office and be set right, and the work will go along pleasantly and profitably to all.

Kind of Work for a Trade-School Shop

By Wesley McArdell

W. D. Forbes, on page 475, discusses the type of work that should obtain in a trade-school machine shop. I feel that exception must be taken to certain statements in the article.

From the teaching standpoint, all machine-shop work can be resolved into a number of elemental processes, and it is the business of the teacher to teach these processes in an orderly, sequential manner. Jobs are simple or complex to the extent that these several elements are involved and to the difficulty of performing each element. Jobs are similar to the extent of their *common* elements.

Conditions wherein a piece of centered stock will have centers resembling extinct volcano craters or No. 50 drilled holes cannot arise when the elemental process, centering, has been taught. This process, however, must be taught. The proper method of dogging, determination of the proper feed, speed, depth of cut, etc., must also be

taught and not merely "commented upon," as these also are elements that, with others, go to make up the stock of knowledge that we call the machinist's trade.

Since repetition is an important part of the learning process, it follows that we must have repetition in the teaching of machine-shop practice. It must not, however, be repetition of the same job until the pupil is disgusted; it must be repetition of the *elements* involved. Thus, several projects that apparently are radically different will be found upon analysis to be composed of certain elements that are common to all. The utilization of this principle of varying repetition does away with the deadening monotony in making many articles of the same kind and size.

Type of Chuck for a Trade School

Mr. Forbes should know as a result of his extended experience that combination chucks, like the combination bootjack, can opener and glass cutter with an apple-coring attachment, which we sometimes see, have all the limitations of any combination tool. For light work a combination chuck may be all right, but in a trade school, of all places, the independent chuck is the logical tool. We want our boys to acquire certain habits, certain muscular memories, certain eye training. These results do not flow so well when the combination chuck is being used as when an independent chuck is the tool. Again, a combination chuck is structurally weaker than either of the two chucks it seeks to replace, and is costlier.

The subject of the mathematics that a young machinist in a trade school should have, admits of discussion. To say that practically no mathematics is needed is a statement that is not in accord with the facts and should not go unanswered. The machine trade is nothing but applied mathematics. The machinist who is weak, mathematically, may be able to do certain types of work, but a trade school is not devised to turn out that brand of machinist. This brings us to the point where the aim of the trade school should be inspected, and we must ask ourselves what is the idea back of it all. Are we training up "hands," or are we preparing our boys so that they will get a running start, to the end that they can rise up to positions of power in the machine-shop world?

A machinist who has little mathematics may get along; but with an adequate store of the number work of this trade he can get along faster and farther. That there is this need for an adequate grounding in mathematics is evidenced by the multiplicity of books on this subject, of which Colvin and Stanley's "Primer" is a good example.

I do not know why a machinist should harden and temper a lathe tool and not a reamer. Certainly the elements involved—(a) heating above the recalescent point, (b) quenching, (c) reheating to a definite temperature to relieve the excessive hardness produced in operation (a)—are the same. That is to say, in each of these jobs there are certain common elements; and once these elements have been taught, the teacher is justified in feeling that the student knows that process and, with a word or two of instruction, can apply his newly acquired store of knowledge to any other project involving these elements. One might as well say that the pupil can be taught to harden round-nose tools and not threading tools. The trouble here is that the boy has been shown the *process* of "hardening a lathe tool," whereas he should have been taught the several elements involved in "hardening and tempering tool steel." There is a difference here. It is just this difference that makes all the difference in the world.

If a boy has a job that is not to his liking, it is worth while to investigate the job. Perhaps the boy is right. The chances are largely that he is. Most boys of trade-school age have a fine sense of discrimination. They know when they are marking time or forging ahead. In these days it is idle to talk of forming character by putting boys on jobs that are disagreeable to them. Carried to its logical conclusion, this doctrine would mean that all jobs must be disagreeable to the end that the maximum amount of character be formed. The work can be made so attractive that all jobs are desirable. If a boy is reluctant to work on a job, it is a pretty safe thing to assume that the boy is generally right and that the trouble is with the system.

I believe that a trade school should teach more than the plain trade. The boys should go out with not only the plain trade, but with a knowledge of the scope of their chosen line of work, with a rich store of ideas on the higher branches of the machine business and with a vision of what they may be in the days to come. A trade school where only the manipulative processes are taught, where only the plain trade is the ultimate object, does not reach the heights it might.

Expanding Nut Arbor

By J. A. Raught

The editorial on page 171 is very much to the point and brings out some vital truths. Converting one machine into something else is nothing new. When I was a boy on the farm, the farmers discontinued raising clover seed; but the threshers by a few changes converted their clover hullers into bean machines.

I have made use of a tool intended for another purpose by making an expanding nut arbor, like the female thread-gage lap described by Hugo F. Pusep, on page 777, Vol. 45. All the change necessary was to put a center in each end. Every machinist knows the importance of having nuts faced square with the thread. This is more easily accomplished with an expanding nut arbor than by any other method I have used.

Watch Your Cutting Compound

By L. L. Thwing

The following is clipped from one of our popular weeklies and will doubtless explain why spoiled work has been so common in the past. It will also, no doubt, stimulate the demand for a Brinell test of the various cutting compounds.

> One of his best mechanics began spoiling shafts during grinding, and he turned out so many cripples that he asked to be put on some other work. He thought that he had lost his nerve. The foreman went back to the machine and watched the operator grind a shaft. Halfway through, the shaft departed from true. Right next to that machine was another one, just like it, run by a less skillful man, who was turning out perfect work. The foreman could not account for the error and called an engineer, who was puzzled too. They went over both machines, making a regular doctor's diagnosis by eliminating every factor that was right. Still nothing was found which seemed to be wrong. Finally the trouble was located in a slight difference in the consistency of the grinding compound, a most obscure trouble. When that was set right, the mechanic got his nerve back.

Electric-Welding Operations on Automobile Parts

Special Correspondence

SYNOPSIS—In this article are shown some parts that are being produced by the use of the electric spot welder. A battery box that is built up and has two holding straps attached by means of the welding process is shown. Two oil pans that are being made more easily by the spot welder and also an automobile fender are included.

In the manufacture of many automobile parts and accessories the electric welding machine is frequently employed. The process is quick, and the parts produced are neat in appearance and are proving strong in service. Some welding operations of this kind, as carried out at the factory of the J. W. Murray Manufacturing Co., Detroit, Mich., are here shown. The machines used are Winfield and Detroit electric welders.

In Fig. 1 is illustrated a battery box that is built up by welding. The body of the part is of 0.0625-in. (No. 16 gage) steel, and the band iron is ⅛ in. thick. In making the battery box, 36 spot welds are used, and the time necessary is 2 minutes.

In making the oil pans the steel, which is 0.031 in. (No. 22 gage) thick, is first cut and bent to shape. The various parts are then placed together and fastened with the spot welder. In Fig. 2 is shown one type of oil pan, on which 66 welds have been made. The average time for the operation is 5 minutes.

An odd-shaped oil pan is seen in Fig. 3. It is made with the spot welder. The pan has four parts of 0.0312-in. (No. 22 gage) steel, which are cut and formed to the correct shapes. The parts are then welded together to make the oil pan illustrated. On this piece 126 spot welds are used, and the average time necessary is 12 minutes.

In Fig. 4 is shown a front fender iron to which two reinforcements are welded. The iron proper is 0.0937 in. (No. 13 gage) thick. It is blanked, pierced and bent to the shape shown. The reinforcements, which are made from ⅛-in. steel, are attached by seven spot welds, requiring 3 minutes.

In making of automobile fenders the spot welder is also being used. In Fig. 5 is shown a fender to which band-iron stiffeners have been added and also a trough-shaped part. This latter part is made separate from the fender proper, thus simplifying the manufacturing operation. To attach the stiffener iron and trough-shaped section, 58 spot welds are needed, and the time required is 4 minutes.

FIG. 1. WELDED BATTERY BOX

FIG. 2. WELDED OIL PAN

FIG. 3. WELDING A CIRCULAR OIL PAN

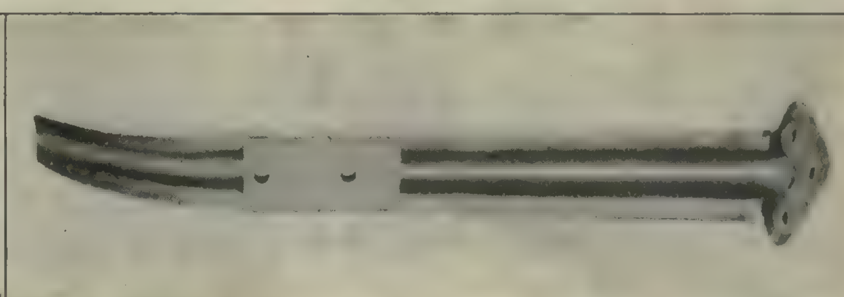


FIG. 4. WELDED FRONT FENDER IRON

In Fig. 6 is illustrated a battery support to which flat iron straps have been welded. The plate is made from 0.031-in. (No. 22 gage) steel, and the straps are $\frac{3}{32}$ in. thick. To attach these four straps, 20 welds are used, and the time required for the operation is 2 minutes.

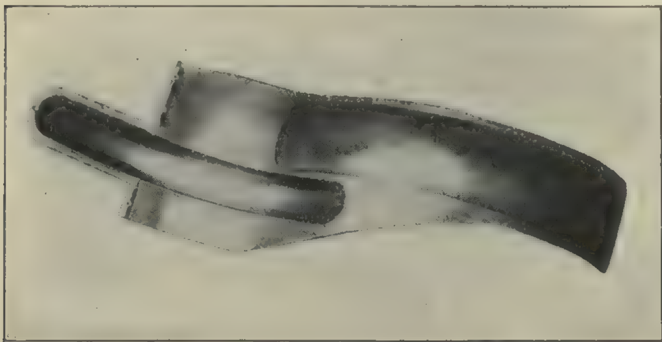


FIG. 5. A WELDED FENDER

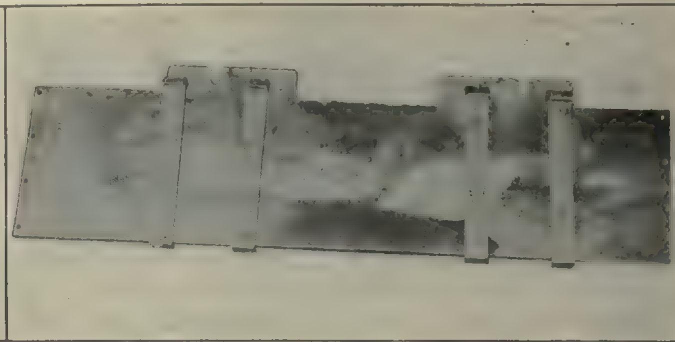


FIG. 6. WELDED BATTERY SUPPORT

The electric spot welder is valuable, not only for manufacturing purposes, but for many special cases that arise in the shop. The gear cover shown in Fig. 7 is built up in this manner. This part is made from 0.031-in. (No. 22 gage) steel, the different elements being first cut and bent to the correct shapes. In the fastening together of these sections to form the guard, 90 spot welds are made, and the time required is 10 minutes.

FIG. 7. WELDED GEAR COVER

In either manufacturing or special work the electric welder produces strong and neat parts quickly and at a low cost.

Plan for a Uniform System of Foundry Costs

To promote the adoption of a uniform system of foundry cost accounting among its members, the American Foundrymen's Association has outlined a plan which provides the personal service of a cost expert whose duty it will be to make the existing cost system conform to the one that is to be adopted.

Since the American Foundrymen's Association, owing to its low cost of membership, is without means to carry on this special work, it was decided to raise a fund by subscription among those who desire to participate in the benefits to be derived from this undertaking. The plan will enable foundrymen to obtain at a nominal cost an accounting system which will be representative of the latest and best practice in cost-keeping methods.

Productive labor is a good measure of the value of the business transacted by a foundry, and, therefore, the expense of this undertaking will be prorated on the basis of the number of molders and coremakers employed. The schedule of charges that will apply is as follows: Foundries employing up to 40 molders and coremakers, \$50; from 40 to 200 molders and coremakers, \$1.25 for each molder and coremaker employed; for plants employing more than 200 molders and coremakers a flat charge of \$250 will be made. Since additional traveling expenses will be involved in the installation of the system outside of the industrial centers of the United States and Canada, an extra charge will be made for this service west of the Mississippi River, south of the Ohio River and outside of the Province of Ontario, in Canada.

Data are now being gathered preparatory to the compilation of a uniform system of cost-keeping for foundries, that can be adapted to shops specializing in the manufacture of gray or malleable iron, or steel castings. The problems of the foundry that is a department of a manufacturing plant and produces no castings for the trade will be considered, and provision also will be made for specialty, light and heavy work shops.

Subscribers to this fund are limited to the membership of the American Foundrymen's Association, but foundries not so enrolled can derive the benefit of this work by becoming members of this organization.

Favorable replies have already been received from 217 members of this organization in the United States and Canada, and 51 have forwarded their subscriptions. This is sufficient assurance that the plan can be carried to a successful conclusion, and it marks the beginning of one of the greatest uniform cost campaigns undertaken in a single industry.

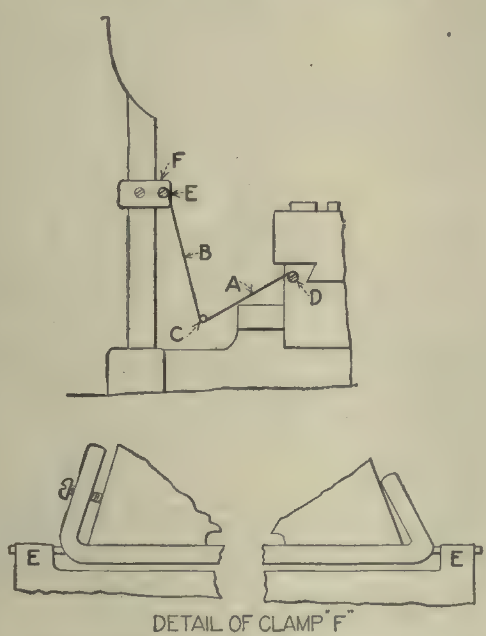
The members of the Cost Committee who conceived this undertaking are: B. D. Fuller, chairman, Westinghouse Electric and Manufacturing Co., Cleveland; H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Penn.; J. Roy Tanner, Pittsburgh Valve, Foundry and Construction Co., Pittsburgh; C. R. Messinger, Sivyer Steel Casting Co., Milwaukee, and A. O. Backert, secretary, Twelfth and Chestnut Sts., Cleveland.

Chip Guard for the Miller

By E. J. Leach

To prevent chips and dirt from getting into the nut of a miller, thereby making the crossfeed stiff, I several years ago employed the following scheme:

Two pieces of sheet iron *A* and *B* were fastened together by a hinged joint *C*, similar to an ordinary butt hinge. Care was taken to see that the hinge made a good joint, so that dirt and chips could not get through. One edge of the hinge was fastened underneath the table of the miller at *D*, and the other to the main



METAL CHIP GUARD FOR THE MILLER

body of the machine at *E*. Both these edges were fastened so that they would permit free hinge motion. The clamp for holding the apron to the column is shown at *F*.

The two pieces of iron were of such length that when the table was out as far as it would go the two pieces would be nearly horizontal, and when it was in as far as it would go they would be folded. This apron would catch all chips and dirt that fell behind the table and prevent them from getting on the screw.

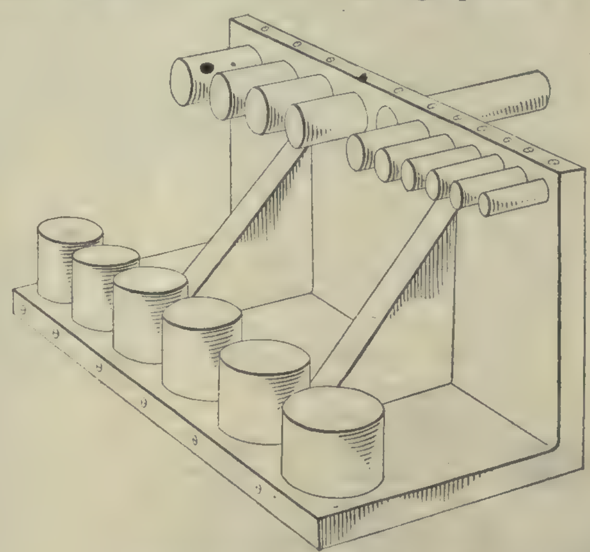
A piece of canvas could be used, but if oil or compound is employed it would soon get soaked and become foul, while the iron can be wiped off when the machine is cleaned.

Drilling Bracket for Hubs

By C. L. Spangler

The drilling bracket shown is employed to drill and tap setscrew holes in hubs of gears, disks, arms, brackets, collars and other special pieces or for drilling oil holes, pin holes, etc.

The angle plate is 10 x 14 x 1¼ in., with a series of holes drilled or bored in both faces of the angle parallel to and



DRILLING BRACKET FOR HUBS

near the edge. The holes are from ⅜ to 2½ in. Setscrews hold the pins, which are cut from cold-rolled steel of a size corresponding to the holes in the angle plate and are used as studs onto which the pieces to be drilled are slid. Pins not in use are pushed back flush with the face of the angle plate, to give the necessary clearance required for the work at hand.

Hardening Circular Forming Tools

By Charles E. Kail

On page 126, a reader asks for information in regard to hardening high-speed circular forming tools of great accuracy. I have been patiently waiting ever since for someone to shed some light on this subject, but it begins to look as if no one who is in a position to give accurate information is going to come across. I hesitate about writing on this subject on account of our shop not being equipped with pyrometers. Consequently, I am not in position to give accurate temperatures, although we do considerable hardening with good results.

Briefly, my experience is as follows: We received an order for a considerable number of special boring bars that carried a form cutter at the end, a shell reamer next and then a cutter for facing to length. They were all of high-speed steel, and the job had to be put through in a rush. The work fitted nicely into our shop, except that we had very little experience in hardening high-speed steel. I thought this would be easily overcome, as the steelmakers in describing the various high-grade steels usually give the necessary information regarding the heat-treatment, but about all the information I found relating to high-speed steel was to heat slowly and then run it up to a "sweating" heat and quench in oil. Of course, if these directions are followed, you have a good cutting tool for ordinary work; but this would not do for form cutters, as a "sweating" heat naturally leaves the tool with a rough and blistered surface that has to be ground away. After a little experimenting we decided to pack the cutters in powdered charcoal, and this worked.

We had a small cyanide furnace idle at the time, so we decided to make use of it. We removed the cyanide pot and placed a crucible in the furnace, so that it came about 6 in. below the top. This arrangement permitted us to cover the crucible with a cast-iron disk to keep the powdered charcoal from blowing out. The opening in the furnace was then covered so as to keep the heat where it would do the most good. While one cutter was heating in the crucible, another was laid on the furnace cover; and it would usually be a dull red by the time the one in the crucible was ready to quench. It took from 20 to 30 min. to bring the cutters to the hardening heat. Of course, the furnace was first brought to a good heat. We quenched in the usual fish-oil bath. We found that it was impossible to overheat in this furnace; but when left in the fire too long, the cutters would show a tendency to crack. We did not draw the temper, except with the shell reamer, which had a very thin wall and a keyway through the hole.

If we have only a few pieces to harden and they are not over $2\frac{1}{2}$ in. in diameter, we place them in a tin can packed with powdered charcoal and heat in a gas furnace until the can is nearly a white heat, hold the heat about 20 min. and quench quickly in oil. We do not preheat nor draw the temper. I have treated milling cutters and rings for drawing dies in the same way.

Shrinking Work Too Large in the Hole

By Joseph R. Sheppard

Once I had a job in the toolroom of a large concern which employed about 60 first-class toolmakers. A large part of the work consisted of deep drawing.

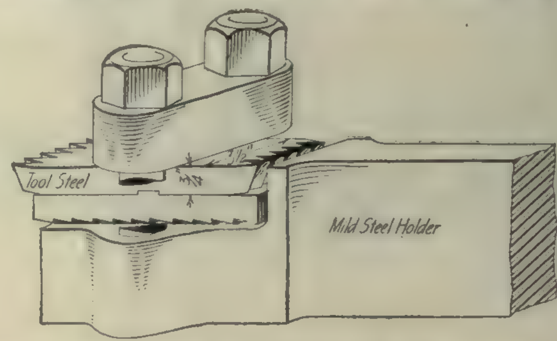
One day I saw the boss toolmaker working over at the oil furnace. I thought at first he was hardening the drawing dies. He had a long bolt and a flat pan of water, and he would take a ring that had been heated to a cherry red and slip it on the bolt and then roll it in the pan of water, only the edge of the work being submerged, the water not touching the inner surface of the hole in the ring.

I questioned him and found that these rings were worn large through use and were being shrunk so that it would be possible to regrind the hole to the original size and use it the same as before. This shrinking operation was repeated as often as 20 times before the rings broke.

Grooving Sugar Rolls

By A. H. Nourse

Among the contracts received in the marine department of the Maryland Steel Co., where I was foreman machinist, was one for sugar rolls, grooved as shown in the illustration on page 91.



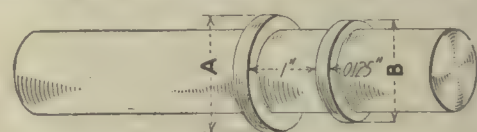
TOOLHOLDER FOR GROOVING SUGAR-MILL ROLLS

As the rolls are of a very hard iron, frequent sharpening of the tools is necessary; and in order to avoid delay we made a toolholder with a number of cutters, as shown in the illustration.

Master Taper Gages

By I. S. Whisler

The illustration shows a grinding kink that I use in making master taper gages. The test plug must be of the same length as the finished plug gage, so that the



DEVICE FOR MAKING MASTER TAPER GAGES

tailstock on the grinder will not have to be moved after the grinder is set to the exact angle wanted. The test plug consists of a soft arbor turned on the lathe, leaving two $\frac{1}{8}$-in. webs exactly $1\frac{1}{8}$ in. apart from outside to outside. This will leave just 1 in. between the largest diameter of each.

Should we desire a plug gage with 1.500 in. per ft., which would be 0.125-in. taper per 1 in., the grinder would be set so as to grind the diameter *B* 0.125 in. smaller than the diameter *A*. This result can be obtained by setting the grinder as nearly as possible by the graduations, then taking a cut across the webs and measuring. If not right, the machine can be changed and another cut taken. This can be repeated until the desired sizes are obtained. By this system accurate plug gages can be made.

The Training of Foremen

By A. L. Hass

An assumption that is by no means warranted by facts is embodied in the statement that a worker from the ranks is not an expedient choice for foreman. Many firms do not select their foremen from among their own men or promote a man of their own training when a vacancy occurs because it is assumed that there is no one

available who measures up to the requirements. Therefore a man who has received experience and training elsewhere steps into the position.

Now where do foremen come from? Certainly not from academic sources, though it would be advantageous if every applicant had held such a post at some period in his career. Are foremen like Topsy, who "just growed"? If they are obtained from external sources, someone obviously gave them promotion from the ranks. It is admitted that the excuse of discipline usually quoted by an employer is more or less valid. He passes over his own staff and installs an outsider in the belief that a man about whom he knows little is a better man than any he can raise.

There is a story hoary with antiquity which pictures a certain animal as always convinced that the grass is juicier because it grows beyond the fence. This, perhaps, may explain the employer's attitude. It may be that men, like plants, thrive by transplantation to new environment; hence the stranger without the gates, by his new locality, is the better man. In any event, it is a poor commentary upon the organization, if of any size, that no man within it is competent to step up.

A more reasonable explanation is that possibly the newcomer is expected to bring a knowledge of methods in use by a rival and so supplement deficiency by his resources. Yet, it is less a question of improved efficiency perhaps than one of legal theft that leads to the practice. Unless offered higher terms or better conditions, wherein lies the motive for the successful shop executive to transfer his services? If, on transference, the man improves his position from assistant to chief, there is good and sufficient reason; but advertisements testify otherwise.

The matter of loyalty, the fostering of which is important, is also involved.

The greatest of all incentives to loyalty and effort is the knowledge that the concern promotes its own men. The bearing of this factor is to a large extent unrealized. It makes for efficiency all round. Human nature is better stimulated by anticipation and faith in the future.

Commercially considered, it is cheaper to promote from the ranks; humanly, it is more satisfactory. The opportunity of promotion is a great incentive to effort and a basic economic factor in the management of men. Responsibility and success in an executive position are matters of gradual acquisition. He must be a poor specimen indeed who does not develop into an individual on more generous lines when responsibility is gradually applied. To define the ideal foreman is far from easy; the characteristics desirable would startle most employers who cataloged them. To raise him inside the firm is more creditable to the management than to have recourse to the open market every time an executive is hired.

The ruler over five, who acquits himself well, may safely be expected to later acquit himself well in the handling of a greater number. It is the selection of the right subordinates that has created huge concerns and made captains of industry. It is one of the duties of management that the capacity of each man be duly assessed.

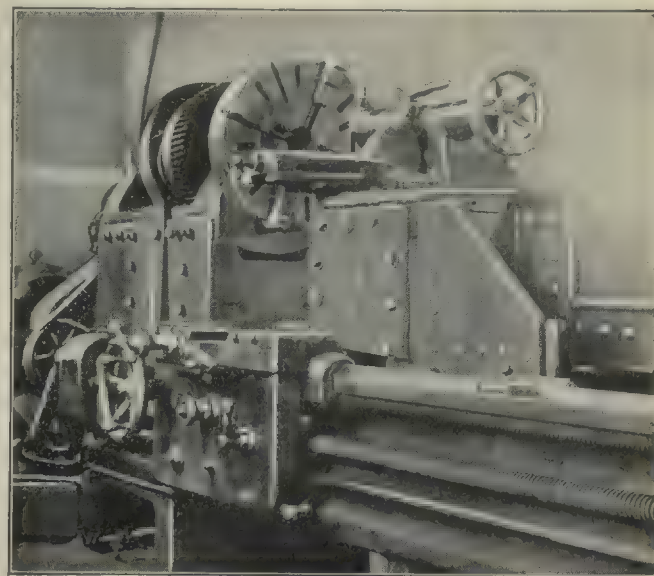
However we may state the problem, the query which was asked earlier in this article, where do foremen come from, if all must have some previous experience of a similar position, remains unanswered. Latent talent is not easy to discern, but much more effort might be made to discover ability.

Raising a Lathe with Steel Plates

By D. Ross

The accompanying illustration shows well the expedients to which small shops have been driven since the beginning of the European War.

This 18-in. lathe was called upon to machine a $25\frac{1}{2}$-in. cast-steel coned piston for a marine engine. Raising blocks were built up of heavy plate from the boiler shop



LATHE HEADSTOCK RAISED ON BOILER PLATE

and angles from the shipfitters' shop. Rather light cuts were necessary, but the piston was machined and installed in less time than it could be sent to a shop with a large enough lathe. This lathe is a part of the equipment of the United States Coast Guard Depot, South Baltimore, Maryland.

Oil-Hole Cover

By John J. McGauley

On a buffing lathe for polishing silver, where emery dust was used, it was thought advisable to put on oil cups; but one purchaser objected, and we had to find a cheaper way, as shown herewith.

A washer was used, and a piece of heavy white felt, which had been cut to a tight fit in the oil pocket, was glued to it. Whenever it is necessary to oil the machine,

CHEAP FELT OIL COVER

all the operator has to do is put oil on the felt, through the washer hole. As the felt is heavy and a tight fit, no dust can get into the bearing. It also gives a more finished appearance to the cup.

Setting a match to a tablespoonful of white shellac for about two minutes, thereby burning off a large amount of the alcohol used in its making, gives a glue that stands the action of oil or soda water.

Method of Forging Cable Eye-Sockets in the Small Shop

By J. V. Hunter

When heavy service is to be demanded from steel cable as a stay line, for hauling, etc., it is not considered safe in the larger sizes—that is, from 1 in. and up—simply to finish the end by making a loop and fastening with a clip. For such service it is preferable that the end of the cable be firmly set in a forged-steel eye-socket, so that the strain of the line shall be uniformly distributed to all strands of the cable and avoid the kinking effect on the inside strands that inevitably follows making a loop.

Forging any great number of these eye-sockets in a small shop that does not handle the job regularly may consume a considerable amount of time; and when done in the old manner, as shown in the series *A* to *D* in the illustration, the work requires, in addition to the forging, the use of a drilling machine and a lathe for boring the tapered inside.

The original process of making these forgings is shown in the series beginning at *A*. At this point the blank stock has one end forged down to a taper and rounded up in a taper swage. The next step, at *B*, is to cut in the shoulders and flatten down the stock for the desired thickness of the loop, at the same time partly shaping it to the desired form.

Then at *C* a hot chisel has been used to cut out the inside stock in order to form a loop. At *D* the loop has been bent over to one side to give clearance for a lathe tool. A drill is run through the shank, approximately $\frac{1}{8}$ in. larger than the cable; then the socket is chucked in a lathe and a taper cut out on the inside so that the thickness of the metal will be practically constant from one end of the shank to the other. The socket next goes back to the blacksmith, who straightens the loop and gives it its final form.

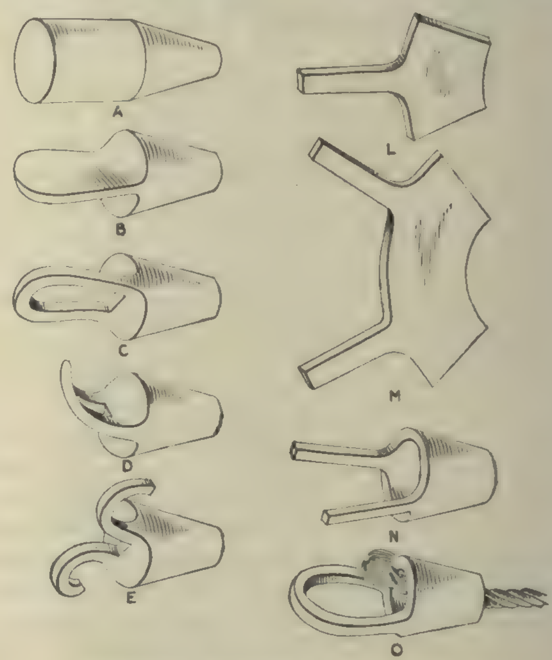
From the point *B* some blacksmiths handle this job differently in order to avoid the large amount of hot-chisel work. Their practice is to split the flattened portion into two halves and draw these out into two long prongs of the same general dimensions as the loop that is to be formed. These prongs are spread apart as shown at *E*, sufficiently to permit the necessary lathe work. When this has been finished, the piece is returned to the fire, the ends of the prongs are welded together and shaped up to form the loop.

Another method of forming these sockets has been developed, which seems to be more economical of the blacksmith's time; it also avoids all the lathe and drilling-machine work required in boring the taper. This method, shown in the series *L* to *O*, also wastes no material, it will be noticed.

In following through this series the smith begins with flat bar stock or draws a larger section down so that its width is sufficient to form one-half of the circumference of the large end of the socket and its thickness is that desired for the shell of the socket. Then one end is drawn out to form half of the loop. The other end is tapered down to one-half of the circumference of the socket, as can be readily understood by an examination of the illustration *L*.

Two of these pieces are prepared and then welded together, as shown at *M*. This is a straight lap weld and is quickly done. The two outside edges are scarfed to have them ready for the final weld, as this scarfing is more easily done before rolling the piece.

From a piece of round stock a mandrel of a taper desired for the inside of the socket can be quickly drawn out. The piece is rolled and shaped up about this mandrel and is then ready for the final weld. With the final heat on the iron, the edges are swaged together with the mandrel inside so that it acts as an anvil to prevent distortion of the socket. This portion is then swaged up smooth and is complete. The two prongs are drawn to



FORGING CABLE EYE-SOCKETS

the desired shape, their ends scarfed, drawn together and welded. The loop is then formed to the correct shape, and the piece is complete, as at *O*.

Careless setting of the cable end will sometimes permit it to be pulled out of the socket. If the cable has been set correctly, it may, under a maximum load, break the cable somewhere outside of the socket; but it will never pull out. For an example, the following method for setting a 1-in. cable is to be recommended as one that will give excellent results if care is taken in cleaning and tinning the individual wires:

To prevent untwisting, wrap the cable tightly with five or six turns of fine wire, about 6 in. from the end. Then pass the end through the socket, as it will be impossible to do so later. Separate the wires above the wrapping and rub each one (individually) clean with emery cloth. This is in preparation for tinning the wire. Dip the end in tinner's acid, and tin it by immersing it in a ladle of melted solder. This is the important part of the whole operation, for it is upon the thoroughness of the tinning that the strength of the finished job depends.

The wires of the cable are now bent back on themselves, about 3 in. from the end, as shown at *O;* this head is then pulled down into the socket, which is stood upright, with the loop up. The lower end about the cable is sealed with a little damp clay or sand, and the socket cavity is poured full of lead or solder. This method is effectual in insuring the permanence of a bond between the two.

Editorials

Mobilization of Fairfield County

Fairfield County, Connecticut, is as typical a combination of intensive industries and extensive farms as could well be gathered together within the borders of one single county. Bridgport, Stamford, Norwalk and Danbury are four cities in this county noted for their manufacturing activities. Bridgeport in particular has been very aptly called the "Essen of America."

During the last six weeks the mobilization of Fairfield County has been accomplished, and accomplished in a way to make it noteworthy as an example for other counties and other states. And it is particularly noteworthy because it is not the mobilization of one particular industry for one purpose, but the mobilization of the land and the factories, and the means of transportation, and the facilities of labor, under one centralized direction.

A coördination that will induce manufacturers in cities to permit farmers in the adjacent country to make use of the manufacturers' motor trucks at night for the transportation of farm produce—an arrangement that will enable farmers without funds to cash their notes at city banks—a coördination which brings into play all of the existing official county machinery and creates a minimum of new offices—is an achievement that deserves to have, and has, the commendation of our Council of National Defense.

The Agriculture Committee, working in coöperation with the Fairfield County Farm Bureau, has secured options on fertilizers, seed and agricultural implements. Arrangements have been made with the local banks to take care of the necessary financing of those farmers whose requirements were even beyond fertilizers, seeds and agricultural implements. This committee is also making arrangements for a sufficient amount of additional labor to take care of the harvesting. In addition to this, it is also in charge of the development of a system of marketing and of the propaganda for preserving, canning, elimination of food waste, and kindred objects.

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This movement in Fairfield County is a practical demonstration of the really close relation between the shop and the farm. It is a realization of the fact that the farmer feeds those in the shop and that those in shops who eat the farmers' produce supply him with money. It is as equally necessary for the machine-shop owner to take an interest in farm matters and farm produce, and the means of getting this produce to his employees, as it is for him to take an interest in healthful working conditions, in good sanitation and in other matters not tied up directly with profits, processes and production.

The Industrial Committee, which has been formed with H. E. Harris, of Bridgeport, as chairman, has outlined and undertaken the following work:

1. An analysis of the industrial census taken by the Council of National Defense, and of the state census, in order to make possible the intelligent assistance of industries for both war and unusual production.

2. The additional industrial surveys that are necessary to supplement the above already collected material.

3. An analysis of production difficulties arising under war conditions. This analysis looks forward to solving the fuel-production problem by studying alternate sources of supply and routes of shipment, and to provide for the collection of reserved supplies. It also looks forward to the protection of raw materials, by studying materials and their substitutes, alternate routes and sources of supply. It also contemplates the possible adjustment of factories to other lines of production.

4. A census of executive and engineering and other skill, with a view to planning so that men needed for national service may be spared with the least crippling of industries. In line with this is the census and classification of skilled and unskilled labor, with a record of the training and experience available. Included in this is the census of women in industries, with a study of the fields in which women can replace men without overstrain.

Another job that this committee has on its hands is the study of the protection of special industrial plants, power sources and the like. Finally, it is faced with the task of planning the transition to peace conditions with the smallest loss of production and efficiency.

One of the most significant features about this whole movement in practical Fairfield County is that the business men, manufacturers and public officials back of this movement do not look upon it merely as a war measure. They regard it more as a permanent step in the direction of the coördination of economic forces, something not for the period of the war alone, but to continue after the war and to make more efficient and effective the efforts of individuals, corporations and of labor, whether in the factory or on the farm.

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Who Is Ignorant?

Very opportunely, Dr. George F. Kunz, president of the American Metric Association, has come along and cleared the air. Coincidentally with the adoption of the Lee-Enfield gun and the abandonment of the Springfield rifle by the Government because of the time required to equip commercial factories with gages, jigs and special tools for the production of the latter, Dr. Kunz makes his bland suggestion that our "new guns and other weapons of war be made in accordance with the metric system."

The official recognition of the serious nature of the gage and tool problem for a gun with which the Government arsenals are already fully equipped, shows that a worse suggestion could scarcely come from the enemy.

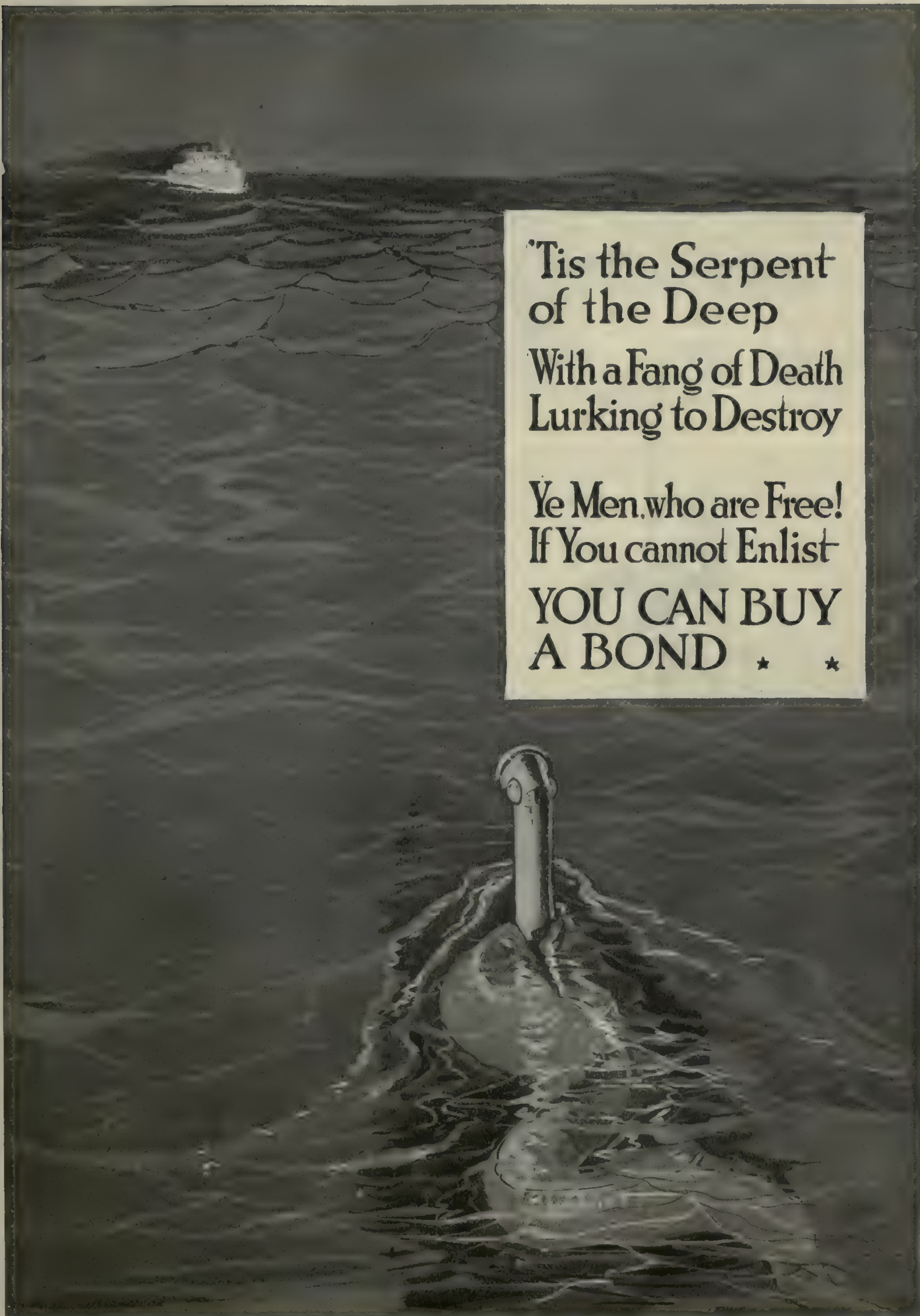
The thing is so absurd as to seem impossible, were it not a fact. There are several proverbs that apply—one about blind leaders, and one about angels and others—but they will suggest themselves to our readers.

With his simple faith in the slogan "It's a good thing, push it along," Dr. Kunz has dropped himself into a very deep hole with very steep sides.

THE Father of our Country
    Who fought and bled and won
To found this great Republic,
    Looks down on you—his son;
Whether through adoption
    From a land across the sea
Or whether of the lineage
    Of our Land of Liberty.
His bugle called the patriots
    Who fought at Bunker Hill
He rang the Bell of Liberty,
    That gave the people—Will;
The Bell that echoed through the years,
    Brought succor to the slaves—
And now, that sounds a Tocsin
    For the Freedom of the Waves.

★

The Father of our Country
    Lived and fought when Men were Men
And now, in Freedom's Hour of Trial,
    He lives and fights again.
And you—his son—for whom he fought;
    For whom he fights today;
Remember, and remember well—
    You have a Debt to pay.
A Debt that signed and sealed with blood—
    With hunger and with tears
Bears interest compounded through
    Some four and fourscore years.
And You, who cannot pay with blood;
    Yet would not shirk your tasks,
Give of your means to buy a Bond
    Now that your Country asks.

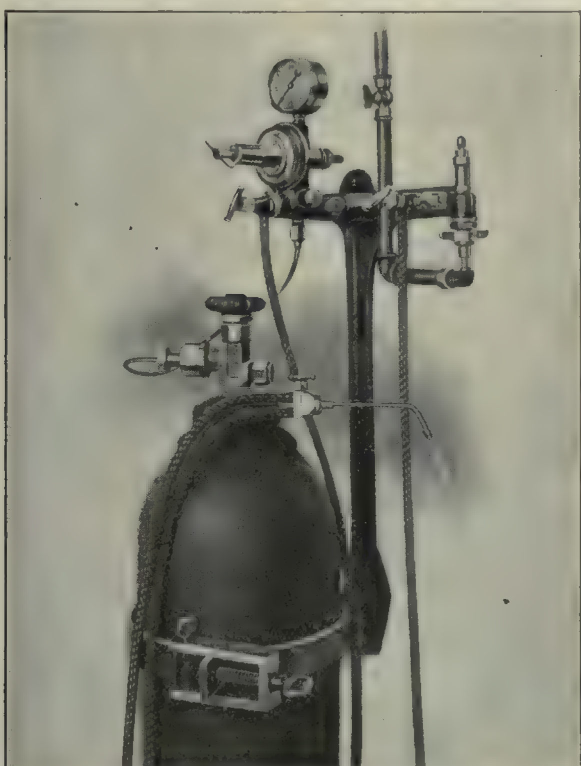

'Tis the Serpent
of the Deep
With a Fang of Death
Lurking to Destroy
Ye Men, who are Free!
If You cannot Enlist
YOU CAN BUY
A BOND * *

Shop Equipment News

Oxy-Illuminating Gas Apparatus

The apparatus illustrated has been placed on the market for the use of storage-battery service stations, garages and other similar places where lead burning, hard tempering, welding, cutting, cylinder decarbonizing and other like processes are carried on. It is known as the "Astra" oxy-illuminating gas apparatus and is being marketed by the Bradford-Ackermann Corporation, 42d St. Building, New York City.

It is claimed that the apparatus is much more economical of operation than those types using acetylene or hydrogen, that the flame temperature is especially adapted to lead burning, and that as there is only one tank there is less handling trouble and expense. The various parts are so arranged that they may be added to existing welding or decarbonizing outfits. Both stationary and portable outfits are supplied, the latter being intended to be moved to convenient gas outlets. A working radius of 16 ft. is provided for with the hose supplied, but this can be increased when necessary.

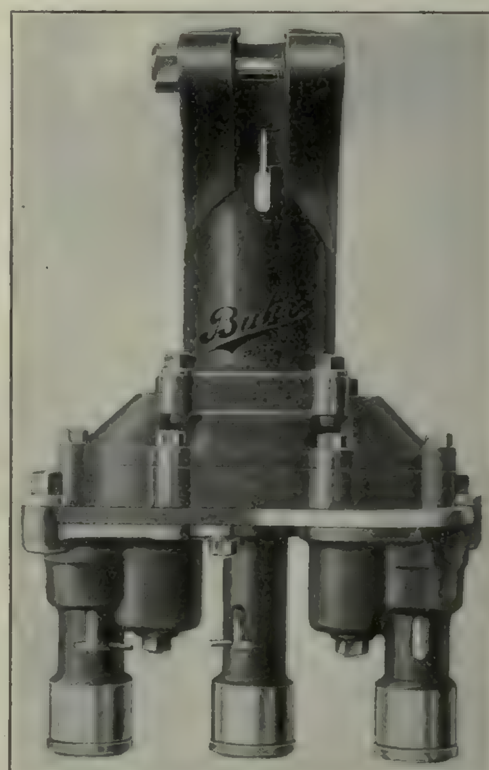


STATIONARY-TYPE APPARATUS

The regulator has a one-piece noncorrosive metallic seat and adjustable countersprings that are interchangeable and accessible. An oxygen regulator and a back-pressure release valve are furnished for the illuminating-gas line. These act automatically and operate alarm whistles in case of danger. A detachable and interchangeable tank connection is used, which is adaptable to any commercial tank regardless of type and size of thread. A scrubber is incorporated to remove foreign substances from the gas before it enters the working parts of the regulator. The equipment includes flexible metallic gas hose, two hose torches with controlling valves and pilot light, five interchangeable burning nozzles of various sizes, gage to indicate the working pressure at the nozzle, and high-pressure gage to show the pressure in the oxygen tank.

Multiple-Spindle Drilling Head

The Nelson-Blanck Manufacturing Co., Detroit, Mich., has placed on the market a new line of adjustable multiple-spindle drilling heads, one of which is shown.



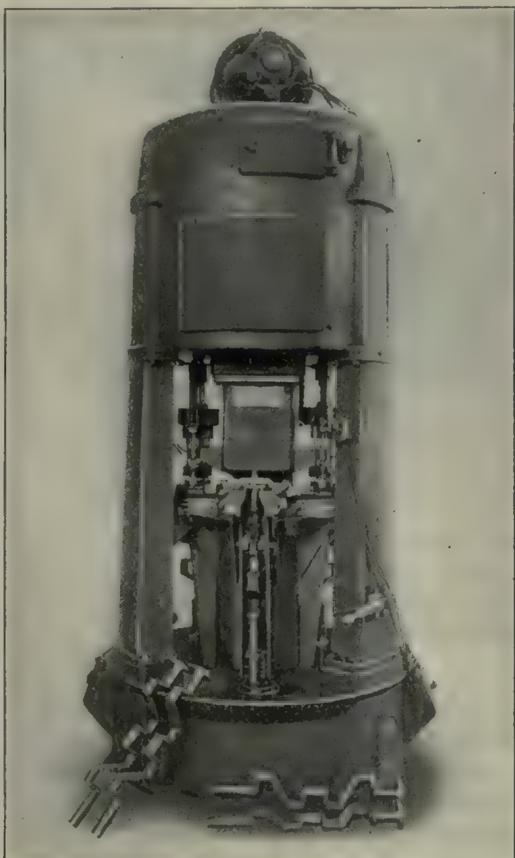
MULTIPLE-SPINDLE DRILLING HEAD

The adapter at the top is separable from the head, so that a change may be quickly made for machines with varying spindle sizes. The driving shank is squared and slides in a square hole in the driving gear, thus allowing different-sized tapers to be used without disassembling the entire head. A ball thrust bearing is provided for the driving shank, and the driving gear runs in S K F ball bearings. Similar bearings are applied to the individual spindles. The drift-pin slots in the spindles are closed by a gate when not in use.

The heads are built in four sizes, to take drills with No. 0 straight and Nos. 1, 2 and 3 Morse taper shanks. Each size may be had equipped with from two to twelve spindles, which may be so placed as to drill holes spaced equidistantly in the circumference of a circle.

Crankshaft Drilling Machine

For the purpose of drilling and reaming the six bolt holes in the flange of an automobile crankshaft, the Baush Machine Tool Co., Springfield, Mass., has built the station-type multiple-spindle drilling machine illustrated. The crankshafts are supported vertically by centers and fixtures, the latter being free to float universally in order to line up correctly with the heads after the table has indexed. The operations at the various stations are as follows: No. 1, loading and unloading; No. 2, two pin holes drilled; No. 3, two pin holes reamed; No. 4, four bolt holes drilled.



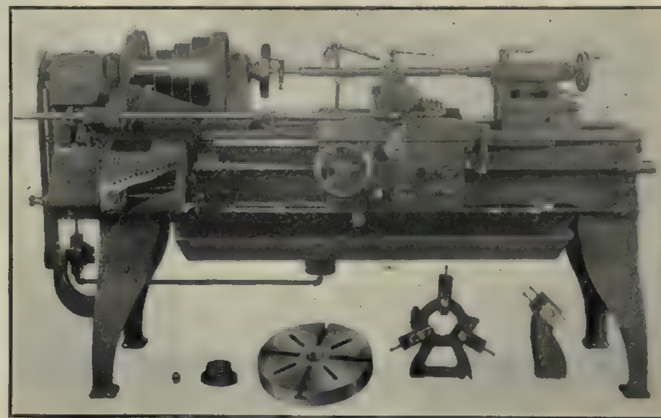
CRANKSHAFT DRILLING MACHINE

Drills: Diameter, $\frac{13}{32}$ in.; speed, 202.6 r.p.m.; feed, 0.0053 in. per revolution. Reamers: Diameter, 0.441 in.; speed, 74.6 r.p.m.; feed, 0.0158 in. per revolution. Horsepower required, 5; dimensions of machine, 4 ft. in diameter, 10 ft. high; weight, 5050 lb.; production time, 50 sec. per crankshaft

Power is supplied by a 5-hp. motor placed at the top of the machine and equipped with electric control convenient to the operator. The hand lever at the right controls the feed. All bearings are automatically lubricated, a sight-feed glass being placed in view of the operator. A system for cutting compound is also incorporated, flexible tubes being used to convey the lubricant to the tools.

Toolroom Lathe

The illustration shows the "Cisco" toolroom lathe with several changes that have recently been incorporated. The machine is the product of the Cincinnati Iron and Steel Co., Cincinnati, Ohio. The swing over the bed and carriage of the 14-in. size has been increased from $15\frac{3}{8}$ to $16\frac{5}{8}$ in., and the carriage bridge has been increased in width from $6\frac{1}{16}$ to $6\frac{3}{16}$ in. All lathes of 8 ft. and under are now equipped with an automatic stop. All gears, with the exception of the back and main head gears, are of steel. Thread stop, tool tray, pan, taper attachment, relieving attachment, draw-in chuck, collets and lubricant pump are all included. The pump is mounted on the leg casting beneath the headstock and is belt driven from a pulley on the spindle. A stop lock at the bottom of the apron controls the automatic stop. The relieving attachment was described in a recent issue.



LATHE FOR TOOLROOM USE

Continuous Miller

The Mann Corporation, Kankakee, Ill., is now building a machine known as the "Manco" continuous miller, which is shown in Figs. 1 and 2. The most important feature of the design is that it is self-contained and can be operated by any drilling machine or like machine of suitable size, the method of drive being through a universal joint. Another valuable feature is its adaptability for machining a great many small jobs that are now done

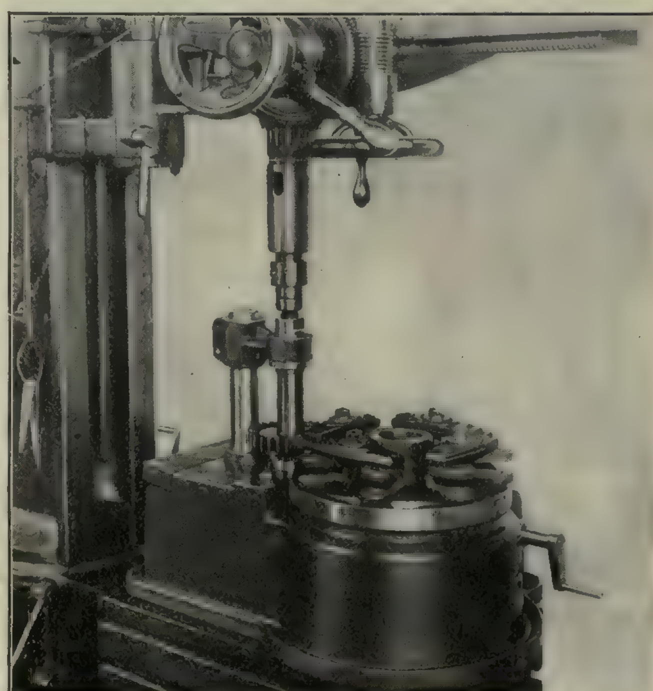


FIG. 1. CONTINUOUS MILLER WITH WORK IN PLACE

on plain and hand millers, and in some cases on very expensive vertical millers. The machine is small and compact and can be operated on any medium-sized drilling-machine table and by an unskilled workman. Every machine shop in the country, large or small, has one or more drilling machines. Thousands of small shops have no millers. The Manco continuous miller will make a good miller out of any old drilling machine.

The cutter is mounted on a $1\frac{1}{4}$-in. arbor that is carried in a sliding block and supported by a steel column 2 in. in diameter. The cutting arbor has an adjustment of $1\frac{1}{4}$ in. perpendicular to the work table and is capable of taking cutters up to 6 in. in diameter.

The work table is $13\frac{1}{4}$ in. in diameter and has both hand and power feed, operated through a set of spur-feed gears that can be changed to suit conditions. The feed-shaft is equipped with a clutch that allows the work table

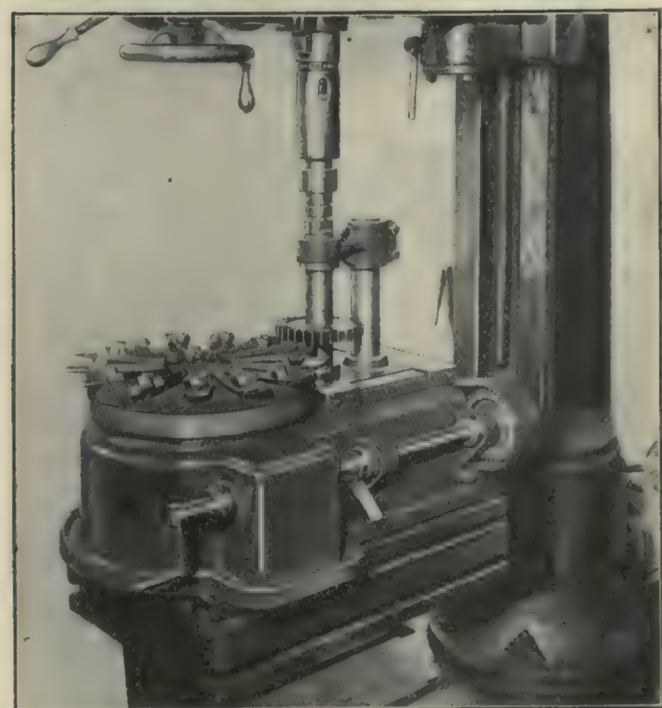


FIG. 2. MACHINE MILLING CLIPPER JAWS

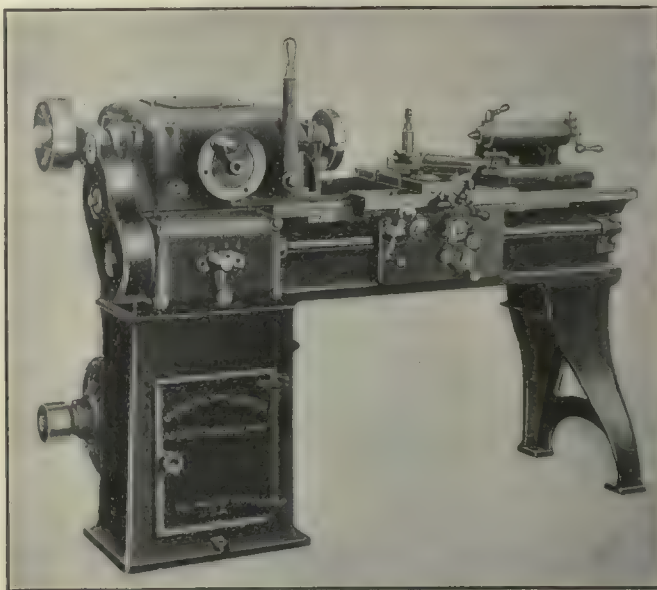
to be operated by hand. The work table and the gears are of ample size to insure very accurate work.

This machine is suitable for the following classes of work: Milling bolt-cutter jaws, sawing off caps of connecting-rods, screw slotting, castellating nuts, sawing off formed links for silent chain, and a large variety of straddle-milling and spot-facing work.

All-Geared Lathes

The illustration shows a high-speed all-geared manufacturing lathe marketed by the Universal Machinery Co., 770 30th St., Milwaukee, Wis. Eight spindle speeds are obtained by the use of gears, and these may be arranged to give either eight speeds forward or four forward and four reverse speeds. The lever at the front of the head controls the reverse, stopping and starting through a set of frictions, thus allowing the motor or countershaft to run constantly.

The spindle is of 70-point carbon steel. All gears in the head run in oil, and the bearings are lubricated by means of splash and felt wipers. Four gear feeds are used for the carriage. The tailstock is of the set-over type, allowing the compound rest to be swiveled at right angles to the carriage. The machine is furnished with turret toolpost, with turret on carriage or with turret on shears,



GEARED MANUFACTURING LATHE

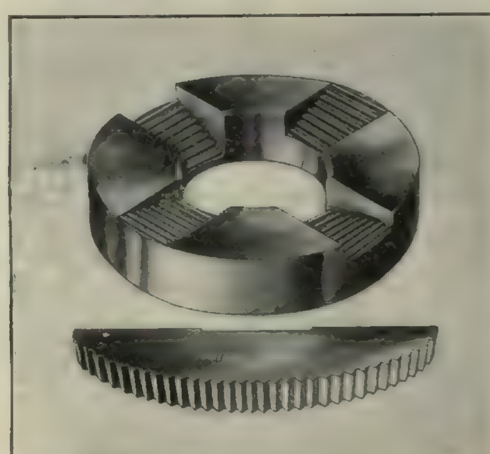
Swing over bed, 12 in.; swing over carriage, 7 in.; distance between centers with $4\frac{1}{2}$-ft. bed, 18 in.; front spindle bearing, 2 x 4 in.; hole through spindle, $1\frac{1}{16}$ in.; centers, No. 3 Morse taper; spindle nose, threaded $1\frac{3}{4}$ x 8; weight, 1150 pounds

the latter either with or without power feed. When motor drive is used, the controlling apparatus is placed in the cabinet leg under the headstock. Chip pan and taper turning attachment can be supplied if desired.

Toolpost Collar and Shoe

In answer to a demand for a toolpost collar and shoe that incorporates a positive locking arrangement, the Du Bois Machine Shop, Inc., is marketing the device shown.

The feature of the device is that the adjusting radius surface on the collar and shoe is corrugated, thus eliminating friction as a means for counteracting the effect of the stress on the tool. It will be noticed that two recesses for the shoe are cut in the collar and are of different depths, to allow for the adjustment of the tool to different heights.



POSITIVE LOCKING COLLAR AND SHOE

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., May 19, 1917—Without question, it is always wise to avoid hysteria and doubly essential in a crisis like the present. The most practical sort of patriotism does not consist in flag waving and in cheers, in training women and children to shoot, or in organizing activities that are never likely to be needed.

Part of the hysteria at present, as has been pointed out by Howard E. Coffin, is the result of a misinterpretation of the President's very timely warning against waste—a warning that should be heeded at all times, though of infinitely more importance at present. The thing to remember is that production of the necessities, both for the sustenance of life and for war, must be increased rather than diminished. The making of machines with which to till the soil, to mine the ore, to make arms and munitions, and to transport them as well as foodstuffs and other materials on land and sea, must be increased, and economies in making these and the prevention of the waste of material and labor in spoiled work are highly essential.

The making of luxuries can well be curtailed as soon as the making of the immense quantity of useful machines and munitions is well under way, for we shall need all available labor in the making of useful materials instead of luxuries. This action will work no material hardship on the workers in that line, as they can be utilized in more useful pursuits. It will be simply a temporary readjustment. We must greatly increase our food supply, even if it becomes necessary to draft men and women for the farms. These men, as has been suggested by Charles B. Barnes, director of employment for the State of New York, can well be taken from those rejected by the military authorities. The backyard garden is not apt to be as productive as many anticipate, but foodstuffs must be raised, even if it costs more to do so; for vegetables are much more digestible and nourishing than the dollars that went for fertilizer and seed. The thing to do is to prevent as much waste of money, time and labor as possible.

A People, but Not Individuals

One of the lessons to be learned is that we are all tied together by the necessities of life and by a unity of interests; in other words, we are a people instead of a collection of individuals, each with a different aim. We can no longer consider solely what we would rather do, but what we can do best, that will be of the most service to the nation.

The ladies who are enthusiastically learning how to march and to shoot should remember that, while this is a novel and interesting experience, it is not nearly so likely to be of real service as to know how to prepare nourishing meals for munition workers, how to preserve farm products that would otherwise be wasted, how to prevent waste in their own kitchens and to teach waste prevention to their less fortunate sisters. In the same way, much of the energy men spend in home-guard drilling would be more effectively patriotic in making their daily work more efficient, in preventing wastes in their offices and shops, in telling their fellow workers through the columns of the *American Machinist* and elsewhere the methods they have found best in their own work.

Futility of Iron-Clad Inspection

Several glaring instances of the futility of iron-clad inspection have recently come to notice, whereby the shipment of much-needed motors was delayed without in any way safeguarding the interests of the purchaser. Intake manifolds, which are under no pressure, were rejected for the slightest leak under hydraulic test, when they could be easily made absolutely tight either by oxyacetylene welding or, in most cases, filling the pores with liquid glass or some other solution that is not soluble in gasoline. Crank cases are rejected for similar reasons, when they can be repaired for much less cost and in much less time than is required to make new ones; and these are days when both time and money count to the utmost.

One particular example of this sort of inspection comes to mind, which serves to show the rigidity and foolishness of some of this inspection. Parts were being rejected without much regard to whether the defects were real or fancied; and as the shop superintendent was a practical man, he saved all parts that he considered good enough for the concern's standard product. After a while he gathered these together and built a motor, intending it for the firm's own use and not for the customer whose inspector was so very particular.

In due course of time this motor came to the testing stand, and its performance was so good that the inspector demanded it for his employer, even accusing the superintendent of giving someone else a better product. The super hesitated, tried to tell the inspector that he did not want that motor, but after much insistence on the part of the inspector assigned it to his order.

Such things are too good to keep in any shop; and after a while someone had to let the cat out of the bag and tell the inspector all about it. After he had come back to earth and realized that no one was to blame but himself, the inspector found the superintendent to tell the latter his *real* troubles in the matter.

"I know the motor is all right," he said, "but what will they say at home when they take it down for overhauling and find my reject mark on so many of the parts?"

The National Advisory Committee for Aëronautics has one of the most difficult problems, owing to the fact that it deals with an industry that has not been developed to the same extent as most others, and far less than in other countries. The greatest problem is that of motors, and this is extremely difficult in many ways. There are but few motors that have been in use long enough or have been built in sufficient quantities really to prove whether they are worth developing at this time or not, for this is no time for experiments that will hold up the supply of motors of an acceptable kind.

Getting Airplane Motors

One of the solutions that is being tried is the building of motors from imported designs that have proved successful on the other side, two notable examples being that of the Gnome, which has already been mentioned, and the Sunbeam motor, developed in England and now being built in Buffalo by the Sterling Motor Co. Then there is the Hispano-Suiza motor, which resembles the Mercedes and which is now being made at the New Brunswick plant of the Wright-Martin Aircraft Co., which was formerly the shop of the Simplex automobile. There are a few other motors that give promise, but they cannot, for months to come, be considered as factors in supplying airplanes.

One probable source of difficulty will be in the farming out of aircraft motors, even of tried design, to shops that have had no experience with work of this class. Unless one has actually been up against the airplane-motor problem and knows the grade of work required, he has no idea of the troubles that lie in wait for him. Those who are not familiar with it imagine, naturally perhaps, that any automobile shop ought to make airplane motors easily, and this is now being tried in some cases. But there are very few automobile shops in this country that can tackle this problem with much hope of success, as the class of work is away above that required for all but a very few of the best-known automobiles made. I am sure that some of these contracts are going to delay the Government's supply of motors rather than facilitate it, as they were designed to do.

Modestly Priced Life and Accident Insurance

The Aëronautical Committee is also doing a most commendable work in its efforts to secure life and accident insurance for aviators at a reasonable figure, and it is meeting with very good results. No man with responsibilities likes to feel that he is beyond the pale in securing protection for his dependents when he enters a service that is increasingly necessary in this war of wars, and it is gratifying to report that a number of the insurance companies are meeting the emergency with praiseworthy coöperation.

The rates are of course higher than for other occupations in times of peace, but in several cases I am informed that the increase is only 2½ per cent. of the face of the policy instead of the 10 per cent. demanded by most companies as soon as war was declared. This means that on a $1000 policy the premium would be $25 more than in times of peace and in ordinary occupations, but this covers flying in military service in this country or abroad and is extremely liberal. Other companies are still sticking to the 10 per cent. increase, both because they do not want the business and in order to safeguard their present policyholders. But the rate should be figured as closely as possible, so as to take care of all those who desire insurance at this time.

Thorough Identification Plan for Workmen

The absolute identification of workmen is more than ever necessary in these times to prevent avoidable "accidents" due to tampering with machinery or otherwise attempting to destroy property and lives. The method of the Midvale Steel Co. is extremely thorough and seems to give little opportunity for any man's getting into the plant as a workman unless he is properly registered and recorded.

Each workman is photographed in duplicate before he goes to work, and his number is also photographed at the same time, so as to be a part of the portrait itself and prevent any attempt at doctoring to suit the occasion. One of these photographs is given to each workman in a little case that he can wear as a badge or carry in his pocket, if he feels that one face at a time is sufficient for the public welfare. As he passes into the shop, his badge is compared with the original to see that he is the same man, and also with the duplicate photograph in possession of the timekeeper. This plan makes it a very difficult matter for a man to get by unless he is the possessor of the photograph and the face that match his number on the timekeeper's list. It takes a little time, but it seems to be a very thorough method of securing the desired result. Just what would happen if a man shaved off his mustache after being photographed has not been explained, but he would probably have to be "done" all over again, the same as a new man.

Wooden-Ship Plan Not Abandoned

Chairman Denman of the Shipping Board recently made the following statement:

"There are contracts for dozens of wooden ships, all preliminary negotiations for which have been carried about to completion, which will be signed immediately upon the passage of appropriations by Congress in an amount sufficient to cover the shipbuilding scheme.

"The wooden-ship plan being definitely under way and satisfactorily progressing, the board and General Goethals have turned to the stimulation of steel-ship production. Undoubtedly, the stories concerning the abandonment of the wooden-ship program arose from the fact that, having nothing more to say about wood, we talked about nothing but steel. The wooden-ship building program will be carried on as it was originally conceived.

"The Shipping Board has never at any time given out a statement of the anticipated number of vessels to be built. We expect within 18 months to turn out an enormous wooden tonnage, and we hope in the same period to turn out a very much larger steel tonnage.

"There are many experts who believe, if we do not do this, Germany will win the war.

"The board welcomes intelligent criticism. It considers unpatriotic a statement of fact concerning its policy which is untrue and about which the person making it has not had the candor to ask the board whether or not it is true."

Machine-Shop Gardens in New England

There has been a widespread response to the appeal for more gardening—for individual effort to increase the food supply of the nation—and it is gratifying to note that the machine-building industry is, as usual, doing its share. The two instances which follow are probably typical of much that is being done elsewhere.

The Brown & Sharpe Co., of Providence, R. I., has secured 30 acres of good land and is ploughing it by tractor and fertilizing it heavily for planting. This area has been divided into plots of 25 x 100 ft., and these have been distributed by lot to applicants among the employees, about 600 being accommodated. A farm superintendent has been employed to advise and instruct the men, and guards have also been furnished. The plots are intended for the raising of staple products such as potatoes, onions, etc., and smaller plots are being arranged for elsewhere, for what are termed home gardens, where anything the man or family particularly fancy can be raised.

The Norton Co., of Worcester, Mass., is extending the activities of its Norton Agricultural Society, which is about four years old and now includes over 600 members. The company provides sufficient land to give each member a plot 50 x 75 ft., has an expert agriculturalist in charge, and also guards the property.

These well-directed efforts are particularly valuable just now, when waste of seed and fertilizer must be prevented so far as possible. The experience of the last-named society shows that nearly every man sticks to his job, that the results are large enough to be well worth while, that the men seem to be benefited by the work and that they take an added interest in the community. The records show that only about 25 per cent. of the men have previously worked at farming in any way.

Incomplete Addresses

By N. G. Near

I believe it would be to the manufacturer's interest always to give street number and street in advertisements, in order that inquiries will be properly addressed in every case. We too frequently see advertisements with the name of the company and the city only. The street and number are omitted.

It is my understanding that post-office employees are not obliged to look up addresses in every case where these details are omitted, and I believe that much mail therefore finds it way into the postal waste-basket. It is a sheer loss both to the inquirer and to the manufacturer.

I have answered a number of advertisements of the kind where the manufacturer says, "Just drop us a card." The addresses are incomplete. Sometimes I get the information I am after and again I do not even get a reply. I therefore attribute this to the faulty address. Large companies in cities like New York and Chicago doubtless get their mail anyway, because the post-office employees know their addresses; but the small manufacturer is not so well known, and I fear the card gets no farther than the post office.

Personals

W. E. Best has severed his connection as superintendent of the National Cash Register Co., Dayton, Ohio.

Bert A. Quayle has been appointed manager of sales of the rim and tube division of the Standard Parts Co., Cleveland, Ohio. **P. W. Gilbert** has been appointed assistant to the manager.

George S. Haley, who for nine years was chief draftsman and mechanical engineer for the H. Mueller Manufacturing Co., Decatur, Ill., is now superintendent of the McDonald Manufacturing Co., Dubuque, Iowa.

Edward J. Pierce, Jr., 253 Broadway, New York City, has returned from a trip to Kansas City, Mo., in the interests of the Automatic Bookkeeping Register Co. Mr. Pierce is specializing in the organization of factories for increased production.

John D. Hurley has been elected president of the Independent Pneumatic Tool Co., Chicago, Ill., succeeding the late James B. Brady. **Ralph S. Cooper**, formerly manager of the New York office, has been elected vice president; and **Robert T. Scott**, formerly manager of the Pittsburgh branch, has been elected a director and member of the executive committee.

Business Items

The Goddard Tool Co., of Chicago, has opened a branch plant at Detroit, Mich., to care for the needs of customers in the Detroit territory.

The Universal Winding Co., Boston, Mass., has just placed in operation at its plant in Cranston, R. I., a new foundry measuring 120 x 161 feet.

The Fairbanks Co. has opened a branch office in Washington, D. C., 325-326 Colorado Building, and extends an invitation to manufacturers of machine tools and supplies to make this office their headquarters when in Washington.

Trade Catalogs

Simplex Independent Chuck. Simplex Tool Co., Woonsocket, R. I. Circular. Illustrated.

Quick-Acting Cam Vise. The F. C. Sanford Manufacturing Co., Bridgeport, Conn. Circular. Illustrated.

Inspector's Compound Bench Plate. A. P. McCulloch Machine Co., 216 High St., Boston, Mass. Circular. Illustrated.

Leather Belting, Belt Lacing, Belt Cement, Belt Dressing, Etc. Charles A. Schieren Co., 30-33 Ferry St., New York. Catalog; pp. 40; 6 x 9 in.; illustrated.

Adjustable Reamers, Quick-Change Chucks and Collets, Turret Tool Holder, Etc. McCroskey Reamer Co., Meadville, Penn. Catalog No. 5. Pp. 64; 6x9 in.; illustrated.

Drop Forgings. Page-Storms Drop Forge Co., Chicopee Falls, Mass. Catalog. Pp. 80; 5 x 8 in.; illustrated. The catalog specially covers the different types of wrenches made by this company.

Drop Forgings. J. H. Williams & Co., Brooklyn, N. Y. Catalog printed in Spanish describing wrenches and other drop forged tools made by this company. Pp. 40; 4 x 6½ in; illustrated.

Machinists' and General Machine Shop Tools. Goodell-Pratt Co., Greenfield, Mass. Tool Book No. 13; pp. 432; 3½ x 6 in.; illustrated. This is a very convenient sized catalog showing over 1500 tools made by this company and giving list prices.

A & L Interior Wood Block Floors. Ayer & Lord Tie Co., Railway Exchange Building, Chicago, Ill. Catalog; pp. 12; 7½ x 10½ in. This contains inserts showing interior views of various machine shops using these floors.

"Producing the Fittest in Waste." The Royal Manufacturing Co., Rahway, N. J. Pamphlet describing the development of waste into a standardized commercial product, which ought to be interesting to users of wiping waste. Pp. 20; 6 x 9 in.; illustrated.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice-president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeteing at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio. on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Quotations were current as follows at the points and dates indicated:

	May 18, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham	$40.00	$35.00	$15.00
No. 2X Northern Foundry, New York	44.00	41.50	20.50
No. 2 Northern Foundry, Chicago	44.00	39.00	19.00
Bessemer, Pittsburgh	44.95	42.95	21.95
Basic, Pittsburgh	42.00	40.00	18.95
No. 2X, Philadelphia	43.50	42.50	20.50
No. 2, Valley	42.00	40.00	18.50
No. 2, Southern Cincinnati	42.90	37.90	17.90
Basic, Eastern Pennsylvania	38.00	38.00	20.50
Gray forge, Pittsburgh	40.95	38.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	May 18, 1917	One Month Ago	One Year Ago	May 18, 1917	Six Months Ago	May 18, 1917	Six Months Ago
Structural shapes	5.00	4.75	3.50	5.00	3.60	5.00	3.35
Soft Steel bars	4.75	4.50	3.55	5.00	3.60	4.50	3.35
Soft steel bar shapes	4.75	4.50	3.25	4.50	3.60	4.50	3.35
Plates	7.00	6.50	4.50	7.00	4.10	6.50	4.00

BAR IRON—Prices in cents per pound at the places named are as follows:

	May 18, 1917	Six Months Ago
Pittsburgh, mill	3.75	2.60
Warehouse, New York	4.60	3.50
Warehouse, Cleveland	4.45	3.45
Warehouse, Chicago	4.50	3.35

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		May 18, 1917	One Month Ago	Six Months Ago	May 18, 1917	Six Months Ago	May 18, 1917	Six Months Ago
*No. 28 black	...	9.25	7.50	4.50	8.00	3.90	7.50	3.90
*No. 26 black	...	9.15	7.40	4.40	7.90	3.80	7.40	3.80
*Nos. 22 and 24 black	...	9.10	7.35	4.35	7.85	3.75	7.35	3.75
Nos. 18 and 20 black	...	9.05	7.30	4.30	7.80	3.70	7.30	3.70
No. 16 blue annealed	...	8.50	6.70	4.45	7.70	3.95	7.70	3.85
No. 14 blue annealed	...	8.50	6.60	4.35	7.60	3.85	7.60	3.75
No. 12 blue annealed	...	8.50	6 55	4.30	7.55	3.80	7.55	3.70
No. 10 blue annealed	...	8.50	6.50	4.25	7.50	3.75	9.50	3.65
*No. 28 galvanized	...	10.75	9.25	6.25	9.50	5.25	9.50	5.40
*No. 26 galvanized	...	10.45	8.95	5.95	9.20	4.95	9.20	5.10
*No. 24 galvanized	...	10.30	8.80	5.80	9.05	4.80	9.05	4.95

*For corrugated sheets add 25c. per 100 lb. Note—No mill quotations.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	May 18, 1917	Six Months Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 20%
Chicago	List plus 5%	List plus 5%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	50%
Cleveland	45%	55%
Chicago	45%	50%

Note—For 7/16-in. and larger the discount is 45% for standard.

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	May 18, 1917	Six Months Ago
New York	$13.00@19.00	$6.00
Cleveland	12.00	5.75
Chicago	11.50	6.30

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*

⅜, 11/32, 5/16, ¼, 7/32, 3/16	19.00
No. 8, 5/32 and No. 10.	20.00@30.00
⅛	
No. 12	
3/32, No. 14 and 1/16	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods

3/16 by 12 in. long	16.00
¼ by 19 in. long	14.00
⅜ by 19 in. long	12.00
½ by 21 in. long	12.00

*Special Welding Wire

⅛	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York May 18, 1917	Cleveland May 18, 1917	Chicago May 18, 1917
Tire	4.80	4.50	4.50
Toe calk	4.75	5.00	4 75
Openhearth spring steel	6.50@ 7.00	7.00	...
"Crucible" spring steel	8.25	12.00	12.00
Best cast steel, base price	10.00@11.00	12.00	...
Special best cast steel	15.00@18.00	19.00	... ..

*In bars.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect May 1, 1917:

Inches	Steel Black	Steel Galvanized	Inches	Iron Black	Iron Galvanized
BUTT WELD					
⅛, ¼ and ⅜	42%	15½%	¾ to 1½	38%	22%
½	46%	31½%			
LAP WELD					
2	42%	27½%	1¼	23%	8%
2½ to 6	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4	33%	20%
			4½ to 6	33%	20%
BUTT WELD. EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜	38%	20½%	¾ to 1½	38%	23%
½	43%	30½%			
¾ to 1½	47%	34½%			
LAP WELD. EXTRA STRONG PLAIN ENDS					
2	40%	28½%	1¼	24%	8%
2½ to 4	43%	31½%	1½	30%	16%
4½ to 6	42%	30½%	2	32%	19%
			2¼ to 4	34%	22%
			4½ to 6	33%	21%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	44%	28%	49%	34%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	45%	31%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	May 18, 1917	One Month Ago	One Year Ago
Copper, electrolytic (carload lots)	33.00	34.00	30.50
Tin	65.00	55.50	49.50
Lead	11.00	9.50	7.50
Spelter	9.50	9.75	16.37½
ST. LOUIS			
Lead	10.75	9.50	6.75
Spelter	9.25	9.50	16.50

At the places named, the following prices in cents per pound prevail:

	New York			Cleveland		Chicago	
	May 18, 1917	One Month Ago	Six Months Ago	May 18, 1917	Six Months Ago	May 18, 1917	Six Months Ago
Copper sheets, base.	42.00	44.00	37.50	42.00	38.50	43.00	38.00
Copper wire (carload lots)	39.50	39.50	32.00	41.00	33.00	40.00	33.00
Brass pipe, base	47.50	47.50	46.50	50.00	46.00	47.50	46.00
Brass sheets	45.00	45.00	44.50	43.00	43.00	43.50	39.50
Solder ½ and ½ (case lots)	39.50	37.63	27.00	39.50	27.00	37.25	26 50

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	May 18, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	....
New York	45.50	45.50	$44.50
Cleveland	42.00	42.00	38.00
Chicago	42.50	42.50	40.00

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill 19.00

	In Casks		Broken Lots	
	May 18, 1917	Six Months Ago	May 18, 1917	Six Months Ago
New York	22.00	18.00	23.00	19.00
Cleveland	23.00	17.75	23.25	18.25
Chicago	22.50	17.50	23.50	18.50

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	May 18, 1917	Six Months Ago
New York	28.00	13.50
Cleveland	27.00	14.50
Chicago	37.00	13.50

Panama Canal Machine and Erecting Shops

By Frank A. Stanley

SYNOPSIS—The great shops of the Panama Canal, at Balboa, have been described as a whole and their principal features of construction illustrated in earlier articles. In the present description it is purposed to show certain important features of the machine and erecting shop, the layout of the equipment, character of machine foundations and other points of interest.

A general interior view illustrating the north end of the main aisle of the east section of the building is given in the headpiece, showing the boring machines, radial drills, large shapers, slotters, etc., in this section of the shop. In Fig. 2, which is a view in the same aisle, but at the opposite end, will be seen the arrangement of large planers and lathes. For serving the machines in this aisle there are two traveling cranes of 20 and 60 tons' capacity respectively. All the machines here are individually driven by electric motors.

The ample illumination at all points through the systems of louvers at sides and ends and the skylight overhead is well brought out by Fig. 1. The general artificial illumination by tungsten-filament lamps is equally well shown by Fig. 2, which is reproduced from a photograph taken at night. These lights operate on 110-220 volt circuits, and the wiring is run through conduits secured to columns and roof trusses. Drops are carried down the columns to plugs for lamp extensions. The lamps used are 100, 150, 250 and 500 watt, according to position and intensity of illumination required.

The general layout, Fig. 3, shows the arrangement of all the tools in this shop. From this drawing it will be seen that about one-half of the north end of the west aisle is utilized as an erecting shop for overhauling, for heavy locomotive repairs and for heavy repairs on dredges, steam shovels and other equipment of similar nature. There are four pits here. They are served by a motor-operated transfer table, to which apparatus requiring repairs is brought from longitudinal tracks extending north of the building. The other half of this aisle—that is, the south end—contains the air-brake and tool department, the latter including the toolroom for the entire building. Small equipment is also provided in the line of lathes, millers, grinders for tools, and so on. The group system of drive is applied to these small machines.

Between the two high sections of the building there is a saw-tooth section that contains at the south end small- and medium-sized lathes and turret machines. For serving the heavier machines here, overhead trolleys are employed, which are operated on rails below the roof trusses. Individual motors are installed on the heavier tools, and the others are group driven. In the north end are drilling machines, and near the locomotive pits are the wheel and axle lathes, hydraulic wheel presses and other equipment of like character. A list of the equipment follows.

The location of the large lathes and planers is shown in the south end of the east section of the shop. The boring machines, radial drilling machines, heavy shapers, etc., will be noticed in the north half of this bay. As pointed out, the two cranes in this aisle have 60 and 20 tons' capacity; the opposite, or west, high section of the building has one traveling crane of 60 tons' capacity. Reference was made in an earlier article to the "leanto" at the east side of the shop proper. This is fitted up with small planers, slotters and shapers. The floor of the shop building is of wood blocks 3½ in. thick, placed on 8 in. of concrete with ½ in. of dry sand between, as shown in the sectional views in Fig. 3.

The concrete foundations for machines vary with the weight to be supported, some being slabs about 12 in. deep, while others use 9-in. slabs with piers or bases from 18 to 24 in. deep under the feet or bases of the machines. These slabs are reinforced with old rails spaced 8 to 9 in. apart. The top of the concrete is 1 in. above the floor level. In each pier there are a pair of bolts, which are anchored near the bottom of the piers by steel angles located crosswise in the concrete. These bolts pass upward through sections of pipe, as indicated.

Reference has already been made to the diversity of the work handled in this shop. While most readers are familiar with the general run of operations necessary in locomotive-repair shops, comparatively few have seen so much of the work essential to the upkeep of dredging and towing equipment, steam shovels and the like. Figs. 1 and 2 show a few characteristic parts requiring handling

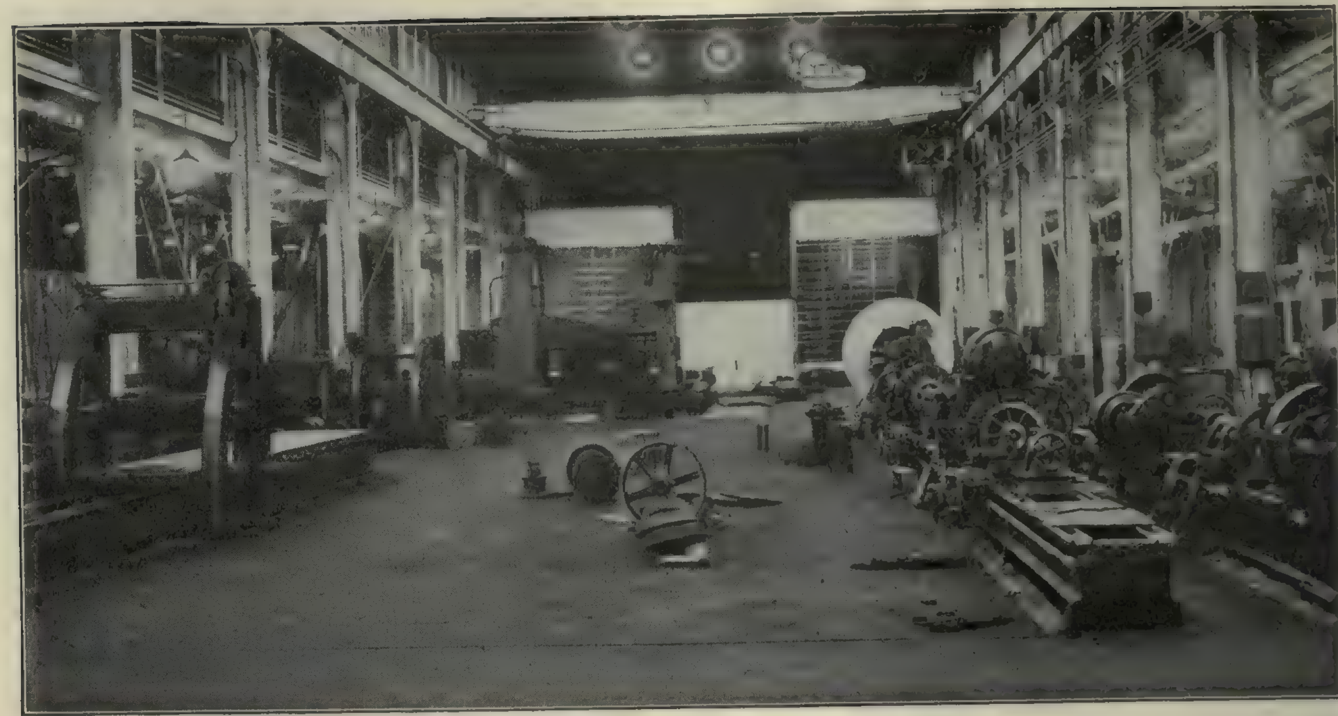


FIG. 2. SOUTH END OF MAIN AISLE, TAKEN BY OWN ILLUMINATION

here, and a variety of work along similar lines will be described in later articles.

Only those who have spent considerable time at the Isthmus can have a full appreciation of the enormous engineering units employed there for the purposes of dredging and excavating. The sum total of such equipment is amazing even to sophisticated observers. While it is not intended at this time to discuss in detail the

FIGS. 4 TO 7. SOME OF THE MACHINERY THAT MUST BE KEPT IN REPAIR

work that has been and is being accomplished with such apparatus, it is believed that a few illustrations of some of the great equipment which these shops must keep in order will be of interest.

Figs. 4, 5, 6 and 7 show some of the dredges and shovels as they appear in actual operation. Some conception of the size of these machines may be obtained upon inspection of the views. Such equipment is constructed for rapid handling of material, and it goes without saying that there is always more or less repair work drifting into the shops from the dredging and shoveling outfit. Dipper bails, shackles and sticks break upon occasion; dippers and buckets are torn open, spuds are ruptured or bent at times; and numerous other members, such as gears, chains and engine parts, demand more or less attention from the repair department.

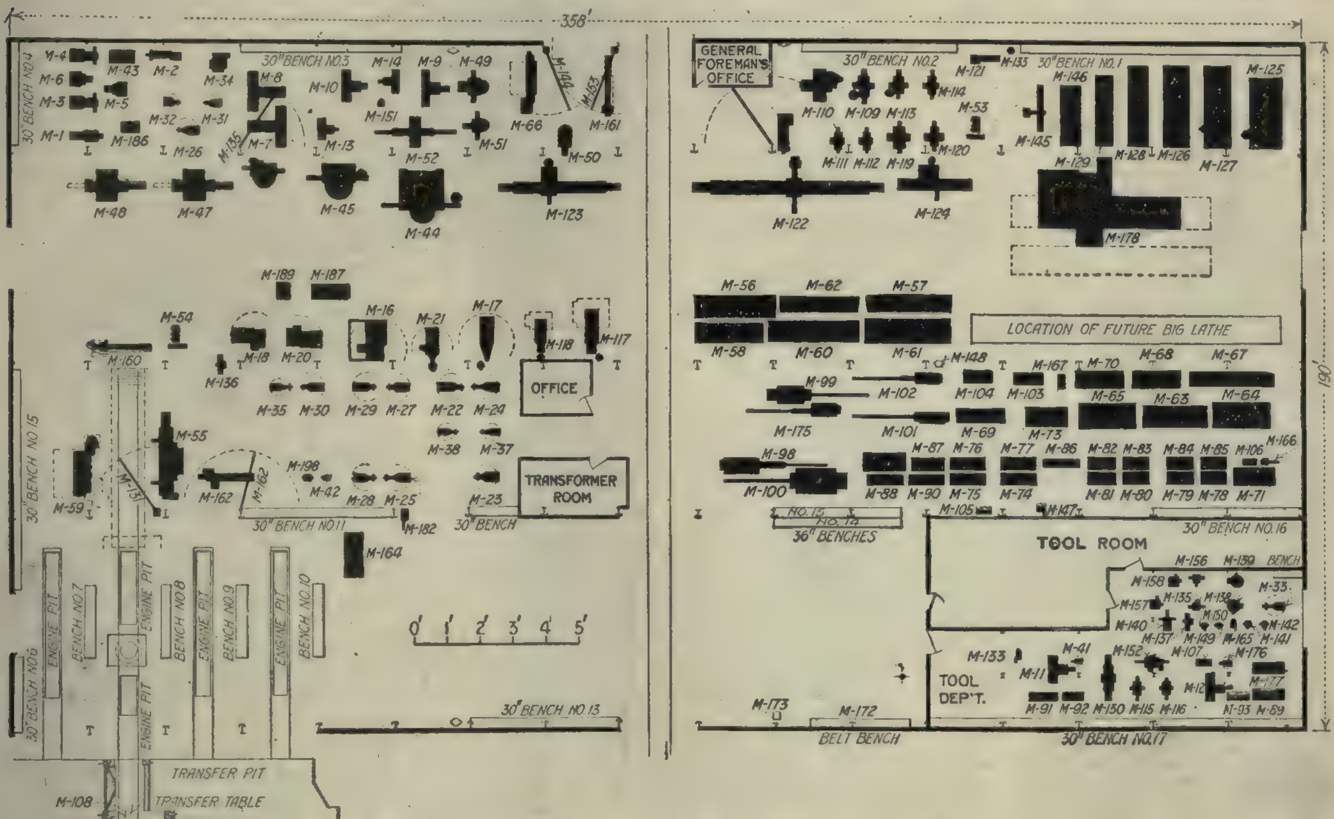


FIG. 3. GENERAL LAYOUT OF MACHINE EQUIPMENT

MACHINE EQUIPMENT USED

Machine Number	Description of Machine	Manufacturer
M-1	Cutter, bolt, 3½-in. single head	Acme Machine Co.
M-2	Cutter, bolt, 2½-in. single head	Foote-Burt Co.
M-3	Cutter, bolt, 2-in. double head	National Machine Co.
M-4	Cutter, bolt, 2-in. double head	National Machine Co.
M-5	Cutter, bolt, 1½-in. single head	National Machine Co.
M-6	Cutter, bolt, 1½-in. triple head	National Machine Co.
M-7	Miller, 50x12x20-in. vertical feed, plain	Brown & Sharpe
M-8	Miller, 50x12x20-in. vertical feed, plain	Brown & Sharpe
M-9	Miller, 34x10x20-in. vertical feed, plain	R. K. LeBlond Machine Tool Co.
M-10	Miller, 34x9x20-in. vertical feed, plain	Cincinnati Milling Machine Co.
M-11	Miller, 30x10x19-in. vertical feed, universal	Hendey Machine Co.
M-12	Miller, 30x10x19-in. vertical feed, universal	Hendey Machine Co.
M-13	Miller, 24x7x18-in. vertical feed, universal	Oesterlein Mfg. Co.
M-14	Miller, 24x7x18-in. vertical feed, universal	Oesterlein Mfg. Co.
M-15	Crane, portable, 2-ton, 6-ft. 3-in. hoist	Franklin Portable Crane Co.
M-16	Drilling machine, radial, 6 ft. vertical, semi-universal	Niles-Bement-Pond
M-17	Drilling machine, radial, 6 ft. plain, 3 in	Pond Machine Tool Wks.
M-18	Drilling machine, radial, 5-ft. vertical, universal, 3 in	Niles-Bement-Pond
M-19		Niles-Bement-Pond
M-20	Drilling machine, radial, 5-ft. vertical, semi-universal, 3 in	Niles-Bement-Pond
M-21	Drilling machine, radial, 5-ft. vertical, universal, 3 in	Dreses Mach. Tool Co.
M-22	Drilling machine, sliding head, 42-in. vertical	Aurora Tool Works
M-23	Drilling machine, sliding head, 40-in. vertical, 2½ in	Aurora Tool Works
M-24	Drilling machine, sliding head, 36-in. vertical, 2 in	Prentice Bros. Co.
M-25	Drilling machine, sliding head, 34-in. vertical, 2 in	W. F. & J. Barnes Co.
M-26	Drilling machine, sliding head, 34-in. vertical, 2 in	W. F. & J. Barnes Co.
M-27	Drilling machine, sliding head, 32-in. vertical, 3 in	Cincinnati Machine Tool Co.
M-28	Drilling machine, sliding head, 32-in. vertical, 3 in	Cincinnati Machine Tool Co.
M-29	Drilling machine, sliding head, 31-in. vertical, 2½ in	Aurora Tool Works
M-30	Drilling machine, sliding head, 31-in. vertical, 2½ in	B. F. Barnes Co.
M-31	Drilling machine, sliding head, 26-in. vertical, 1½ in	W. F. & J. Barnes Co.
M-32	Drilling machine, sliding head, 26-in. vertical, 1½ in	W. F. & J. Barnes Co.
M-33	Drilling machine, sliding head, 26-in. vertical, 1¾ in	B. F. Barnes Co.
M-34	Drilling machine, 3-spindle, 26-in. vertical, 1½-in	B. F. Barnes Co.
M-35	Drill, sliding head, 25-in. vertical, 1½ in	Garvin Machine Co.
M-36	Crane, portable, 3-ton, 11-ft. 8-in. hoist	Franklin Portable Crane Co.
M-37	Drilling machine, sliding head, 24-in. vertical, 1½ in	Garvin Machine Co.
M-38	Drilling machine, sliding head, 24-in. vertical, 1½ in	Garvin Machine Co.
M-39	Stand, air pump, overhauling	
M-40	Stand, air pump, overhauling	
M-41	Drilling machine, sensitive, 14-in. upright, ¾-in. drill	B. F. Barnes Co.
M-42	Drilling machine, sensitive, 14-in. upright, ¾-in. drill	B. F. Barnes Co.
M-43	Tapper, nut, ¼-2-in. four-spindle	Acme Machinery Co.
M-44	Mill, boring, vertical, 2 heads	Betts Machine Works
M-45	Mill, boring, vertical, 96 in	Betts Machine Works
M-46	Grinder, double, 10-in. emery wheels	
M-47	Mill, boring, horizontal, 60 in	Niles-Bement-Pond
M-48	Mill, boring, horizontal, 60 in	Niles-Bement-Pond
M-49	Mill, boring, vertical, 51-in. double head	Niles Tool Works Co.
M-50	Mill, boring, vertical, 42 in	Putnam Machine Co.
M-51	Mill, boring, vertical, 37 in	Niles-Bement-Pond
M-52	Mill, boring, horizontal, 24 in	Binsse Machine Co.
M-53	Tapper, drill and; horizontal, 3-in. drill	B. F. Barnes Co.
M-54	Tapper, drill and; horizontal, 3-in. drill	B. F. Barnes Co.
M-55	Lathe, 79-in. driving wheel	Niles-Bement-Pond
M-56	Lathe, engine, triple gear, 36 in. by 20 ft	W. B. Bement & Sons
M-57	Lathe, engine, triple gear, 42 in. by 22 ft	Fitchburg Mach. Works
M-58	Lathe, engine, triple gear, 42 in. by 16 ft	Lodge & Shipley Machine Tool Co.
M-59	Lathe, tire, 42-in. diameter wheels	Niles-Bement-Pond
M-60	Lathe, engine, triple gear, 36 in. by 24 ft	Niles-Bement-Pond
M-61	Lathe, screw-cutting, 36 in. by 22 ft	Schumacher & Boye
M-62	Lathe, engine, triple gear, 36 in. by 20 ft	American Tool Works
M-63	Lathe, engine, triple gear, 36 in. by 17 ft	Niles-Bement-Pond
M-64	Lathe, engine, quick-change, 32 in. by 14 ft	Schumacher & Boye
M-65	Lathe, engine, quick-change, 32 in. by 14 ft	Schumacher & Boye
M-66	Lathe, axle, single head, 16 in. by 8 ft. 5 in	Bement-Niles & Co.

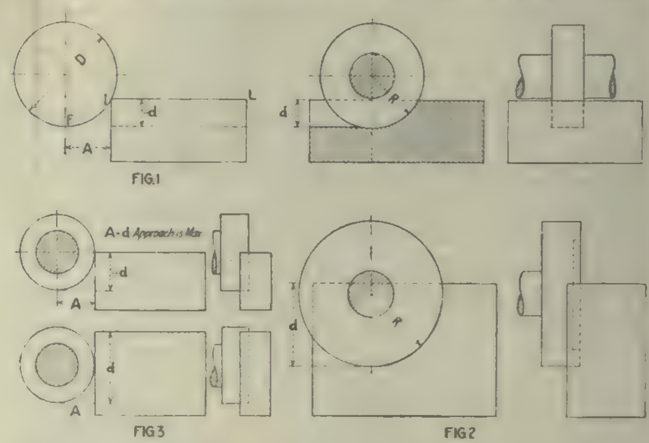
Machine Number	Description of Machine	Manufacturer
M-67	Lathe, engine, quick-change, 24 in. by 22 ft	New Haven Mfg. Co.
M-68	Lathe, engine, quick-change, 24 in. by 12 ft	R. K. LeBlond Machine Tool Co.
M-69	Lathe, engine, quick-change, 24 in. by 12 ft	American Tool WorksCo.
M-70	Lathe, engine, quick-change, 24 in. by 12 ft	R. K. LeBlond Machine Tool Co.
M-71	Lathe, engine, screw-cutting, 24 in. by 10 ft	Schumacher & Boye
M-72	Lathe, engine, screw-cutting, 24 in. by 10 ft	Schumacher & Boye
M-73	Lathe, engine, screw-cutting, 24 in. by 10 ft	Schumacher & Boye
M-74	Lathe, engine, screw-cutting, 18 in. by 8 ft	F. E. Reed & Co.
M-75	Lathe, engine, screw-cutting, 18 in. by 8 ft	Prentice Bros. & Co.
M-76	Lathe, engine, screw-cutting, 18 in. by 8 ft	Prentice Bros. & Co.
M-77	Lathe, engine, screw-cutting, 16 in. by 8 ft	F. E. Reed Co.
M-78	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-79	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-80	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-81	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-82	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-83	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-84	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-85	Lathe, engine, screw-cutting, 18 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-86	Lathe, key, double head, 16 in. by 9 ft	Warner & Swasey Co.
M-87	Lathe, engine, quick-change, 16 in. by 8 ft	Hendey Machine Co.
M-88	Lathe, engine, toolroom, 14 in. by 8 ft. 6 in	Pratt & Whitney
M-89	Lathe, engine, toolroom, 14 in. by 8 ft	Hendey Machine Co.
M-90	Lathe, engine, toolroom, 14 in. by 7 ft	Pratt & Whitney
M-91	Lathe, engine, screw-cutting, 14 in. by 6 ft	R. K. LeBlond Machine Tool Co.
M-92	Lathe, engine, toolroom, 12 in. by 5 ft	Hendey Machine Co.
M-93	Lathe, engine	Hendey Machine Co.
M-94	Pump, air testing outfit	
M-95	Valve, air-brake testing outfit	
M-96	Valve, triple, testing outfit	Westinghouse Air Br.Co.
M-97	Crane, jib, 1½ tons, 14-ft. radius serving test outfit	
M-98	Lathe, turret, 3x36 in	Pratt & Whitney
M-99	Lathe, turret, flat, 3x36 in	Jones & Lamson
M-100	Lathe, turret, 6x28 in. motor driven	Niles-Bement-Pond
M-101	Lathe, turret, 2x26 in	Warner & Swasey
M-102	Lathe, turret, 1½x18 in	Pratt & Whitney
M-103	Lathe, turret, 1½x18 in. universal monitor	Warner & Swasey
M-104	Lathe, turret, 1½x18 in., Fox monitor	American Tool and Machine Co.
M-105	Lathe, centering, 6 in. by 3 ft. 9 in., two speed	National Machine Co.
M-106	Lathe, centering, 4 in. by 3 ft., two spindle	Pratt & Whitney
M-107	Lathe, centering, 4 in., horizontal	Pratt & Whitney
M-108	Table, transfer, electric	Shop made
M-109	Shaper, crank, back geared, 32 in	Cincinnati Shaper Co.
M-110	Shaper, traverse, spindle head, 22 in	Cincinnati Shaper Co.
M-111	Shaper, crank, 24 in	Smith & Mills Co.
M-112	Shaper, crank, 24 in	Smith & Mills Co.
M-113	Shaper, crank, back geared, 24 in	Cincinnati Shaper Co.
M 114	Shaper, crank, back geared, 24 in	Cincinnati Shaper Co.
M-115	Shaper, friction drive, 24 in	Hendey Machine Co.
M-116	Shaper, friction drive, 24 in	Hendey Machine Co.
M-117	Slotter, crank, vertical, 26 in	Niles-Bement-Pond
M-118	Slotter, crank, vertical, 18 in	William Sellers & Co.
M-119	Slotter, crank, vertical, 15 in	Niles-Bement-Pond
M-120	Slotter, crank, vertical, 10 in	Niles-Bement-Pond
M-121	Seater, key, vertical, 2x21 in	Chattanooga Mach. Co.
M-122	Planer, four head, 60x60 in. by 24 ft	Niles-Bement-Pond
M-123	Planer, double head, 48x62 in. by 16 ft	Cincinnati Planer Co.
M-124	Planer, double head, 42x42 in. by 12 ft	William Sellers & Co.
M-125	Planer, double head, 42x42 in. by 8 ft	Cincinnati Planer Co.
M-126	Planer, double head, 33x33 in. by 10 ft	Cincinnati Planer Co.
M-127	Planer, double head, 33x33 in. by 10 ft	Cincinnati Planer Co.
M-128	Planer, double head, 30x30 in. by 10 ft	Niles-Bement-Pond
M-129	Planer, single head, 30x30 in. by 8 ft	Whitcomb Mfg. Co.
M-130	Planer, single head, 24x24 in. by 5 ft	J. S. Wheeler & Co.
M-131	Crane, jib, serving M-55 lathe	
M-132	Saw, cold, friction feed, 31-in. saw	Higley Mach. Tool Co.
M-133	Saw, hack, 14-in. stroke	Railway Appliance Co.
M-134	Crane, jib, serving M-162	
M-135	Crane, jib, serving M-7	
M-136	Grindstone, portable, 48-in. diameter, 6-in. face	Niles-Bement-Pond
M-137	Grindstone, portable, 48-in. diameter, 6-in. face	Niles-Bement-Pond
M-138	Grinder, cold saw, automatic feed, 36 in	Higley Machine Co.
M-139	Grinder, cold saw, automatic feed, 36 in	Higley Machine Co.
M-140	Grinder, tool, universal	Tabor Mfg. Co.
M-141	Grinder, tool, wet, 18x2½x6-in. wheel	Safety Emery Wheel Co.
M-142	Grinder, tool, wet, 16x2x1¼-in. wheel	Challenge Machine Co.
M-143	Grinder, tool, wet, 16x2x1¼-in. wheel	Challenge Machine Co.
M-144	Crane, jib, serving M-66	
M-145	Grinder, surface, automatic open side	Springfield Mfg. Co.
M-146	Grinder, surface, 14x2x1⅝ in	Converted planer
M-147	Grinder, double, 10x1½x1¼ in	Valley City Mach. Co.
M-148	Grinder, wet, 14x2x1 7/16 in	Springfield Mfg. Co.
M-149	Grinder, double, dry, 14x2x1⅛ in	Valley City Machine Co.
M-150	Grinder, single, wet, 14x2x6 in	Bridgeport Safety Co.
M-151	Grinder, single, wet, 14x2x6 in	Bridgeport Safety Co.
M-152	Grinder, universal, friction	Landis Tool Co.
M-153	Crane, jib, serving M-161	
M-154	Crane, jib, serving M-132	
M-155	Grinder, tool and cutter, universal 8-in. diameter	Oesterlein Machine Co.
M-156	Grinder, tool and cutter, universal 8-in. diameter	Oesterlein Machine Co.
M-157	Grinder, twist drill, ⅛ to 2¼-in. drills	Heald Machine Co.
M-158	Grinder, twist drills, ⅛ to 3½-in. drills	Heald Machine Co.
M-159	Crane, serving pit, erecting shop	
M-160	Press, hydrostatic, 300-ton, 78-in. wheels	Niles-Bement-Pond
M-161	Press, hydrostatic, 200-ton, 48-in. wheels	Niles-Bement-Pond
M-162	Press, hydraulic, 100-ton, 36-in. wheels	Niles-Bement-Pond
M-163	Press, forcing, 30-ton	Lucas Machine Tool Co.
M-164	Press, hydrostatic, 30-ton	Old French
M-165	Press, arbor, 3-in. mandrel	Greenerd
M-166	Press, arbor, 3-in. mandrel	Greenerd
M-167	Press, arbor, 3-in. mandrel	Greenerd
M-168	Scale, suspension—30,000-lb. cap	Kemp Machine Co.
M-169	Crane, traveling, 60-ton	Niles
M-170	Crane, traveling, 20-ton	Cleveland
M-171	Machine, valve-setting	
M-172	Bench, belt-repairing outfit, Taylor's	Tabor Manufacturing Co.
M-173	Lacer, belt, 12-in. hand power	Peer Belt Machine Co.
M-174	Planer, rotary, valve seat, 26-in. diameter	Pedrick & Ayer
M-175	Lathe, turret, flat, 2x26 in	Warner & Swasey
M-176	Press, 1½-in. drill, upright, stationary head	B. F. Barnes & Co.
M-177	Lathe, engine, toolroom, 16 in. by 8 ft	Hendey Machine Co.
M-178	Planer, removable side, 96x132 in. by 24 ft	Detrick & Harvey
M-179	Car, 80,000-lb. wooden flat	
M-180	Locomotive, type 0-4-2	
M-181	Press, arbor, 1½-in. mandrel	Greenerd
M-182	Press, arbor, 4½-in. mandrel	Greenerd
M-183	Machine, facing, 18 to 28-in. cylinders	Manning, Maxwell & Moore
M-184	Machine, boring, 10 to 24-in. cylinders, 60 in. long	H. B. Underwood
M-185	Machine, boring, 4 to 12-in. cylinders, 30 in. long	
M-186	Table, layout, 3 ft. 6 in. by 5 ft	
M-187	Table, layout, 4x10 ft	
M-188	Table, layout, 3 ft. 3½ in. by 6 ft. 6½ in	
M-189	Table, layout, 3 ft. 6 in. by 5 ft	
M-190	Table, layout, 3 ft. 6 in. by 5 ft	
M-191	Crane, traveling, 60-ton	Niles
M-192	Chisel, pneumatic	
M-193	Machine, air-hose	
M-194	Pump, steam, 4½x2¾x4 in	Prescott Drop Pit
M-195	Pit, drop	
M-196	Scale, 2,000-lb. capacity	Fairbanks
M-197	Engine, vertical, 2x2½-in. single cylinder	
M-198	Grinder, double wet, 14x2x1¼ in., No. 14.	Valley City Mach. Wks.

Calculating the Approach of Milling Cutters

By Francis J. G. Reuter*

The distance between the initial and the final point of contact with the work, considering the point on the periphery of the cutter, is called the approach (see Fig. 1). This distance is used in time-study estimating, together with the length of the piece or cut, to determine the time required by the machine to do the work. The result is called the "machine time."

There are cases when the net machine time is obtained by adding the length of cut and the length of approach,



FIGS. 1 TO 3. APPROACH OF CUTTER AND DEPTH OF CUT

Fig. 1—Approach of milling cutter. Fig. 2—Depth of cut—round pieces. Fig. 3—Depth of cut—rectangular pieces

then dividing the total by the feed per revolutions per minute. This will give the number of turns required to remove the stock.

In other cases, where a clean smooth finish is required, the length of cut must be added to twice the length of approach, all depending upon the requirement. Thus it is important to know the distance called the length of approach.

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To calculate the approach by the ordinary mathematical method requires too much time, the formula being $A = \sqrt{d(D-d)}$, in which

A = Approach;
D = Diameter of the cutter;
d = Depth of cut.

These dimensions are shown in Fig. 1, as are also I, the initial point of contact, and L, the last point of contact.

In this case the depth of cut is not, as is usual, the thickness of the chips. It is rather the part of the radius of the cutter engaged in removing the stock. Fig. 2 shows various cases of this problem. The approach is maximum when the depth of cut equals the radius of the cutter. Should the depth of cut be more than the radius, the approach is still equal to the radius. This applies to rectangular pieces only (see Fig. 3). For a derivation of the formula, refer to Fig. 4. It is easy to analyze the derivation of it; R = the radius, A = the approach, d = the depth of cut.

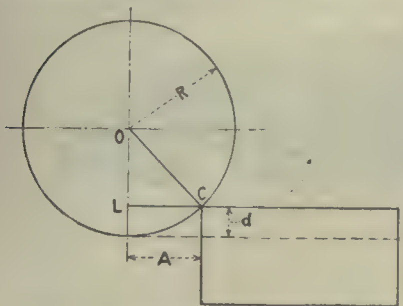


FIG. 4. DIAGRAM FOR DERIVATION OF FORMULA

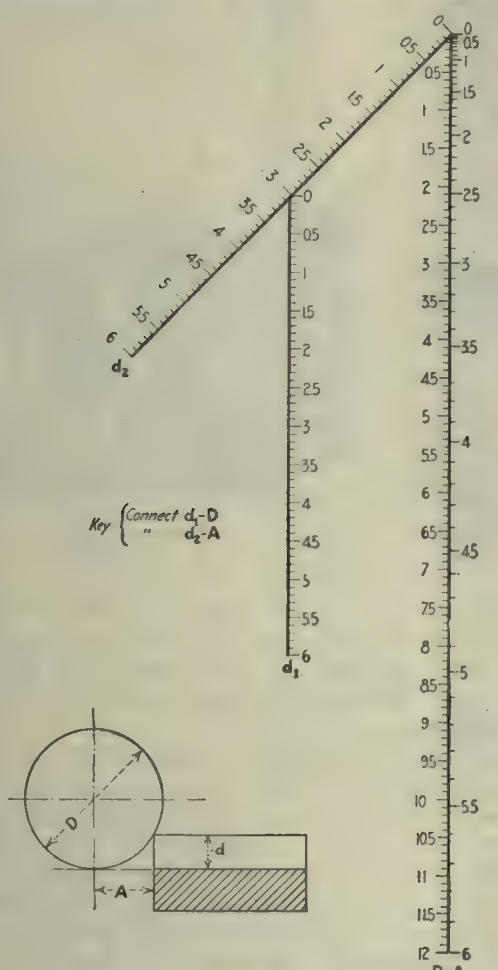


FIG. 5. CHART TO CALCULATE APPROACH

In the figure, notice that there is a right-angle triangle OCL. The side $OC = R$, the side $OL = R - d$, and the side $LC = A$. We know that $\overline{R-d}^2 + A^2 = R^2$. Reducing this original formula to its simplest expression, we have

$$A^2 = R^2 - \overline{R-d}^2$$
$$A^2 = R^2 - (R^2 - 2Rd + d^2)$$
$$A^2 = R^2 - R^2 + 2Rd - d^2$$
$$A^2 = Dd - d^2$$
$$A = \sqrt{Dd - d^2}$$
$$A = \sqrt{d(D-d)}$$

Thus the final mathematical formula is

$$A = \sqrt{d(D-d)}$$

The chart shown in Fig. 5 was designed to calculate this approach. It is foolproof, and obtaining the answer is very simple. There are four scales, marked respectively A, D, d_1 and d_2. To solve the equation $A = \sqrt{d(D-d)}$, let it be supposed that the diameter of a cutter is 6 in.

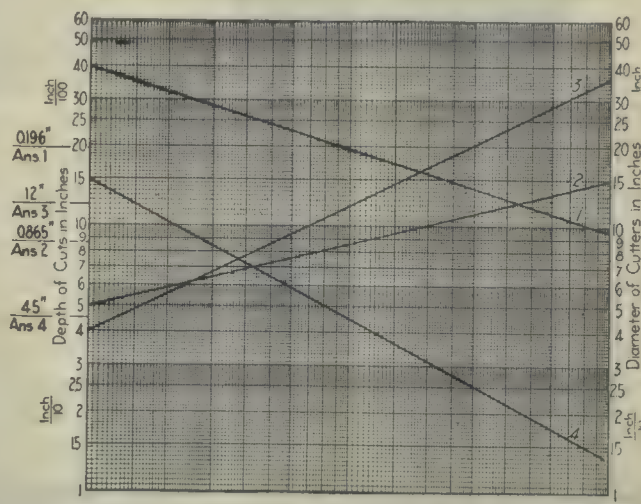


FIG. 6. CHART FOR ONE-DIAMETER CUTTERS

and that the depth of cut, or that part of the radius engaged in doing the work, is 1 in. Then connect 6 on the D scale with 1 on the D scale, using a draftsman's triangle and a straight-edge. Draw a parallel through the number representing the depth of cut on the d_2 scale and read on the A scale the approach, in this case 2.24 in.—and so on for any diameter up to 12 in. and any depth of cut up to 6 in.

Should only one diameter of cutter be considered, a chart on parallel coördinates would answer the purpose. From that statement and with a little mental effort, a chart on parallel coördinates can be used for any diameter of cutters and any depth of cut, one scale to be used

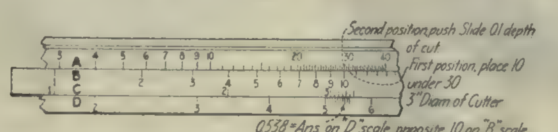


FIG. 7. USING SLIDE-RULE TO SOLVE PROBLEMS

for the diameters, another for the depth of cuts, and a third located in the middle will be the approach.

The solution is easily made with logarithmic cross-section paper, Fig. 6, three parallel scales being ready for use and especially adapted to the case in consideration. Having a cutter 1 in. in diameter and a depth of cut of 0.04 in., to calculate the approach on parallel coördi-

nates proceed as follows: On the diameter scale choose a number representing the given diameter of cutter, move downward a quantity equal to the depth of cut, connect this point with the depth of cut selected on the opposite scale, and read on the middle scale the answer. This is shown in Fig. 6 by line No. 1, the approach being in this case 0.196 in. In the same figure, line No. 2 gives the solution for 2-in. diameter and 0.5-in. depth; the answer is 0.865 in. Line No. 3, for 4-in. diameter and 0.4-in. depth; answer, 1.2 in. Line No. 4, for 15-in. diameter and 1.5-in. depth; answer, 4.5 in. It is evident that there are a few rules for the reading of this chart. If the reader is familiar with logarithms and their use, he will not have any trouble.

If such an equation as $A = \sqrt{d(D-d)}$ can easily be solved on parallel coördinates, I do not see any reason why the ordinary slide-rule would not answer the purpose. Let a cutter 3 in. in diameter with a depth of cut of 0.1 in. be considered. Fig. 7 shows the two positions and the answer, 0.538 in.

Welding Operations on Automobile Bodies

Special Correspondence

In the manufacture of sheet-metal bodies for automobiles, welding operations are advantageously employed. By this means a tight joint is obtained with a neat and smooth appearance. In this article are shown some of the welding operations performed at the factory of the C. R. Wilson Body Corporation, Detroit, Mich., by Toledo and Winfield electric-welding machines.

FIG. 1. REAR VIEW OF TONNEAU MADE UP BY SPOT WELDING

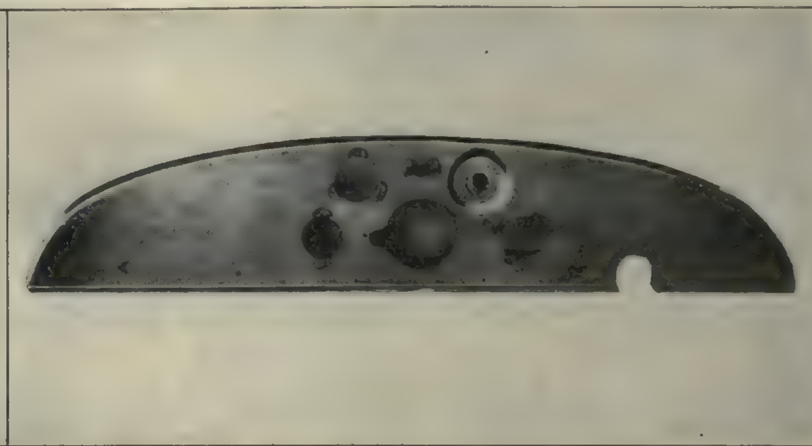


FIG. 2. AN AUTOMOBILE INSTRUMENT-BOARD COVER MADE UP BY SPOT WELDING

In Fig. 1 is illustrated a rear seat, or tonneau, during the making of which 54 spot welds are used. This part is manufactured from 0.0312-in. (No. 22 gage) steel. The time required for the welding operation is approximately 3 min. In making the instrument-board cover, it is first formed to shape, then the various openings are punched. The instrument supports are spot welded to the cover, as shown in Fig. 2. For this work, 32 welds are required, and the time necessary is 4 min. The cover and supports are made from 0.05-in. (No. 18 gage) steel. In Fig. 3 is shown a heel board, to which are welded two angles. The heel board is of steel 0.0312 in. (No. 22 gage) thick. The angles are attached by 11 spot welds, and the time required is 1 min.

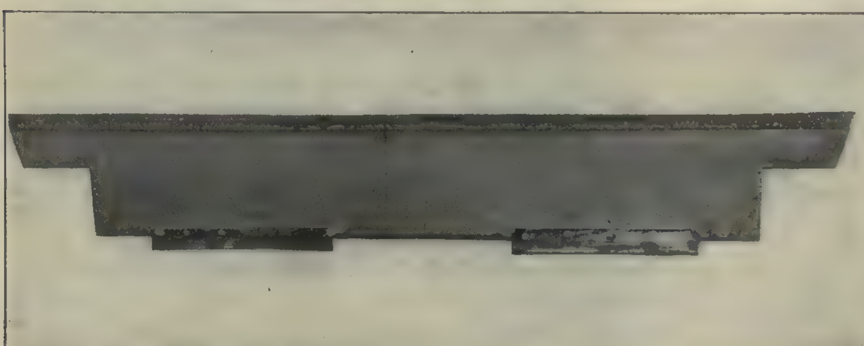


FIG. 3. HEEL BOARD, WITH ANGLE IRONS SECURED IN PLACE BY SPOT WELDING

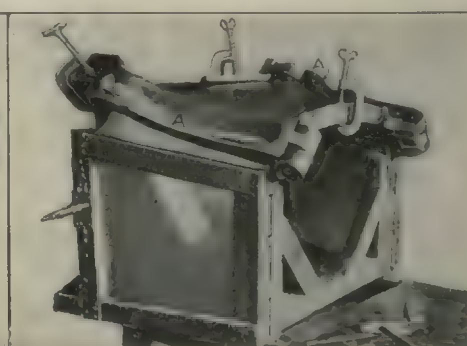


FIG. 4. WELDING THE CORNERS OF THE DASH COWL

Oxyacetylene torches made by the Davis-Bournonville Co. are also employed at the Wilson factory, to obtain a smooth surface in closing the joints of automobile bodies. In Fig. 4 may be seen an automobile-body cowl in the fixture for welding the corners. The steel sheets, which are 0.0375 in. thick (No. 20 gage), are placed in the fixture; and the two clamps A are fastened down, as shown. It will be observed that the clamps are designed with a small opening, or slot, which is utilized to guide the welding torch against the edges of the metal. The result is that a quicker and neater weld is made. After the corners have been welded on the outside, the inside surfaces of the corners are also welded, so that both sides are smooth and a strong joint is secured.

The Human Factor in Industry—II

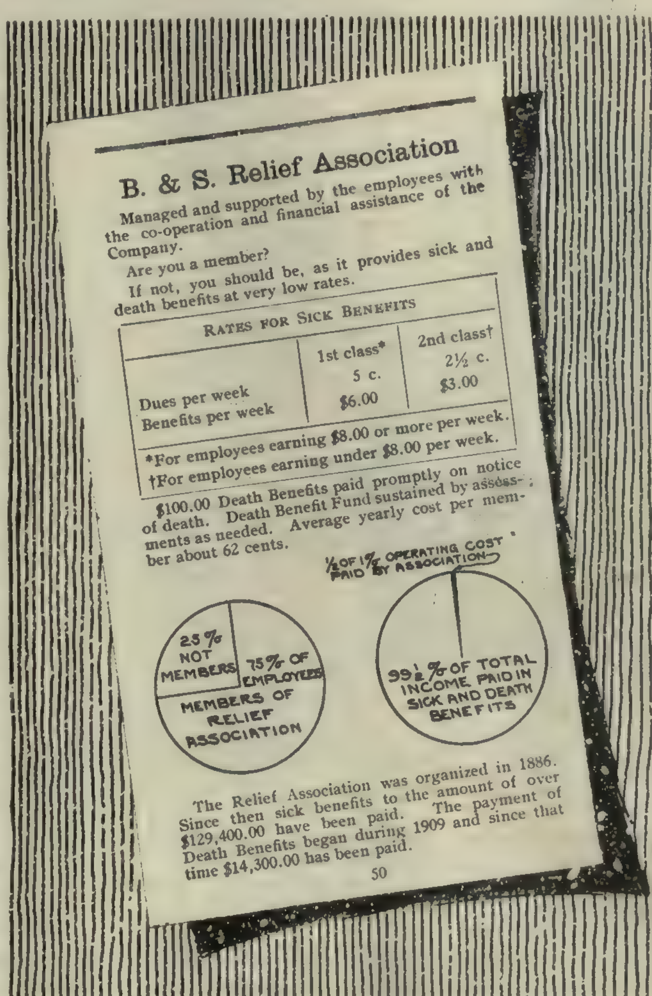
BY LUTHER D. BURLINGAME*

SYNOPSIS—In this concluding installment the author takes up in detail some of the social problems of the manufacturers. These include provisions for financial aid of employees, their education, discipline and the drink question, hiring employees and the "turnover" of the working force.

There is no one element that has more to do with the workman's contentment, spirit of loyalty and readiness to coöperate than the financial one. In the casual salutation, when friends or acquaintances meet, after the question, "How are you?" referring to health, comes the next, "How do you prosper?" or an equivalent, referring to "finances." Among wage earners the question of finances is often uppermost in the mind of the workman and his family, at times of sickness, death and other misfortunes often becoming acute and sometimes seriously interfering with his value to his employer. It has already been pointed out that it is in dealing with such matters as this that we come to the parting of the ways, and the question arises, How far shall the manufacturer, either voluntarily or by law, be required to take up and carry these burdens for wage earners? While it may seem the simplest plan for the state to step in and say by sweeping enactment that compulsory provision shall be made for sickness, out-of-employment, death benefits, etc., it is not believed that such a plan will conduce to the best results under our institutions. Many manufacturers are now voluntarily carrying some form of insurance protection, coöperating with their employees and conducting the business more economically and with the cultivation of a better spirit than would be possible through outside channels. If forced on manufacturers by legislation, as is now being attempted in some states, it would become a heavy burden of expense alike to the manufacturer, the workmen and the taxpayers, due to the increased cost of administration; and all the wholesome influence now resulting from the cordial relations developed in mutually conducting this business would be lost. It seems far better to encourage the extension of the voluntary mutual system and thus conserve the American spirit.

In a recent paper on "Medical Supervision," Charles H. Lemon, M. D., chief surgeon of the Milwaukee Electric Railway and Light Co., said regarding the Employees' Mutual Benefit Association conducted by that company, "It has served as a melting pot into which have been poured the burdens of the employer as well as those of the employee, and out of which has come a record of health, happiness and prosperity."

To further illustrate: At the works of the Brown & Sharpe Manufacturing Co. the voluntary Mutual Relief Association (see Fig. 9) has been in operation for the last 30 years. The membership includes a large percentage of those who have others dependent on them, and where financial difficulties would become acute in cases of sickness or death. This association is managed and supported by the employees, who take great pride in it and are enthusiastic in having its provisions carried out successfully and economically. The company coöperates not only by contributing directly toward the fund, but by providing for the clerical and other work necessary in carrying on the work of the association. All this tends to a cordial and friendly relation between the company and its employees, which would be entirely lost if a compulsory plan were enforced; and at the same time, being voluntary on the part of the workmen, it does not in any way undermine their independence or free will in deciding for themselves what protection they may choose to carry. It would seem a decided step backward to abandon this and come under a compulsory state law. The cost of operating a compulsory plan, toward which the state, the manufacturer and the workmen were all required to contribute, would be much more than the present cost; and this would be a direct burden on industry and the taxpayers, with about equal expense and no greater return to the workmen. Another objection that comes from state-controlled sickness insurance is the



B. & S. Relief Association

Managed and supported by the employees with the co-operation and financial assistance of the Company.

Are you a member?

If not, you should be, as it provides sick and death benefits at very low rates.

Rates for Sick Benefits	1st class*	2nd class†
Dues per week	5 c.	2½ c.
Benefits per week	$6.00	$3.00

*For employees earning $8.00 or more per week.
†For employees earning under $8.00 per week.

$100.00 Death Benefits paid promptly on notice of death. Death Benefit Fund sustained by assessments as needed. Average yearly cost per member about 62 cents.

The Relief Association was organized in 1886. Since then sick benefits to the amount of over $129,400.00 have been paid. The payment of Death Benefits began during 1909 and since that time $14,300.00 has been paid.

50

FIG. 9. LEAF FROM BROWN & SHARPE BOOKLET, "HEALTH AND SAFETY"

The information given is in regard to the Mutual Relief Association

*Industrial superintendent, Brown & Sharpe Manufacturing Co.

advantage taken by the workmen to increase the amount of lost time due to sickness. Thus, Frank F. Dresser, speaking for the National Association of Manufacturers and the National Machine Tool Builders' Association at a recent conference in Washington on social insurance, corroborates what has already been quoted from Mr. Lott. Mr. Dresser said that the average sickness among workers in America has been found to be nine days per year. In Germany the average had risen during its insurance experience from six to nine days per year, and the Model Leipzig Fund average for the years 1888 to 1905 was nine days per year, while in 1912 it was 10.4 and in 1913 was 11.3. On the other hand, in France, where compulsory insurance does not exist, the workmen lose fewer days on account of sickness than they did 10 years ago, and Mr. Dresser asks: "Is health insurance operating therefore to increase or to decrease sickness loss, and which effect will it have here?" Many concerns are now taking out life insurance for their employees without expense or responsibility on the part of the latter. This may be commendable as a matter of charity, but it lacks entirely the helpful influence toward self-reliance and thrift, which comes where the workmen coöperate and where the company in such cases pays a portion, perhaps increasing for length of service and making the conditions of payment, etc., easy for the workmen. The matter of investment is also to be encouraged: and much successful work is now being done by providing savings departments in connection with the factory, so that small sums can be saved with little inconvenience on the part of the employee and with liberal terms as to the payment of interest. Plans for investment are also being combined with insurance, so that the payment of insurance carries with it an investment for the future, which has a growing cash-withdrawal value and on maturity pays back to the depositor his original investment, with good interest returns, in addition to his having had the benefit of insurance protection during the time of the accumulation of the fund. Some of these forms provide annual payments in old age during life.

The fact that "loan sharks" have been so successful in most of the large cities shows that often there is such desperate need of money and, in the words of Frank A. Vanderlip, "our people are such economic illiterates" that they yield to the temptation of securing it even under very unfavorable conditions. Many concerns are now making provision so that loans can be made to responsible employees, to be paid back in small amounts and with low rates of interest. In many cities such work is being carried on through public loan associations, as under the "Morris plan," so that character and past good record become assets in securing a loan, when other security is not available. This work well conducted becomes a business proposition rather than a charity and need in no way compromise the character of the borrower.

The encouragement and backing of building and loan associations on the part of the manufacturers promote systematic saving and home building. In many cases it becomes his direct responsibility, especially when the factory is located in an unsettled neighborhood, to organize and stand back of a home-building project, which, even though operated under outside management, is strengthened and guided by the coöperation of the factory. Some comprehensive and very successful efforts in this direction became part of the record of the conference of the National Housing Association, held in Providence last October. Provisions for education in the factory have gradually been securing a foothold. There are many reasons why such provisions have a place in or in connection with the factory activities and become a direct asset toward training and maintaining a better and more efficient force of employees. Industrial education takes many forms, being especially adapted to be carried on as a part of an apprenticeship system, as the apprentice is under an agreement and in the position of a learner. School instruction in such cases can be applied directly to the line of work in which the apprentice is being instructed (see Fig. 10) and, if rightly conducted, not only imparts knowledge, but aids in developing character and lays a foundation for carrying responsibilities later. Here, again, making use of the public provisions for education can often be of advantage. In such cases the public schools can organize a department for giving the special instruction required in a given trade, so that the boys can attend school alternate weeks and be learning their trade in the shop during the remainder of the time. Or a few hours each week can be given to school, so that in either case the apprentice can continue his school training and avoid the complete break which in the past has come at the time of his leaving school.

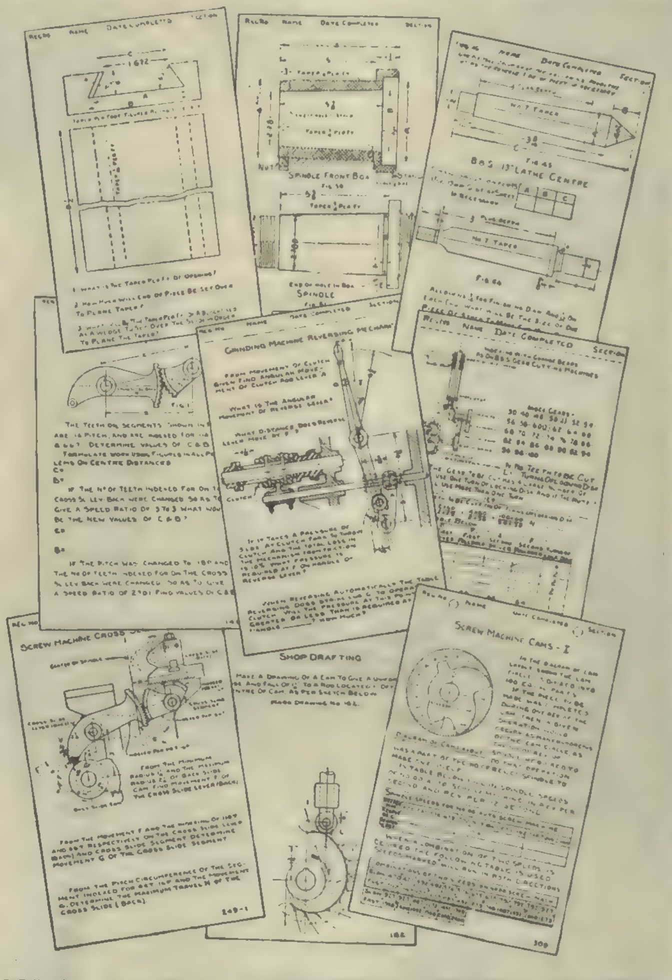


FIG. 10. PRACTICAL SCHOOLWORK DIRECTLY RELATED TO THE TRADE

From the apprentice course at the works of the Brown & Sharpe Manufacturing Co.

During the last few years there has been a great amount of study given to this matter, and it is generally conceded that it is only where some form of apprenticeship or definite training is carried on in each trade that satisfactory results can be obtained in keeping up the standard of workmanship and skill, although all employees do not as yet do their part in carrying out such a plan.

While there may be a certain value in the old-time training "in the school of hard knocks," as illustrated in Fig. 6, it is believed that the value of this old-time training is over-estimated as we see it, rosy in the haze of the past, and that it cannot be compared with modern training, when organized and conducted by uptodate methods in a modern shop.

Division of Apprentice's Work

Such a training, as worked out in one of our large machine-tool building establishments, gives an average of between three and four hours per week for school instruction; and the shop time for the four years' apprenticeship is divided in accordance with the following schedule, the work being taken up practically in the order named:

Departments	Weeks	Departments	Weeks
Lathe Work—centering, turning to gauge, taper turning and boring	50	Scraping	6
Drilling—jigwork, laying out work	12	Planing	12
Milling—plain, universal and vertical indexing, spiral milling and tool grinding	16	Assembling and erecting gear-cutting machines	12
Assembling—in own department	11	Gear cutting—spur gears, 3 weeks; bevel gears, 3 weeks	6
Screw cutting	3	Assembling and erecting screw machines	12
Assembling and erecting millers	12	Tool making	12
Assembling and erecting grinders	12	Repair work	12
Grinding — straight, taper, external, internal, cutters and tools	6	Back in own department	6
		Vacation—2 weeks each year	8

Fig. 11 shows an apprentice doing assembling and fitting work on millers in the establishment mentioned.

Teaching Citizenship and English

With the great influx of foreign workmen and especially those whose native language is not our own, a new problem has arisen in assimilating such men in our factories, as well as in our community life. This has led to the conducting of classes in citizenship and English under the supervision of the factory. In many cities there is close coöperation between the factories and the school department, in order to obtain the results desired among the workmen. The training in citizenship should not only call for loyalty to the state and nation, thus educating the workmen so that they may become good American citizens, but for loyalty to the factory in which the daily bread is earned. There need be nothing "paternal" in the sense in which that word has been here used in guiding and training toward citizenship. Instead it can be a direct step toward independence of thought and action.

No great manufactory can consider that it is established on a stable and safe foundation unless to a great degree the spirit of loyalty and of common interest on the part of the workmen in its employ is created and maintained.

Henry D. Sharpe, speaking recently in the interests of the campaign for citizenship in the industries of Providence, referred to our American shops as having been in the past the main point of contact between the new arrivals to our shores and our American life, serving as a school for adult immigrants, and that it is from impressions and training which they derive from this great school that their ideals of our American citizenship are obtained.

A great problem of the factory is to encourage loyalty and coöperation, while at the same time maintaining the strict discipline necessary for successfully carrying on an organization where many thousands of varied and divergent personalities are brought together. Aside from the rewards that may come in increased wages and promotion, or the penalties that may come from discharge or less severe measures, there are many opportunities where, if tact is used and due allowance made for human nature, discipline can be maintained without personal offense and while still keeping the good will of the employee.

As pointed out in the editorial on page 83, the drink problem is one of the most difficult of all of solution. It requires education (to show its evils) and discipline (to enforce sobriety when education fails). Fortunately, many of our workers are now so located, thanks to the no-license and prohibition wave that is sweeping over the country, that they are not exposed to open temptation. It is interesting to note that the suppression of the saloon is now being taken up by industrial leaders as an economic rather than as a moral issue, as shown by the pronounced position taken by the National Safety Council, and the complete success of this movement will largely solve the problem that the editor of the *American Machinist* justly looks on as so serious.

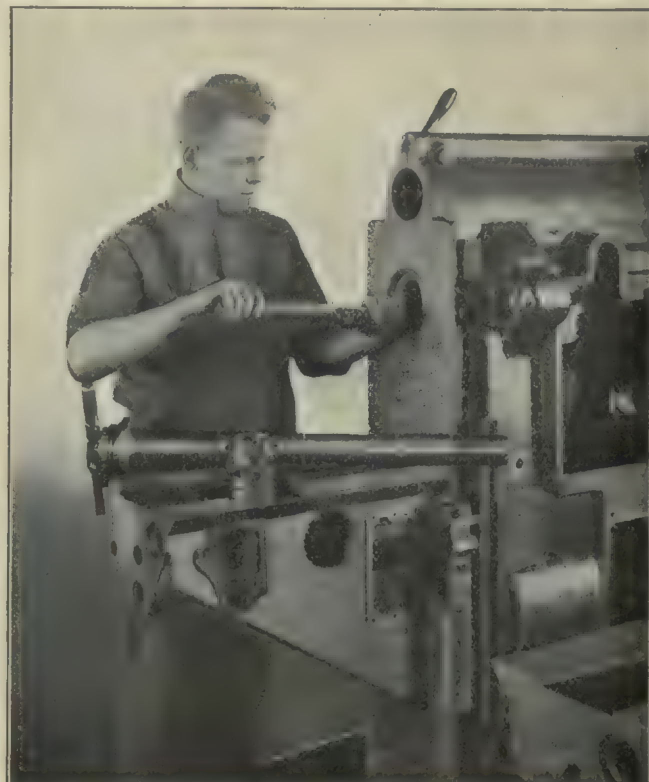


FIG. 11. APPRENTICE DOING ASSEMBLING AND FITTING WORK ON MILLERS

One of 15 different departments in which the apprentice works during his time of service at the Brown & Sharpe Manufacturing Co.'s works

Hiring Employees

The "hit or miss" method of hiring employees is rapidly passing, and in its place is coming the establishment of well-ordered employment departments (see Fig. 12), where applicants can be courteously received, their cases given due consideration, a record made of their qualifications, some test made of their capacity and experi-

ence for the particular work for which they are being considered, and perhaps a preliminary medical examination made, to determine their physical fitness for the work.

The workman comes with something to sell—his labor—and it is no more than his due that he should at least have courteous treatment. Many concerns materially lower the standard of their employees because their methods of hiring are such that self-respecting men will not submit to make application for jobs under the conditions prevailing; and so there are only the less satisfactory to choose from, when adding to the force. Lack of care in hiring also tends to increase greatly the "turnover" of the force, on account of the many misfits.

The facts that the "turnover" in our factories is so great, that there are so many "tramp" workmen, that change of employment is made with so slight an excuse present to us one of the greatest problems of the day.

FIG. 12. EMPLOYMENT BUREAU AT THE WORKS OF THE NORTON CO.

How workmen are received in a way to secure full information regarding their fitness, while at the same time maintaining their self-respect

Various statistics have been compiled to show the great cost to the manufacturer of this excessive "turnover," as well as loss in the long run to the workmen. While these figures are intangible and hard to prove, it is generally agreed that the cost is great and that radical steps should be taken to maintain a more stable force. The first step toward this is in using greater care in hiring employees, and some of the more progressive shops are now giving careful attention to this item of the conducting of their business.

Organization More Important Than Plant

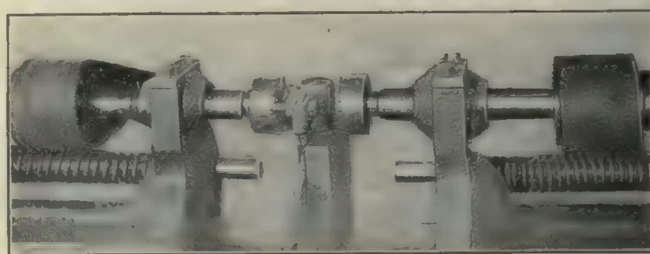
So, after all, it is securing and keeping together the organization and conserving the force of skilled workmen, when it is once trained, that will prove the greatest asset. As was repeatedly pointed out in the recent American Society of Mechanical Engineers session on "Development in Industrial Management" (another session from the one previously spoken of), no matter how refined the systems are, the man should be given greatest importance; buildings, machines and systems could all be replaced, while a satisfactory force of workmen, once scattered, would take years to restore, thus emphasizing the prime importance of the human factor in industry.

Two-Spindle Milling and Drilling Machine

By E. Shaff

The illustration shows a two-spindle milling and drilling machine made from an old trimming lathe. As a miller it is used for milling the sides on square, hexagon and octagon brass nuts from ½- to 2-in. pipe size. The nuts are held on a plug by pulling up on the lever shown, and the milling cutters are fed into the work by foot power. When the pressure on the foot lever is released, the cutters are pushed back from the work by the springs shown under the spindles. The mills turn in the same direction. An output of 100 an hour is possible.

It is used to drill foot and robe rail brackets made of malleable iron. A jig is bolted to the top of a block, and the work is put in bottom side up. The pieces are held in the jig by pulling up on a lever similar to the one shown and are ejected by pushing the lever down. The spindles can be locked separately, so that they cannot be fed too far. It has an output of 400 or 500 an hour of the heavy brackets and 600 or 700 of the lighter ones, depending on the operator. This production is considerably greater than could be secured by ordinary methods, and the expense involved in making the special machine has been more than repaid.



TWO-SPINDLE MILLING AND DRILLING MACHINE

The Lyons Fair

We are in receipt of a 600-page catalog of the Lyons Fair, which was held at Lyons, France, from Mar. 18 to Apr. 1 of this year.

Knowing, as we do, that ever since the outbreak of hostilities France has been concentrating all her man power, all her factories, all her industries—her entire resources, literally—to the successful carrying on of the war, the conception and consummation of a project such as the "Foire de Lyon, 1917," the exhibit that has recently come to a close, is nothing if not miraculous.

No insignificant display was this, but a comprehensive representation on a large scale that drew exhibits not only from practically all the industries of France and her colonies, but from many allied and neutral countries as well. In short, it was a "fair" that would be deserving of more than passing notice even in peace times; but coming as it does now, amid the turmoil and pressure of war, it causes one to question: "How did they do it?" It is a concrete example of how French industry is even now looking toward rehabilitation and increased endeavor after the war.

The machine-tool section of the catalog covers 14 pages, and among the representatives of the industry we notice the names of 15 American builders of machine tools.

Hardness Tests of Brass

By William Kent Shepard*

SYNOPSIS—In this article is recorded an investigation made at the Sheffield Scientific School to test the hardness of brass. Tests were made by both the Brinell and Shore scleroscope methods, and the results were proved in chart form. The thickness of metal tested, with the results obtained, is shown in a table.

This paper is the report of an investigation made in the Mason Laboratory of Mechanical Engineering at the Sheffield Scientific School of Yale University to determine the relation between the ultimate tensile strength of brass and the hardness number as found by the Brinell and scleroscope test.[1] Investigations of a nature similar

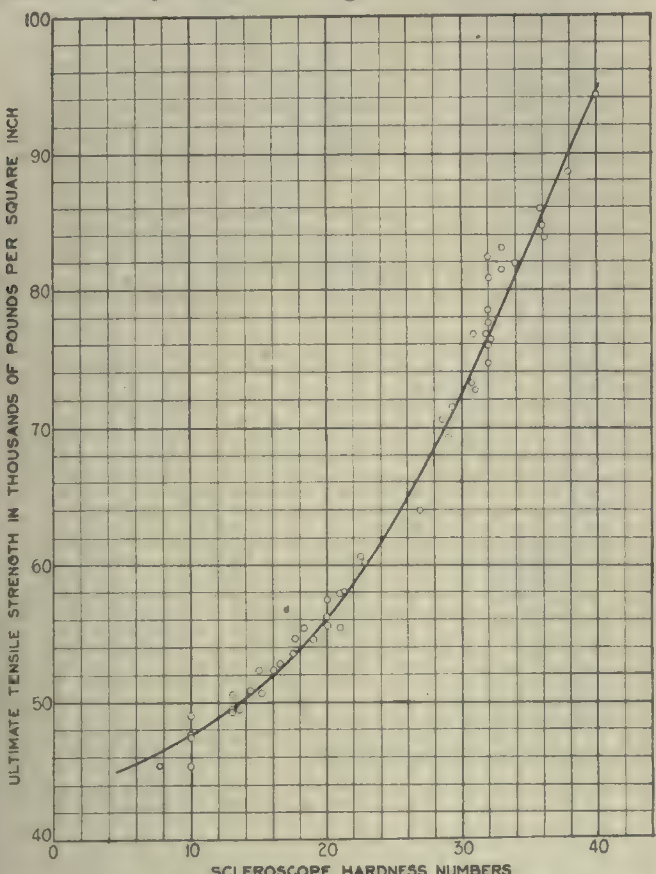


FIG. 1. CURVE FOR SCLEROSCOPE HARDNESS NUMBERS

to the present have been made on treated and untreated alloy and plain steels by Robert R. Abbott[2] and on cold-rolled steel by Shepard and Porter.[3] In each case an approximate straight-line relation was found to exist between the ultimate tensile strength and the Brinell hardness number and the ultimate tensile strength and the scleroscope hardness number.

Annealed brass and brass that had been cold rolled, with reductions in thickness from 4 to 45 per cent. of the original, was used in these tests. The brass was all one grade, about 66 per cent. copper and 34 per cent. zinc, and was furnished the Sheffield Scientific School through the kindness of the Scoville Manufacturing Co.

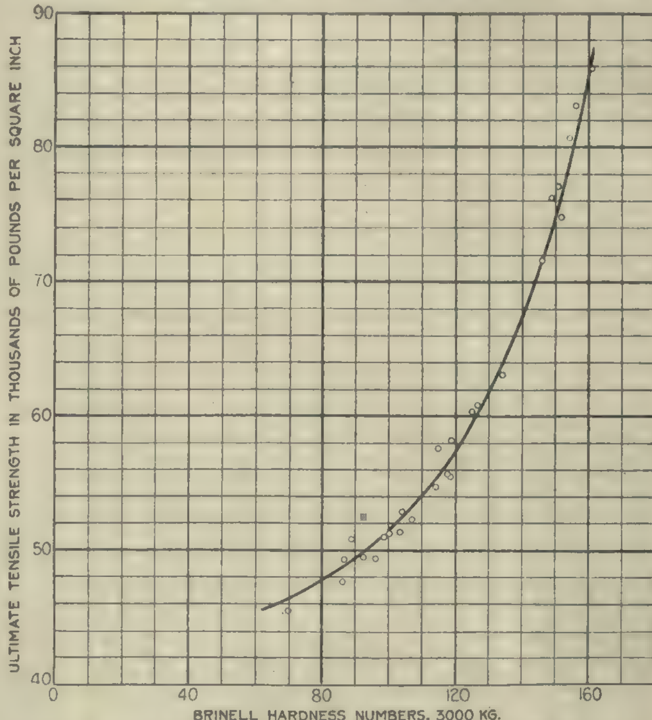


FIG. 2. CURVE FOR BRINELL HARDNESS NUMBERS—3000 KG.

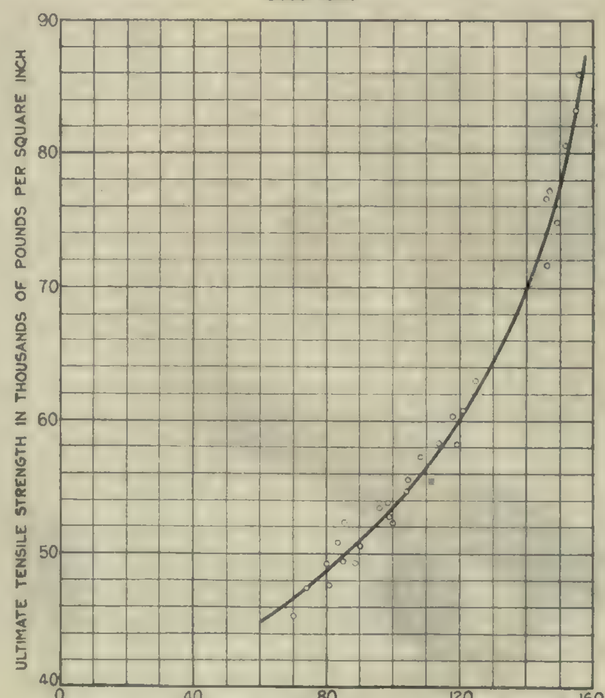


FIG. 3. CURVE FOR BRINELL HARDNESS NUMBERS—1000 KG.

The Brinell tests were made on all the specimens with three different loads to determine if possible the load that would prove to be the best adapted for the brass under all conditions.

*Assistant professor, Sheffield Scientific School, Yale University.

[1]The experimental work for this investigation was done under the author's direction by Daniel Summers as part of his thesis requirement.

[2]American Society for Testing Materials, p. 42, 1915.

[3]"American Machinist," Vol. 42, p. 277.

The Brinell hardness tests were made with a 10-mm. (0.39-in.) steel ball and instantaneous loads of 3000 kg. (6615 lb.), 1000 kg. (2205 lb.) and 500 kg. (1103 lb.); The impressions were made on the ends of the tensile test specimens, and the diameters of these impressions were measured in the direction in which the brass was rolled. The diameters were measured with a comparator reading directly to 0.01 mm., and the hardness numbers were found by dividing the loads of 3000, 1000 and 500 kg. respectively by the spherical areas of the impressions in square millimeters.

In making the Shore scleroscope tests the standard universal diamond-pointed hammer was used. Ten readings were taken on each side of each specimen. Two or three specimens were tested for each different condition of the brass, and the average values are given in the table.

In the accompanying table will be found the results of the tensile, Brinell and scleroscope tests. The Brinell numbers are omitted for specimens so thin that the impression showed through on the opposite side.

ULTIMATE TENSILE STRENGTHS AND HARDNESS NUMBERS

Thickness In.	Ultimate Strength Lb. per Sq. In.	Scleroscope Number	Brinell Number Load in Kg. 3,000	1,000	500	Ratio Brinell to Scleroscope Number Load in Kg. 3,000	1,000	500
0.130	45,450	7.8	.....	.....	.....	...	....	...
0.781	45,350	10.0	70	70	66	7.0	7.0	6.6
0.376	47,450	10.0	78	74	72.5	7.8	7.4	7.3
0.716	47,600	10.0	86	81	74.5	8.6	8.1	7.5
0.061	49,030	10.0	.....	.....	.....	...	....	...
0.717	49,440	13.5	96	89	84	7.1	6.6	6.2
0.231	50,880	14.3	89	83.5	83	6.2	5.8	5.8
0.237	52,450	15.0	93	85.5	85.5	6.2	5.7	5.7
0.704	49,500	13.0	92.5	85	82	7.1	6.5	6.3
0.237	49,340	13.0	86.5	80	82	6.7	6.2	6.3
0.689	50,650	13.0	99.5	90	88.5	7.7	6.9	6.8
0.116	50,700	15.1	.....	.....	.....	...	....	...
0.677	52,350	16.0	107	100	92.8	6.7	6.3	5.8
0.660	52,830	16.5	104	98.5	91.5	6.3	6.0	5.5
0.652	54,730	17.8	114	104.5	103.5	6.4	5.9	5.8
0.214	53,650	17.5	101	96	101	5.8	5.5	5.8
0.216	53,850	17.5	103	98.5	98	5.9	5.6	5.6
0.054	54,650	19.0	.....	.....	.....	...	....	...
0.627	55,550	18.3	118.5	111.5	106	6.5	6.1	5.8
0.192	55,650	21.0	118	104.5	102.5	5.6	5.0	4.9
0.052	55,600	20.0	.....	.....	.....	...	....	...
0.054	56,200	20.0	.....	.....	.....	...	....	...
0.106	55,700	20.0	.....	.....	.....	...	....	...
0.207	57,600	20.0	115	108	107	5.8	5.4	5.4
0.622	58,200	21.3	124	119	116	5.8	5.6	5.5
0.201	58,300	21.0	119	113.5	111	5.7	5.4	5.3
0.593	60,090	22.6	127	121.5	119.5	5.6	5.4	5.3
0.194	60,350	22.8	125	118.5	118	5.5	5.2	5.2
0.577	63,050	25.0	134	125.5	122	5.4	5.0	4.9
0.046	64,000	27.0	.....	.....	.....	...	....	...
0.082	69,450	29.0	.....	.....	.....	...	....	..
0.042	70,850	28.5	.....	.....	.....	...	....	...
0.501	71,650	29.1	146	146	138.5	5.0	5.0	4.8
0.041	72,580	31.0	.....	.....	.....	...	....	...
0.040	73,030	30.8	.....	.....	.....	...	....	...
0.486	76,300	32.0	149	146.5	143	4.7	4.6	4.5
0.477	77,000	31.0	151	147.5	143.5	4.9	4.8	4.6
0.039	76,750	32.0	.....	.....	.....	...	....	...
0.435	74,880	32.0	151.5	149.5	142.5	4.7	4.7	4.5
0.040	77,600	32.0	.....	.....	.....	...	....	...
0.077	78,700	32.0	.....	.....	.....	...	....	...
0.437	80,700	32.0	154	152.5	147.5	4.8	4.8	4.6
0.137	82,350	32.0	.....	.....	.....	...	....	...
0.038	81,700	33.0	.....	.....	.....	...	....	...
0.036	81,730	34.0	.....	.....	.....	...	....	...
0.420	83,250	33.0	156	155	150	4.7	4.7	4.6
0.066	84,900	36.0	.....	.....	.....	...	....	...
0.053	83,770	36.1	.....	.....	.....	...	....	...
0.399	85,850	36.0	161	155.5	149.5	4.5	4.3	4.2
0.057	88,700	38.0	.....	.....	.....	...	....	...
0.049	93,100	40.0	.....	.....	.....	...	....	...
0.023	94,230	40.0	.....	.....	.....	...	....	...

In Fig. 1 the scleroscope hardness numbers are plotted as abscissas and the corresponding ultimate strengths as ordinates.

In Figs. 2, 3 and 4 the Brinell numbers are plotted as abscissas for loads of 3000, 1000 and 500 kg. respectively, and the corresponding ultimate strengths as ordinates.

In Figs. 5, 6 and 7 the scleroscope numbers are plotted as abscissas and the Brinell numbers as ordinates, as determined for the loads of 3000, 1000 and 500 kg. respectively.

In Fig. 1 it is seen that the relation between the scleroscope hardness number and the ultimate tensile strength is parabolic for brass and not a straight-line relation, as in the case of steel. In Figs. 2, 3 and 4, in the same way, a parabolic relation is found to exist

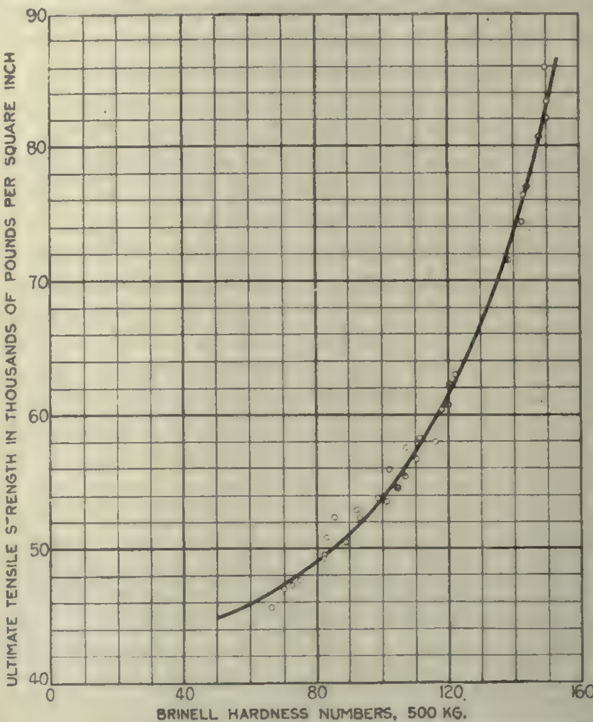


FIG. 4. CURVE FOR BRINELL HARDNESS NUMBERS—500 KG.

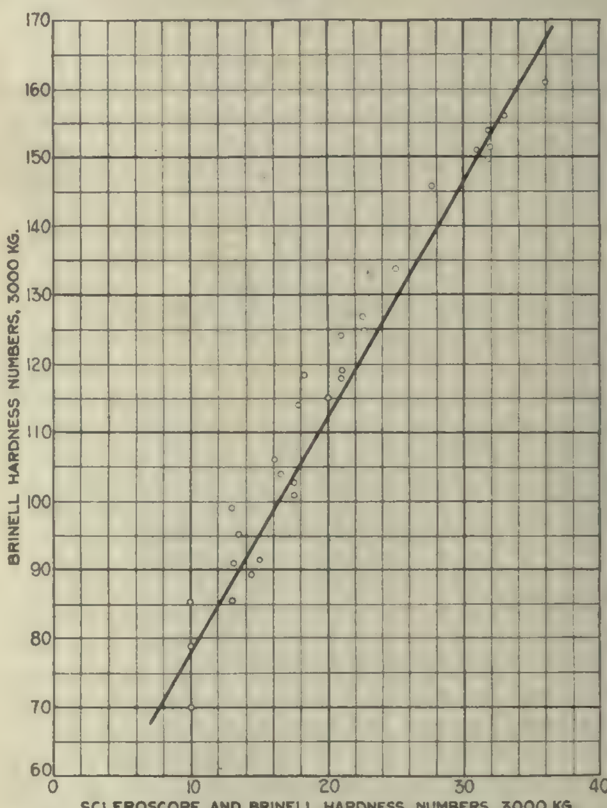


FIG. 5. CURVE WITH SCLEROSCOPE AND BRINELL HARDNESS NUMBERS—3000 KG.

between the Brinell hardness number when determined by each different load and the ultimate tensile strength of the brass. Smooth curves have been drawn through the points in Figs. 1, 2, 3 and 4. By means of these curves

one can determine approximately the ultimate tensile strength of any specimen of brass of the composition used in this investigation, if the scleroscope or Brinell hardness number is found for the specimen.

Figs. 5, 6 and 7 show the relation between the scleroscope numbers and the Brinell numbers as determined

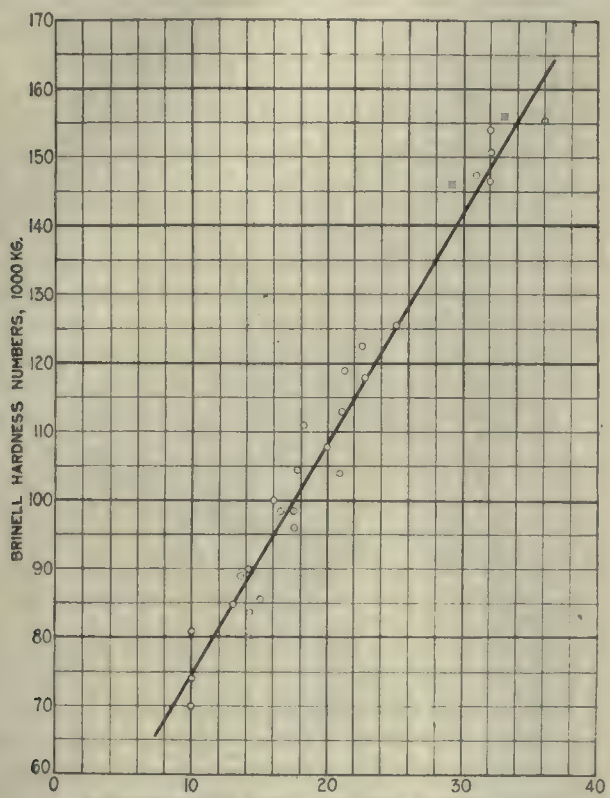


FIG. 6. CURVE WITH SCLEROSCOPE AND BRINELL HARDNESS NUMBERS—1000 KG.

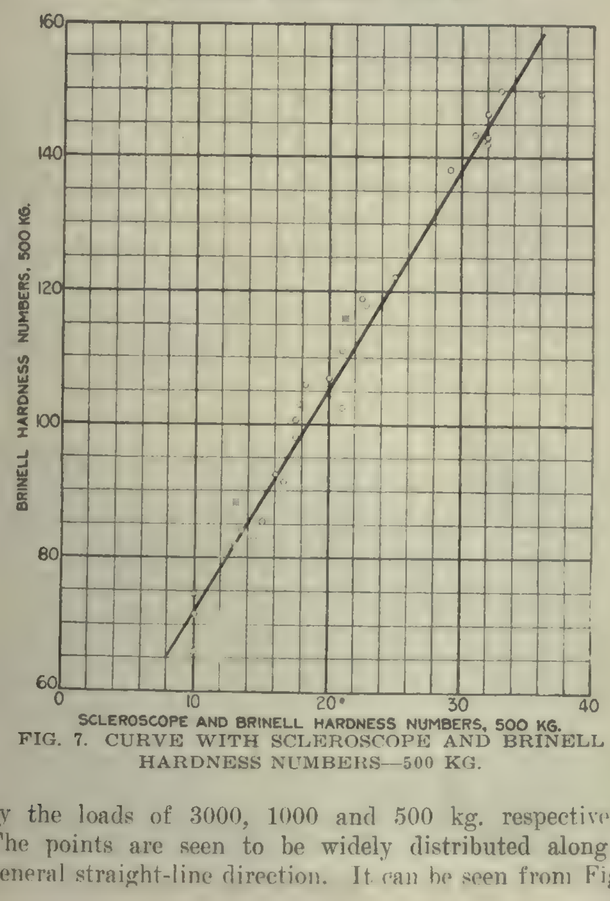


FIG. 7. CURVE WITH SCLEROSCOPE AND BRINELL HARDNESS NUMBERS—500 KG.

by the loads of 3000, 1000 and 500 kg. respectively. The points are seen to be widely distributed along a general straight-line direction. It can be seen from Figs. 5, 6 and 7 as well as from the table that no constant relation exists between the scleroscope and the Brinell hardness numbers for brass.

The following facts were evident in working with the different loads for the Brinell tests: The 3000-kg. load made a very large depression, which was liable to show through on the opposite side of the specimen. A great deal of difficulty was encountered when the diameter of the 500-kg. impression was measured. These impressions were not always circular, and for the cold-rolled brass the indentation was so small that the diameter could not be accurately measured. The 1000-kg. load was by far the best to work with and gave satisfactory impressions for all specimens of the brass over 0.2 in. in thickness.

Cost-Plus Basis for War Supplies

BY C. J. MORRISON

Government orders for supplies, munitions, ships, airplanes, etc., to be paid for on a cost-plus-percentage basis, will bring up many questions that should be answered at an early date.

The first question is, quite naturally, "What is cost?" The United States Government has an idea of costs and a method of accounting that are entirely different from the costs and accounting of commercial concerns. The Government uses no burden charge, but considers the cost of an article to be labor plus material. For instance, when the cost of a rifle manufactured at an arsenal is given out as $12, it means that the labor and material cost $12. The real cost of the rifle is probably about $30. Heretofore when commercial concerns have submitted bids on supplies for the Government, the higher efficiency of such concerns has enabled them to compete with the so-called costs of the Government.

However, now that various articles are not to be furnished at a flat figure, but for cost plus a percentage for profit, the question "What is cost?" must be answered. Obviously the burden must be included in the cost, or the commercial concerns supplying the Government will not only fail to make a profit, but will lose money and may go bankrupt.

Even when a decision has been reached to allow the addition of a burden charge, the question is only partly answered; for a determination must be reached as to what shall enter into the burden. Unfortunately no arbitrary set of rules, to apply in all cases, can be used. For example, what depreciation on machinery shall be allowed? One plant may be equipped with special machines that will be practically useless at the end of the war, while another concern may use its regular equipment, which will be only a little less valuable at the close of the war than at present.

Evidently each plant must be considered individually. There is lots of work here for the best accountants of the modern school, and they should be set to work on the problem soon.

THE VEXING PROBLEM OF INTEREST

Another vexing problem is that of interest on the investment. On the one hand, it seems that a concern should be allowed interest on its investment; but, on the other hand, should it also be allowed to make a profit on this interest? This question cannot be answered offhand,

although it appears easy to do so. Consider two extreme cases.

Suppose one plant has the best equipment obtainable, but has insufficient working capital and must borrow considerable money. The interest paid represents a real manufacturing cost, and probably no one would deny that it should be included in the costs. Shall a profit on this interest also be allowed? If so, the more money borrowed, the larger the profit. Just to complicate the case, suppose the money was borrowed from the officers of the concern, shall they be paid interest as individuals and a profit as officers?

On the other hand, suppose a plant with a miserable equipment, illy adapted to the work and badly in need of repairs, but with so much money that it does not need to borrow. Manufacturing costs will be high, but no interest is paid. Shall the plant be allowed a profit on the high costs, interest on the investment and a profit on the interest?

There are a vast number of combinations of these elements, but nothing would be gained by discussing them as the one given illustrates the tangle and shows the difficulties.

Thin and Padded Official Salaries

The question of salaries of officials also arises to complicate the problem. Practice varies tremendously in regard to salaries. In one well-known concern the president, who devotes his entire time to the business, draws a salary considerably lower than the one paid his superintendent, while in another concern the president, who devotes less than a quarter of his time to the business, draws a salary far larger than the business warrants. In determining costs, shall these actual salaries be used or shall arbitrary standards of salaries be adopted?

Another nice question is, Shall the same percentage of profit be allowed on both labor and material? Here again the answer is complicated. Some products take a small amount of material and a large amount of labor, while other articles require very little labor on a great deal of material. For instance, the firing mechanism of a rifle has little material but much labor, while the nets for catching submarines have a small amount of labor and a great deal of material.

Events having led to war, everyone will be called upon to help pay the bills; therefore, the size of these bills is of interest to all. When supplies are furnished on a basis of cost plus a percentage for profit, a premium is placed on high costs. The more an article costs, the greater the profits will be.

An Inducement to High Costs and Inefficiency

The whole scheme of contracting on a basis of cost plus a percentage is wrong, not only from the standpoint of the tangle of questions involved, but from the unavoidable fact that high costs are made desirable.

There are in the country today a number of plants that have done much business on a cost-plus-percentage basis. These plants are notoriously badly equipped and inefficient in management. A short time ago a high official in one of these plants made the blunt statement, "Why should I improve the plant and decrease profits?"

Contracts should be let on a sliding-scale basis of prices. The first order should be at a comparatively high figure in order to allow the plants to get under way, and the price should be gradually reduced until a minimum is reached. Moreover, the Government should supply a corps of experts to assist the manufacturers in solving their problems and in perfecting their organizations. An exchange of ideas should be effected, so that improved methods developed in one plant could be adopted in others.

An objection will be made that manufacturers cannot tell in advance what an article will cost. This is all humbug. How have they determined costs for commercial work? How do shipbuilders make bids on battleships and come out within a few hundred dollars of each other? Moreover, jobbing shops are regularly bidding on jobs the like of which they have never before made.

Proper Estimating by Competent Men Will Determine Costs in Advance

It is perfectly possible to determine the costs in advance if the costs are properly estimated and not trusted to guesses.

Shortly after the start of the present war, estimates were made and bids submitted for all kinds of war supplies. Several men figured on the cost of manufacturing a certain rifle. They spent over two weeks on the job, determined exactly how each operation should be performed and furnished an estimate that was within a few cents of the actual cost of the rifle. Costs of shrapnel, high-explosive shells, gun carriages, saddles, machinery, etc., were determined in the same careful manner. All of the estimates proved to be good.

Many manufacturers have not in their employ men who can make such estimates, therefore let the Government furnish a staff of competent estimators.

The cost-plus-percentage method is a lazy and an expensive one that would be a disgrace to the United States if followed.

Summer Meeting Place of Society of Automotive Engineers Changed

Because of war conditions, the summer meeting of the Society of Automotive Engineers, scheduled to be held the last week in June at Ottawa Beach, Lake Michigan, has been canceled by the council of the society, as extensive canvass showed a general feeling that few of the members could afford the time. Instead, it was voted to spend one day on the summer meeting and hold it in Washington, D. C., on Monday, June 25. The activities of the society have not been reduced, as such announcement might tend to convey. Instead of the large meeting there will be several smaller and more specific ones.

The meeting of the Standards Committee in Cleveland on May 3 increased greatly in importance this year. Besides the 140 men on the various divisions of this committee a call was made to the members at large of the society to attend, as the work of standardization is of greatest importance.

It is possible that a special meeting will be required by the new branch of marine engineering recently amalgamated with the society.

Spiral Bevels on the Universal Miller

A correspondent would like to know how to cut a spiral bevel on a universal miller. If any of our readers have accomplished this, the information will be welcomed.

Making Curtiss Camshafts and Connecting-Rods

By Fred H. Colvin

SYNOPSIS—Continues the methods of building the smaller Curtiss airplane motors, begun in a previous issue, and takes up some of the details and the manner in which they are handled. Some interesting testing fixtures and gages which have been developed from time to time are included.

The camshaft on the Curtiss airplane motor is an interesting machining job, as a special form of cam is made use of for lifting the valves. These cams are double, the central portion operating the intake valves and the outer ends the exhaust. Something of the construction can be gathered from Fig. 2, which shows a camshaft being

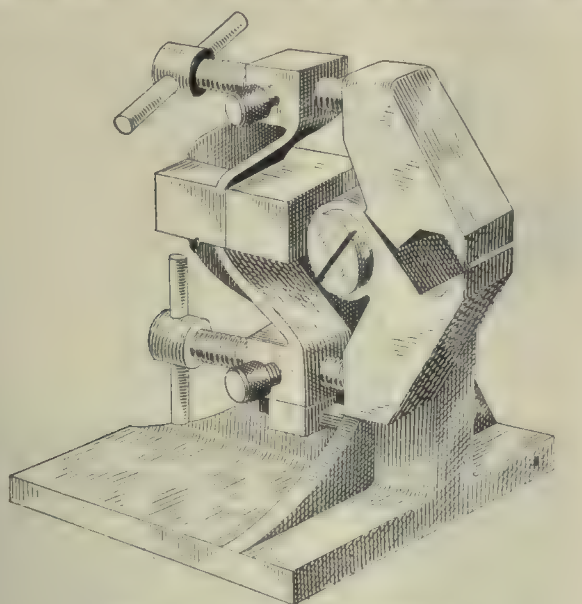


FIG. 1. CAMSHAFT SUPPORT

ground on a Bath grinder. The camshaft support used while the cam is being turned is shown in Fig. 1 and needs no explanation.

After a camshaft is cut to length (about 36 in.), it is drilled from each end on a Jones & Lamson machine, twist drills being employed to produce a $\frac{3}{8}$-in. hole the entire length of the camshaft. This not only insures lightness, but also forms a part of the oiling system. The camshaft is then rough-turned between cams, the journals are rough-turned, and by means of a special index head the cams are milled on a knee type miller, a two-lip end mill being utilized for cutting out the center cam. The portions to be turned are either copper plated or coated with enamelite, to prevent hardening at these points.

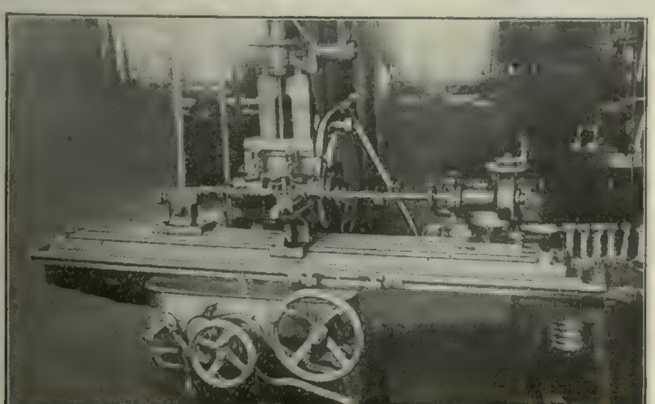


FIG. 2. GRINDING CAMSHAFT

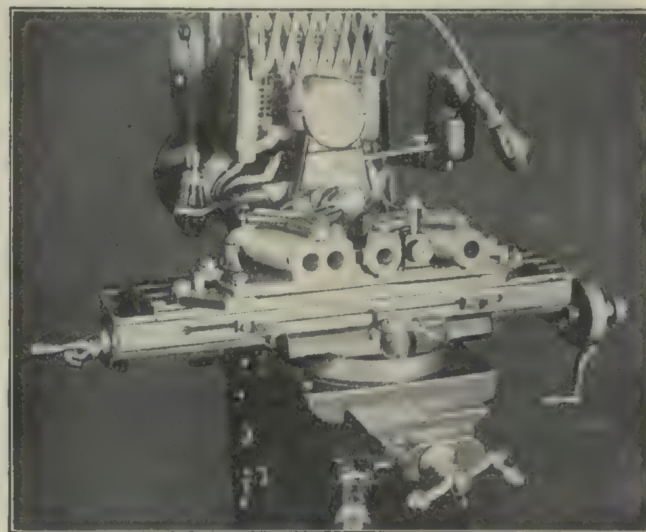


FIG. 3. MILLING INTAKE Y FLANGES

After carbonizing, the shaft is inspected in a lathe for concentricity, straightened in a press, the oil holes drilled out and the ends tapped. The shaft is then ground all over, after which it is ready for use. The grinding allowance is 0.0025 inch.

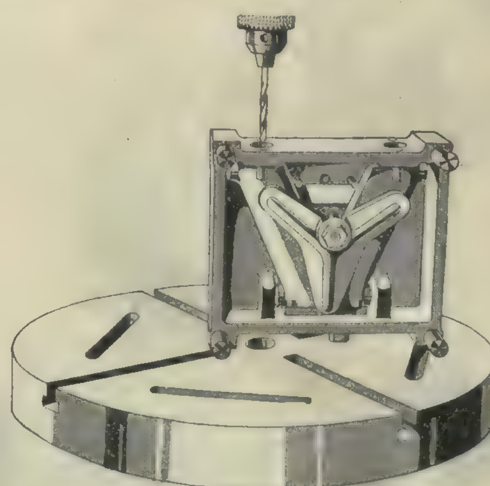


FIG. 4. DRILLING THE INTAKE Y'S

The flanges of the intake Y's are milled as illustrated in Fig. 3. They are clamped in place by a three-point clamp with a slot that fits around the central bolt, so as to be adjusted easily and quickly. The Y is positioned by the central block shown, the round portion being used as a

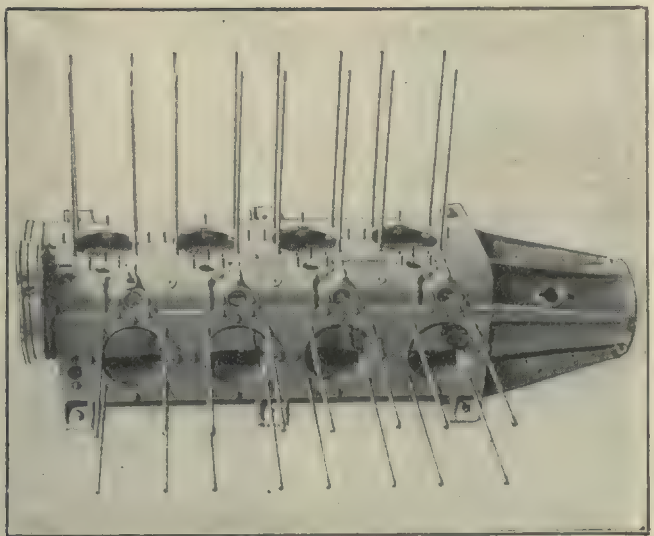


FIG. 6. CYLINDER BASE WITH STUDS IN PLACE

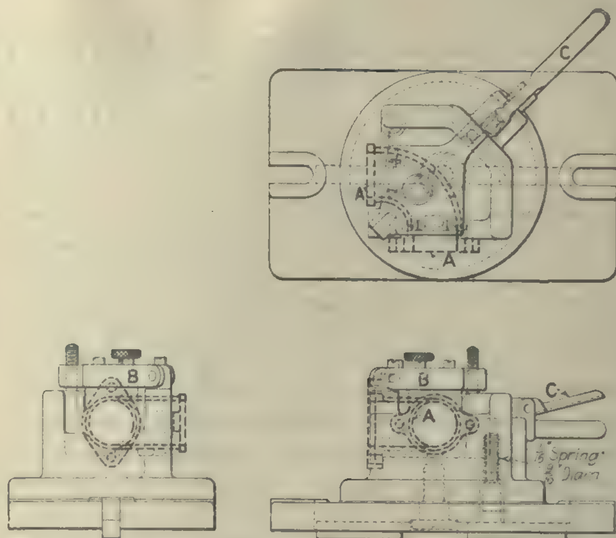


FIG. 5. MILLING FIXTURE FOR MANIFOLD ELBOW

gage for setting the milling cutters. The bolt holes in the flange are drilled in the open-sided jig shown in Fig. 4, the same sort of a clamp being used in this case. This gage can also be rolled over on its side, as is shown by the feet at the corner. Another interesting fixture in connection with the motor attachments is that for milling the manifold elbow, and pictured in Fig. 5. This is an indexing fixture, the elbow being held at *A* by means of a suitable strap *B* and indexed to 90 deg. by the latch *C*. This indexing must be held to within very close limits, the tolerance being only 0.007 in. Coming to the motor assembly, Fig. 6 shows the engine base with all studs in place, including four long studs and four short studs for each cylinder as well as the short studs that hold the valve plunger guides in place. The long studs fit around the cylinder, a pressed-steel bracket

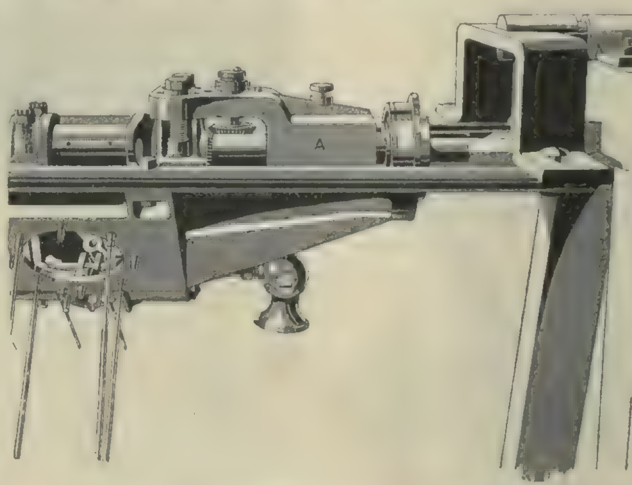


FIG. 9. TESTING GEARS IN POSITION

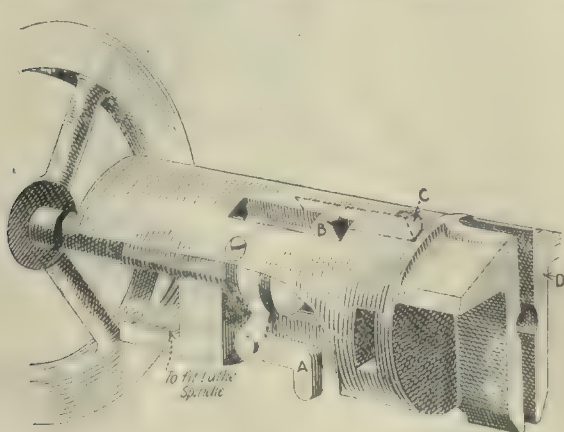


FIG. 11. MANDREL FOR PISTON

in the form of a cross going over the top of the cylinder and holding it in place, while the four short studs hold the cylinder by the lower flange. The long studs prevent the top of the cylinder from flying off if, for any reason, a bad crack should develop around the barrel or head. The oil-pump gears require very careful attention, particularly as the main driving gear is an integral part of the crankshaft. Fig. 7 shows this gear being cut on the end of a crankshaft and the type of fixture used for supporting it during the cut. The gear that meshes with the crankshaft gear is tested carefully in the fixture shown in Fig. 8, the large gear in the illustration representing that on the crankshaft. As can be seen, the driven gear is mounted on an adjustable slide that has a micrometer cross-adjustment, so that different depths of mesh can be tested accurately. Fig. 9 shows how the gears are tested in position and the holes for the oil pump drilled to secure the best alignment of the driving

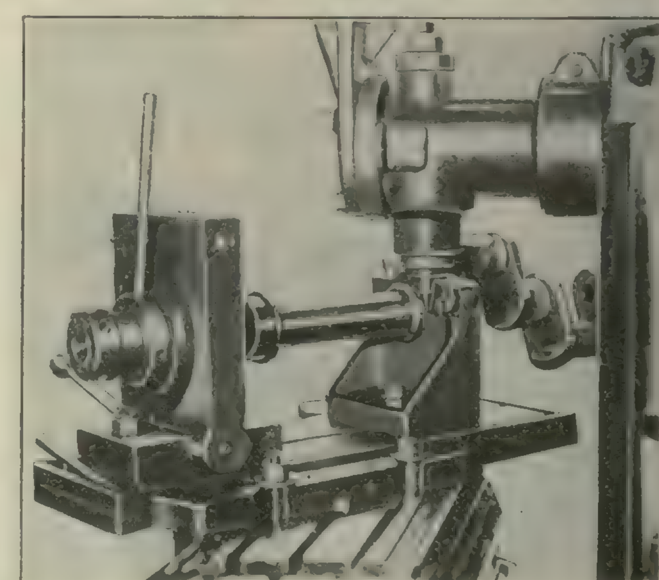


FIG. 7. CUTTING BEVEL GEAR ON CRANKSHAFT

gears. Here the engine base, shown in Fig. 6, is mounted in the assembling stand with the crankshaft in place. The substantial fixture *A* carries the gear, and the front end is bolted to the bearing cap, which permits careful adjustment to be made so as to secure the best running posi-

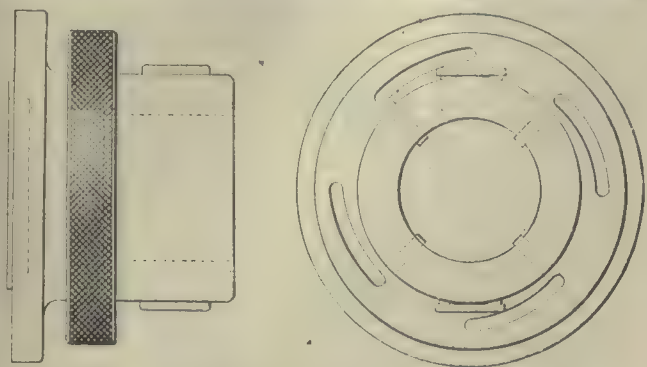


FIG. 10. CHUCK FOR HOLDING PISTONS

tion for the gears. Fig. 6 also shows the ball thrust bearing in place, as well as the outer flange that covers it.

First the pistons are rough-turned on a special chuck, which holds them by the inside of the lower end, or skirt. Then they are placed in a special chuck in a Jones & Lamson machine, and the piston pin-hole is bored at right angles to the outside. The next operation is to bore the bottom and face the open end, this being done in the special chuck shown in Fig. 10. The piston is centered by means of the four cam-operated jaws, but is held by a pin that passes through the bosses and the piston-pin holes. Next comes the turning of the outside, which is done on Jones & Lamson machines. A special draw-bolt mandrel is used, the details of which are shown

FIG. 12. WEIGHING FIT OF PISTON PIN

FIG. 14. LINING UP RODS NOT EXACTLY SQUARE

in Fig. 11. This mandrel centers the piston with a three-point support, as seen in the end view, and at the same time centers the open end of the piston by the three jaws, *A*, *B* and *C*, which practically are bell cranks operated by the draw bolt through the lathe spindle. The three-

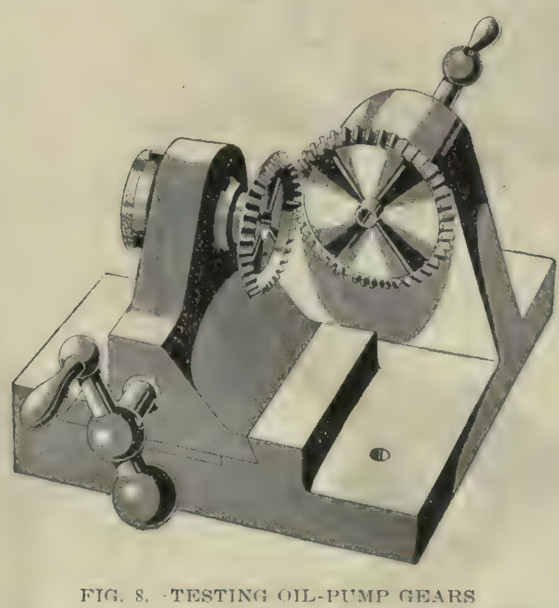


FIG. 8. TESTING OIL-PUMP GEARS

cornered block *D* supports the front end of the piston, its peculiar shape permitting it to slip between the piston-pin bosses on the inside. The piston is then turned and the head crowned by a special former. For grinding the piston, carborundum wheel 365-M has been found very

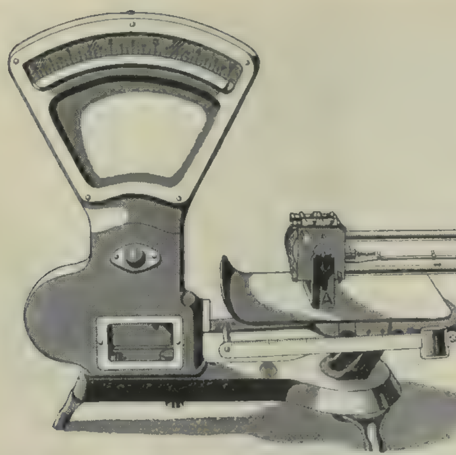


FIG. 15. WEIGHING ENDS OF A CONNECTING-ROD

satisfactory. An allowance of 0.008 in. for expansion has been found to be about right.

The increased expansion of aluminum over cast iron makes it necessary to give a special allowance for the piston-pin bearing in order to prevent too great play when the piston has been heated by long running. The bearing for the piston pin is directly in the aluminum bosses of the piston, an arrangement that has been found to work out well in service.

In order to secure the proper running fit when the piston is hot, it is necessary to make the piston pin a snug fit when the piston is cold; and to be sure that this fit is correct in each case, the practice of weighing the friction caused by the fit has been adopted. The method of doing this is shown in Fig. 12, in which the piston pin is as-

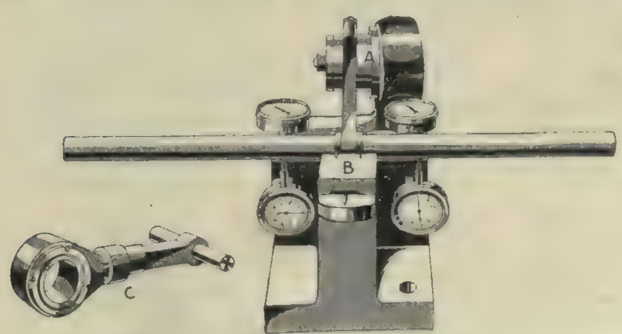


FIG. 13. TESTING SQUARENESS OF CONNECTING-RODS

sembled with a connecting-rod. A spring balance is employed in order to learn how much force is necessary to turn the pin in its bearing in the piston. A pull of 12 lb. is required to secure the fit that has been found best for this work.

The method of testing the squareness of the two holes in the connecting-rod is shown in Fig. 13. Here the rod is slipped into place over the stud *A*, which represents the crankpin, while the upper end with the long test bar in place is swung down so as to contact with the four Ames dial gages shown. These dials indicate any variations from parallel or if there is a twist between the two holes. In addition to this the gage *B*, by means of the pointer shown, shows the relation of the ends of the piston-pin bearing to the crankpin bearing. A master connecting-rod for testing the correctness of these gages is illustrated at *C*.

If it is found necessary to make a slight correction in the alignment of the two holes, it can be done without removing the rod from this fixture, as shown in Fig. 14, the fixture being made rigid and substantial for this purpose. Fig. 14 also shows the five gages and the master rod employed for inspection purposes.

The method of weighing the two ends of the connecting-rod is shown in Fig. 15. The rod is placed in a special holder, which consists of two studs connected by the rod shown and provided with a knife-edge at each end located so as to coincide with the centers of each hole in the connecting-rod. These knife-edges rest on the blocks *A* and *B* and permit the rods to be weighed accurately.

Fig. 16 illustrates a device for testing the strength of each valve spring so as to have it correct and uniform. The spring is placed in the testing yoke at *A* and compressed by means of the block *B*, which is operated by the lever *C*. This block is connected to the spring balance *D*. When the block *B* is swung against the end of the spring, it forces the yoke to the right and registers the amount of pull on the spring balance *D*. The movement of the

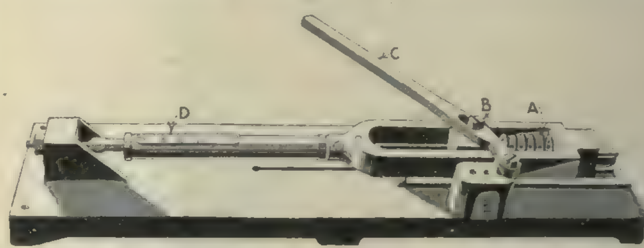


FIG. 16. TESTING STRENGTH OF VALVE SPRING

yoke is also graduated, so that the inspector easily sees if the spring has the correct amount of compression at the distance it should have moved; in other words, if it requires the correct amount of pressure to compress the spring the proper distance.

Various methods are employed for holding the propeller hub to the crankshaft, one of these involving the use of four splines milled on the shaft. This overcomes the danger of loose keys. The method of inspecting these splines is shown in Fig. 18 and consists of a ring gage *A* with three micrometer screws *B*, *C* and *D*. The two horizontal openings in the gage, *E* and *F*, are made of the proper width to fit the splines. The vertical openings, *G* and *H*, each have a side clearance of $\frac{1}{32}$ in., which allows micrometers *B* and *C* to gage the outside diameter of the splines and micrometer *D* to show exactly how the width or thickness compares with the desired standard dimensions.

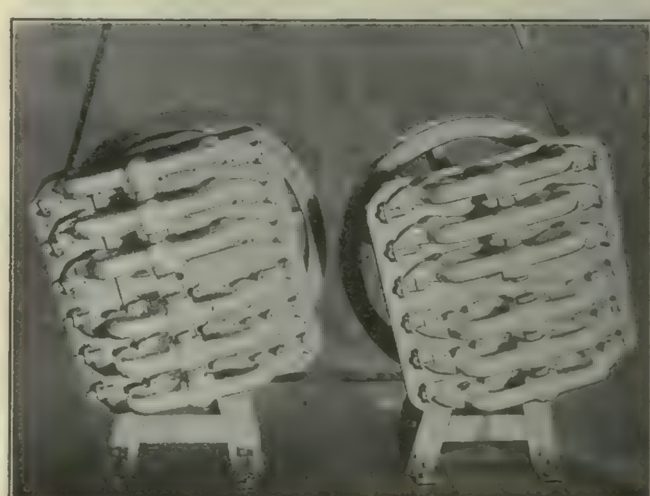


FIG. 17. TUMBLING INTAKE MANIFOLDS

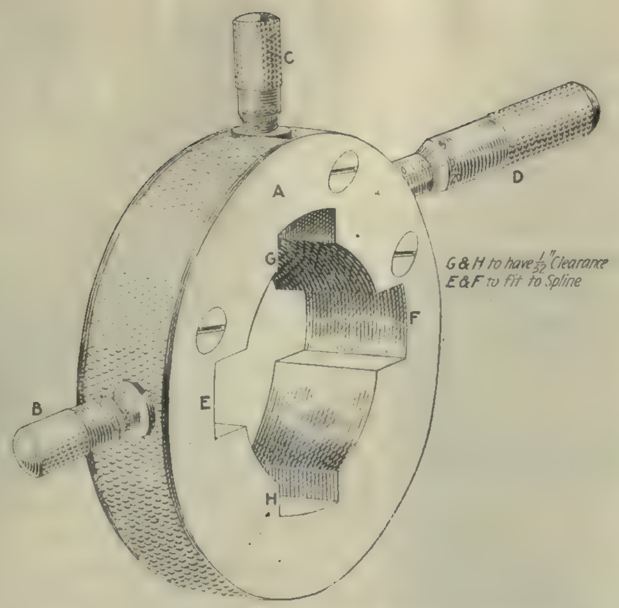


FIG. 18. MEASURING CRANKSHAFT SPLINES

Earlier in this article reference was made to the former method of cleaning crankcase castings, by tumbling them. This method is still used for the intake manifold, the method being illustrated in Fig. 17. Instead of putting the whole casting in a tumbler of the old type, six castings are clamped onto a revolving board, as shown, one end slipping under a staple and the other fastening by a hook. Each manifold is loaded with tumbling jacks, broken files and steel balls, the outlet being closed by a plug, as shown. The boards are then revolved for an hour or more, which loosens the sand and removes all the snags from the manifold passages.

After the motors are assembled, they are run for 10 hours on the testing stand shown in Fig. 19. This stand provides means for weighing both the propeller thrust and the torque, by means of the spring balance and scale shown. After this 10-hour run the motor is taken down and gone over to note the condition of each bearing surface and to make sure that no oil holes are clogged. It is then reassembled and run on the stand for 2 hours, after which, if its performance is satisfactory to the inspector, it is ready to be shipped out to its destination.

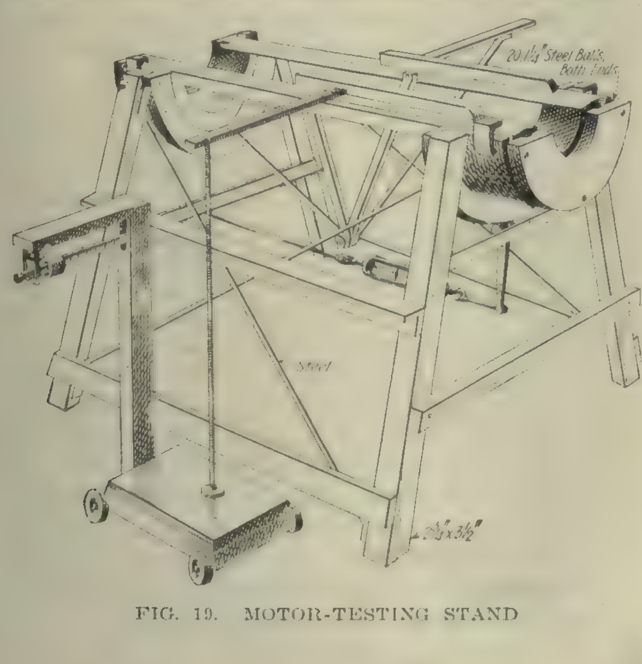


FIG. 19. MOTOR-TESTING STAND

Russia and Its Opportunities for America*

By R. Poliakoff

The Russian Empire is the largest of all countries. It comprises an area of 8,417,115 square miles, or approximately one-sixth of the land surface of the world. The territory of Russia is equal to four times the size of the European continent and is more than double the area of the United States, including all of its island possessions.

In population Russia is surpassed only by China and India. The population on Jan. 14, 1913, was authoritatively estimated at 174,099,600, which compared with 128,123,270 reported by the 1897 census shows an increase of 35 per cent. in 16 years.

Considered in relation to its undeveloped natural resources, Russia's debt and current taxation, including the additional burden of the war, are the lowest of the belligerent countries.

Agriculture, forestry, cattle raising and mining normally constitute the backbone of Russia's economic system. Three-fourths of the population are engaged in farming, and Russia is known as the granary of the world, normally producing a larger excess of foodstuffs over its own needs than any other country.

Greater Part of Imports from Germany

Out of Russia's total import figures of $600,000,00 in 1912, 52 to 55 per cent., or $325,000,000 worth of goods, came from Germany alone. It will be of interest to note the elements which composed this item and to consider by what means Germany gradually gained her economic hold on the Russian market. One of the main factors which produced the increase of German trade with Russia, an increase from 40 per cent. in 1870 to 55 per cent. in 1912, was the Russian-German Commercial Treaty of 1904. This treaty was forced upon Russia during the Japanese War. When Germany set before Russia the dilemma, either to conclude with her a treaty selfishly favorable to Germany or to see Germany mobilize her armies on Russia's western frontier while Russia was busy with Japan, the Russian Government had to choose the first alternative. The treaty of 1904 turned out to be so detrimental to Russia's interests that the question "Is Russia to continue to be a German colony?" was repeatedly raised in Russian economic literature. And in all fairness to Germany, one must say that she did not fail to take advantage of this treaty, and year in and year out flooded Russia with all kinds of manufactured goods. The result of this deluge of German products proved to be most disastrous for Russia.

It would be unjust, however, to suppose that the Russian-German commercial treaty was the only condition that determined the German success in dealing with Russia; methods of trade adopted by Germany were equally momentous. If the question of choice as between German and, say, English goods were merely a matter of quality and no other factors would have to be considered, then the English would perhaps always have the preference; but the English never considered the comparatively low buying power of the Russian population.

*Extracts from an address delivered before the Foreign Trade Bureau of the Cincinnati Chamber of Commerce.

English goods were always higher priced and did not present as great variety and novelty as the German product.

In dealing with Russia the English almost never sold on credit. All contracts with Russian houses were closed with the condition "f.o.b. English port." That was something that went against all the customs of the Russian market. The largest and most reliable Russian houses avail themselves greatly of the credit system when buying goods. To ask them for payment, as the English did, about a month and a half or two months before seeing the goods, was surely fatal for the success of English trade in Russia.

Germany Catered Extensively to Russian Trade Before the War

A Russian could deal with a German almost the same as he could deal with one of his own countrymen. German salesmen spoke Russian fluently, presented buyers with catalogs printed in Russian, with goods marked according to the Russian system of measuring, with prices marked in rubles and kopecks. In addition to this, they gave Russian houses large and long-time credits. All this built up Germany's success in her trade with Russia.

Generally speaking, there is not the slightest doubt that a foreign trade cannot be interrupted for three or more years without serious results. In Germany's case, far more deplorable consequences will be brought about by the application of this rule, as the harmony established by her before the war will be ruined. This will not be the only reason why other countries, and the United States in particular, may reckon upon their share in the heritage of the former German trade with Russia. One must also take into consideration that Germany will lack both elements of highly developed industrialism after the war. She will not command, any more, a considerable amount of available capital, and the number of her skilled workmen will have been largely killed off in her vast military activity.

A more serious competition for the American industries and for American goods in Russia is to be expected from the allied countries and from Scandinavia. But, even in this case, many reasons will render an equal competition of those countries with the United States extremely difficult.

The lack of free capital and the scarcity of skilled labor will affect Germany's foes, if not exactly in the same degree as Germany herself, still in a very considerable way.

United States Can Push Trade

The United States, with its accumulation of capital and the number of its skilled workmen, increased by war industries, will be in a unique position to push forward its foreign trade on an immense scale. But one important condition must not be lost sight of with respect to a successful foreign trade even under most favorable circumstances; it is a condition, the neglect of which in the long run is likely to transform the brightest prospects of success into the saddest failure. This condition is an adequate organization of an efficient selling apparatus.

A staff of agents and salesmen, familiar with the language and conditions of the prospective market, must be created in advance, and agencies must be established in the proper places. In this connection it is all important to realize the respective standing of Moscow and Petrograd.

Petrograd was and is up to the present the seat of the Government, and she has been regarded by foreigners as the center of Russia's economic and spiritual life. This has always been a grievous mistake. Petrograd never expressed the Russian national life, and even now the news from Russia, being cabled from Petrograd, suffers from provincialism. If some of the American correspondents would go to Moscow, they would find there far more reliable material for their reports on the present political situation in Russia.

A business proposition originating from Moscow has a far better chance for success than one originating anywhere else in Russia. This will make it clear that the headquarters of a foreign firm should be invariably located in Moscow. There can be, of course, no doubt that Petrograd is now an important industrial center of a large district of northern Russia, and a large seaport, and therefore she should have well-equipped branch agencies worked from Moscow. Agencies of the same importance as Petrograd should be established in Odessa. This latter city commands the sea commerce on the Black Sea and is the chief port for the export of grain. It lies in a district of great industrial and commercial importance. The same applies also to Ekaterinoslav and Kharkoff, round which are centered the richest iron and coal-ore deposits of Russia, and where the most important metallurgical works, coal mines and collieries and other similar industries are located.

An energetic and enterprising American business man, desirous of taking advantage of the coming opportunity and engaging in trade with Russia, may easily have his doubts as to the purely external difficulties which he might meet with in that country.

Russia Not as Barbarous as Generally Imagined in the United States

Russia has been described as a half savage country for so long a time that the average American is likely to expect a complete lack of comfort and dreadful means of communication. This is one of the erroneous conceptions that must be dispelled.

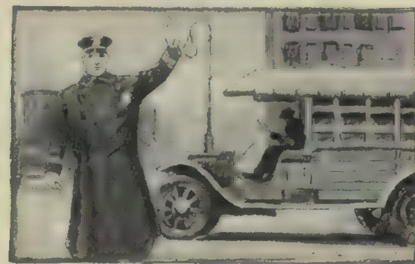
As to her railway mileage, Russia is second only to the United States, having over 45,000 miles of railways. With respect to the vast territories of the country, the railway net is entirely insufficient, but all the centers which are important for foreign trade have excellent connection with Moscow, Petrograd, Kharkoff, etc., and all American and English writers who have traveled in Russia are unanimous in their unqualified praises of the splendid comfort of the Russian trains.

Still another point cannot be emphasized too strongly, and that is that the events which took place in Russia recently are not only of a political character, but also of far-reaching international economical importance because, having brought about a change toward a broad democratic régime of the people by the people and for the people, this change will without doubt create new national demands and needs which will have to be satisfied both by domestic and foreign commerce and industry. I take it to be an axiom—and statistics prove it—that in a democratic country the income and corresponding expenses per capita are much higher than in a nondemocratic country.

Mechanical Inefficiency a Communal Loss

BY FREDERICK REMSEN HUTTON, Sc.D.*

"Accidents in Power Plants are Communal Waste



for which we need Communal Regulation"

The writer had a recent opportunity to claim that an accident in the power house increases the high cost of living. It does this by increasing the cost of production in the individual plant and hence the upward tendency of the market price. It may be also stated that industrial safety and freedom from accident act as a means of lowering the cost of production in any factory or shop, and the introduction of safety devices and safety management may be defended on purely economic grounds.

First, every machine (and a power-house boiler and engine and generator are in this class) should be functioning continuously if possible, to earn the interest on its cost and pay the proper share of overhead charges.

Second, an accident that involves the machine or disables its operator, or both machine and operator, breaks into this continuity of earning and involves losses. These losses fall into several groups: First, the cost of repair; second, the losses of idleness; third, the costs of compensation for the bodily injuries, or of insurance against this cost; fourth, the costs in wasted stock and defective work, due to teaching a new operator, also in the slow and inferior production of the worker as yet inexpert; and fifth, the costs of the slackened speed of all workers in the department while the shock and the memory of it are fresh in the minds of those who witnessed the accident and the disablement. These costs appear in the selling price directly.

There are furthermore indirect losses from the accident, which reach the community only through the heavy losses borne in the narrow circle affected when its wage earner is disabled. These are the losses in buying capacity when full wages are no longer received; in losses of schooling and in lowered standards of living in such circle of dependents of the victim; and there is finally the more inclusive community loss in the costs of ambulance, nurses and hospital maintenance, which appear in the taxes or in the voluntary contributions of that community as a whole.

It should need little or no argument to convince that the cost of power appears as a factor in the cost of every manufactured article or product, whether the power is generated within the producing plant or is brought into it on a rental or service basis. Almost everything that we use in these days has had power and labor expended on it at every step from the raw-material stage to the final transportation to the consumer's plant or home; hence, increased cost of power and of transportation of fuel and material for manufacturing is a charge paid by every consumer. Every consumer is for this reason interested in preventing accident in the power house, and both legislative and executive branches of a democratic government are justified in taking measures to prevent and minimize such accidents and their economic burden and their pain and sorrow.

PROVING THE SOUNDNESS OF THE CONTENTION

The soundness and defensibility of the foregoing contention may be further proved by the expedient, which is familiar to mathematicians, of carrying a trend or tendency to the limit of its application and testing it there; for there can be no question that if the deaths and disablements in any community exceed its normal rate of growth, such community is on its way to extinction. Natural instinct and commonsense would send experts and commissions to remedy this state of affairs, and such study and remedial action would not be deemed meddlesome nor improper nor an invasion of any personal liberty. In other words, the response and reaction to excessive loss are instinctive and defensible, and in a democracy it will be its organized representatives who will take the necessary action.

Has the way then been cleared for the next step in logic and economic progress? If accidents are a waste to be prevented because of their cost, are other preventable economic wastes a similar community waste, and may the community take steps to protect itself?

An excessive cost of generation of power is of course first borne by the producing plant, but such plant at once faces an alternative. It may keep its prime or factory cost what it has been by reducing some other element, usually the wages of the operators, and thus meet the competition of its rivals; or it may let the prime cost go up and hope to carry the market or selling price up with it, if it can.

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Let these two alternatives be studied for a moment. It is to impoverish the community to reduce wages on the one hand, because all tradesmen who sell to the poorer buyers find their market invaded—the latter buy fewer and poorer shoes and clothes, less food and pay less rent. If on the other hand, the market price of the manufacturer can go up without a cut in wages, then it is all the buyers of that product who are impoverished, for they have less to buy other things with or they buy less. If the market price cannot go up by reason of sound competition, then the plant with excessive power cost will soon go out of business, discharging its men, forcing withdrawal of savings of former years and throwing dependent relatives of the idle men on community beneficence. This is an obvious impoverishment. The writer has elsewhere defended the thesis that the normal market price is fixed by the cost of prime production in the plant reasonably well equipped to produce that article under healthy competition. When the market price falls below that figure, that plant ceases to produce, and the diminished supply sends the price upward; then this plant comes back and makes a small profit again.

The Boycott and the Closed Market

If on the other hand again, by the help of transportation problems or other forces the higher price can be maintained, then the community calls first on the boycott or other form of closed market, or by the public service commission investigation it seeks to punish the offender and to protect itself from what it conceives to be its communal loss.

The writer is an individualist by theory and by preference. Our ancestors won their economic conquests by individual ability and effort. Strong men are developed under this philosophy, and opportunity is always the prize of the individual. But as the community grows in size and its activities in complexity, the need for associated action increases. We have to get our water by a corporate plan and no longer from our private and individual well; we must dispose of our sewage in an organized system and not merely cast it into a hole in the ground. So as we have grown accustomed to the idea of having the community legislate to prevent and minimize accident in the power house and factory, is there any logical pausing stage before the community demands economy and efficiency in the use of increasingly precious and costly fuel in the generation and distribution of power, with a view to lowering the cost to the community as a whole of such commodities as call for power in their production?

Jones Pays the Freight—Who Pays the Damages?

By J. P. Brophy*

You enter into a contract to build and ship a lot of machinery. You complete your work and notify the railroad company that you want a car in which to send the goods. The answer you receive will probably be, "We have no cars at this time, you will have to wait." All of us are up against this condition during any exceptionally busy period. If, under these circumstances, you are slow in making your shipments, you are unquestionably not to blame. If the railroad company cannot supply you with cars, you certainly cannot make shipment.

Finally, after waiting for days—or weeks—you are notified by the railroad company to send along your goods as they have found a car for you. If you have a carload to ship, you are supposed to do the loading. If your goods will only require half a car space, all you have to do is to deliver the freight at the depot and obtain a receipt—the railroad does the rest.

In busy times, regardless of what your own desires in the matter may be, a flat car or a coal car may be used in which to ship the material—and you are powerless to prevent it. In fact, your duty is at an end as far as your contract with your customer is concerned, for that stated "freight on board cars, your town or city."

Perhaps we must admit that at this time we cannot be choosers, but should rather feel that the railroad companies are favoring us by handling our freight!

Now comes the interesting part of this subject. The railroad is supposed to carry the shipment to its destination. If the machines are damaged in transit, they will compensate you provided you place your claim in the proper way—that is, notify their agent, call their attention to the matter and allow them to inspect the damaged goods before they are accepted.

The Shipper Should Not Have To Seek Damages

I claim that on f.o.b. shipments the shipper is not the one to demand damages. It is up to the consignee, for the reason that the clause "f.o.b. cars" ends the shipper's responsibilities and therefore should end his obligations.

Now for the unbusinesslike attitude of some purchasers. If the railroad company does not place the loaded car just where the purchaser wants it, and it costs the latter considerable to unload and convey the merchandise to the consignee's place of business, or if the machinery is damaged by being exposed to the weather, is there any justification for the purchaser to claim damages from the shipper because of damage or demurrage charges and excess cost of drayage? I hold that the company which shipped the goods and completed its duties according to the contract, "f.o.b. cars," is not liable in any way. Of course, if the consignor agrees to pay the freight and deliver the article in question at the purchaser's place of business, then the consignor would be responsible.

I have experienced some trouble during the last year along this line, either through the nonsensical ideas of the company receiving the shipment, or through their taking a chance of collecting various amounts because these things occurred, and resulted in an excess of what they expected it to cost them to remove the machines from the cars and place them on their floor.

I maintain that the moment the merchandise is accepted by the railroad and is started on its journey to the customer it belongs to the purchaser, and that anything unusual occurring in transportation—rough handling or failure to locate the car on the consignee's siding or at the point at which he desires it to be placed in order to expedite unloading and hauling—cannot under any consideration be blamed on the man or company that originally shipped the goods. The railroad company should be held responsible to the purchaser.

I hope that those reading this article who have had more or less trouble of this kind will give their opinions on this matter.

*Vice president and general manager, the Cleveland Automatic Machine Co.

United States Munitions*

The Springfield Model 1903 Service Rifle

Oiler and Thong Case, Spare-Parts Container, Screwdriver

SYNOPSIS—This completes machine work on the rifle proper and will be followed by descriptions of the stock and hand guard. These, together with the bayonet, will complete the series.

Oiler and Thong Case

This fits into an opening in the stock of the rifle, this opening being covered by the butt-plate cap. These parts are furnished for every alternate rifle only, the spare-parts container being supplied with the remaining rifles.

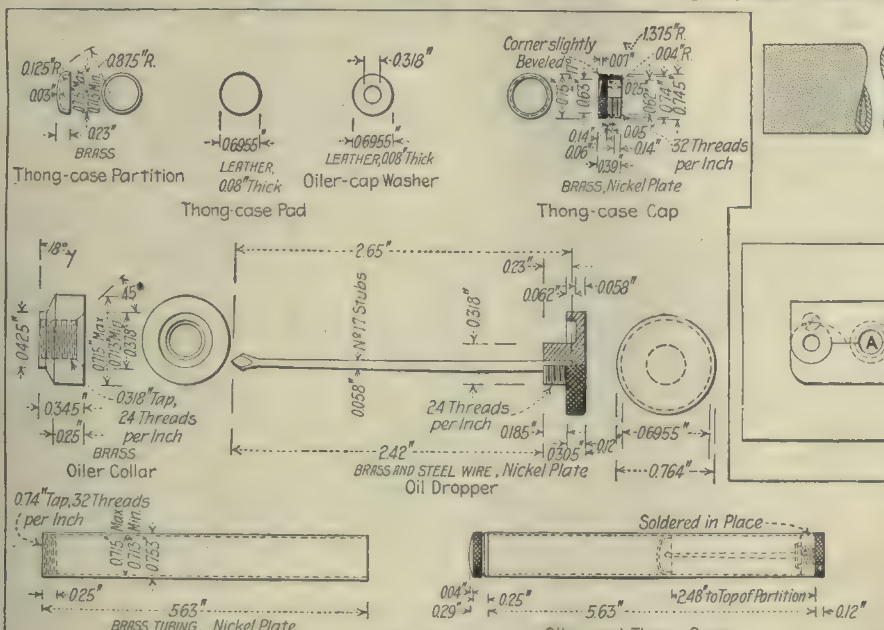


FIG. 1882

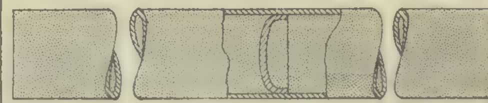


FIG. 1883

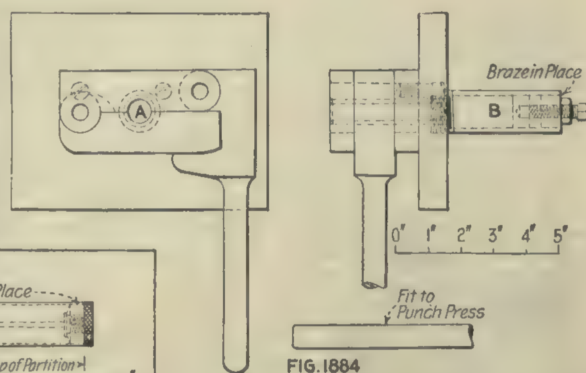


FIG. 1884

OPERATION 2

OPERATIONS ON THE OILER AND THONG CASE

Operation
1 Cutting off
2 Assembling
2–A Making partition in punch press
3 Soldering collar
4 Soldering partition
5 Square end, thread and countersink
6 Thread thong-case end
7 Assembling

OPERATION 1. CUTTING OFF

Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Crossfeed. Cutting Tools—Cutting-off tool. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Length, 3⅝ in. Production—350 pieces per hr.

OPERATION 2. ASSEMBLING PARTITION

Transformation—Fig. 1883. Number of Operators—One. Description of Operation—Assembling partition and case. Apparatus and Equipment Used—Vise in punch press, Fig. 1884; is also done with hammer and block. Gages—Position of partition. Production—350 pieces per hr.

OPERATION 2-A. PUNCHING AND FORMING PARTITION DISKS

Machine Used—Niagara No. 31 press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew, Fig. 1885. Stripping Mechanism—Forced out of die by spring knock-out. Production—650 pieces per hr. Note—Disk punched from strip and cupped at one operation.

OPERATIONS 3 AND 4. SOLDERING COLLAR AND PARTITION

Transformation—See complete case, Fig. 1882. Number of Operators—One. Description of Operation—Soldering end collar and partition; strip solder in form of a ring; heat applied by torch at side; revolved slowly by belt beneath. Apparatus and Equipment Used—Soldering machine and torch, Fig. 1886. Gages—None. Production—200 pieces per hr.

OPERATION 4½. OILER COLLAR

Transformation—See Fig. 1882. Machine Used—Cleveland automatic. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Cutting Tools—Drill, counterbore and tap; cutoff. Number of Cuts—Four. Cut Data—600 r.p.m. Gages—Diameter, length and plug thread. Production—140 pieces per hr.

OPERATION 5. SQUARE END, THREAD AND COUNTERSINK

Transformation—Fig. 1887. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Facing cutter, tap and countersink. Number of Cuts—Three. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Length and thread. Production—150 pieces per hr.

OPERATION 6. THREAD THONG-CASE END

Transformation—Fig. 1888. Machine Used—Pratt & Whitney hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Tap. Number of Cuts—One. Cut Data—250 r.p.m. Average Life of Tool Between Grindings—5000 pieces. Gages—Threaded plug. Production—350 pieces per hr.

OPERATIONS ON THE THONG-CASE CAP

Operation
1 Automatic
2 Forming end
3 Swaging and assembling leather

OPERATION 1. AUTOMATIC

Transformation—Fig. 1889-A. Machine Used—Pratt & Whitney or Acme automatic. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Spot, form, drill, knurling tool, thread and cutoff. Number of Cuts—Six. Cut Data—1200 r.p.m.; $\frac{3}{16}$-in. feed. Average Life of Tool Between Grindings—900 pieces. Gages—Diameter, depth and thread. Production—35 pieces per hr.

OPERATION 2. FORMING END

Transformation—Fig. 1889-B. Machine Used—Pratt & Whitney No. 1 hand screw machine. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Forming tool. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces per hr. Gages—Diameter and form. Production—150 pieces per hr.

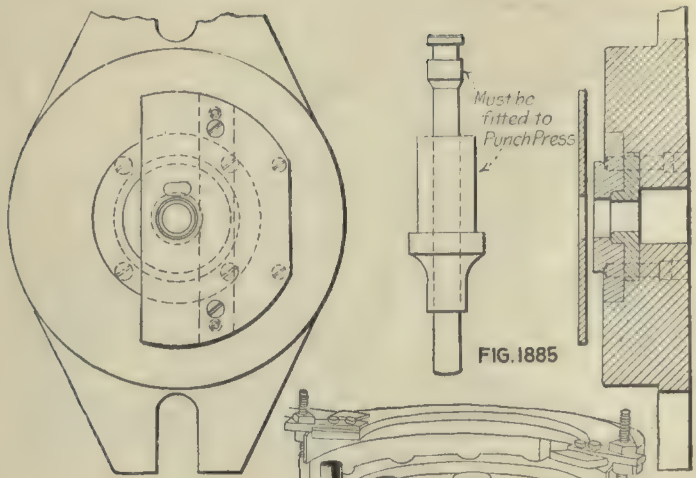


FIG. 1885

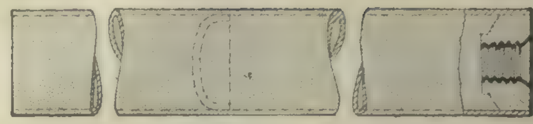


FIG. 1887
OPERATION 5


FIG. 1888
OPERATION 6

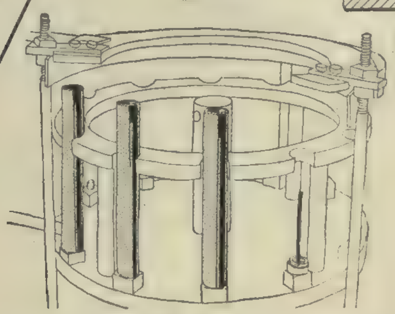


FIG. 1886

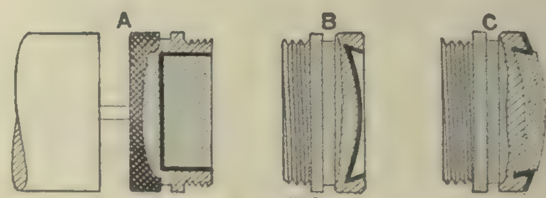


FIG. 1889

OPERATION 3. SWAGING AND ASSEMBLING LEATHER

Transformation—Fig. 1889-C. Machine Used—Old 10-in. Prentice lathe. Number of Operators per Machine—One. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Crossfeed. Cutting Tools—Swaging or spinning tool. Number of Cuts—One. Cut Data—250 r.p.m.; hand feed. Production—350 pieces per hr.

OPERATION 1. AUTOMATIC

Transformation—Fig. 1890. Machine Used—Any automatic screw machine. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Spot, former, drill and cutoff. Number of Cuts—Four. Cut Data—1200 r.p.m.; $\frac{3}{16}$-in. feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Thread, diameter and thickness of head. Production—125 pieces per hr.

OPERATION 7. ASSEMBLING

Transformation—Fig. 1892. Number of Operators—One. Description of Operation—Assembling cap to case and wire, with end flattened, to cap. Apparatus and Equipment Used—Special vise for holding wire while cap is forced on. Gages—Assembled length, Fig. 1893. Production—350 pieces per hr.

OPERATIONS ON THE THONG TIP

Operation
1 Automatic
2 Milling
3 Punching thong hole and rag slot
4 Straightening
5 Countersinking
6 Polishing
8 Dipping

OPERATION 1. AUTOMATIC

Transformation—Fig. 1895. Machine Used—Any small automatic screw machine. Number of Machines per Operator—Four. Work-Holding Devices—Held in draw-in chuck. Tool-Holding Devices—Tool in turret of machine. Cutting Tools—Spot drill, tap and cutoff. Number of Cuts—Four. Cut Data—1500 r.p.m.; $\frac{3}{16}$-in. feed. Coolant—None. Average Life of Tool Between Grindings—1000 pieces. Gages—Diameter, length, depth of hole and counterbore; threaded plug. Production—215 pieces per hr.

OPERATION 2. MILLING

Transformation—Fig. 1896. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Two. Work-Holding Devices—Vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Milling cutters. Number of Cuts—One. Cut Data—125 r.p.m.; $\frac{5}{8}$-in. feed. Average Life of Tool Between Grindings—5000 pieces. Gages—Thickness and contour. Production—125 pieces per hr.

OPERATION 3. PUNCHING THONG HOLE AND RAG SLOT

Transformation—Fig. 1897. Machine Used—Snow-Brooks No. 1 punch press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Die fixture bolted to bed of press. Stripping Mechanism—Stripper held by jaws. Average Life of Punches and Dies—1500 pieces. Gages—Fig. 1898, location and size of holes. Production—400 pieces per hr.

OPERATION 4. STRAIGHTENING

Number of Operators—One. Description of Operation—Straightening after punching. Apparatus and Equipment Used—Lead hammer and block. Gages—Contour. Production—350 pieces per hr.

OPERATION 5. COUNTERSINKING

Number of Operators—One. Description of Operation—Countersinking thong hole and patch slot. Apparatus and Equipment Used—Bench lathe and countersink. Production—350 pieces per hr.

OPERATION 6. POLISHING

Number of Operators—One. Description of Operation—Polishing or burring. Apparatus and Equipment Used—Polishing jack and wheel. Production—600 pieces per hr.

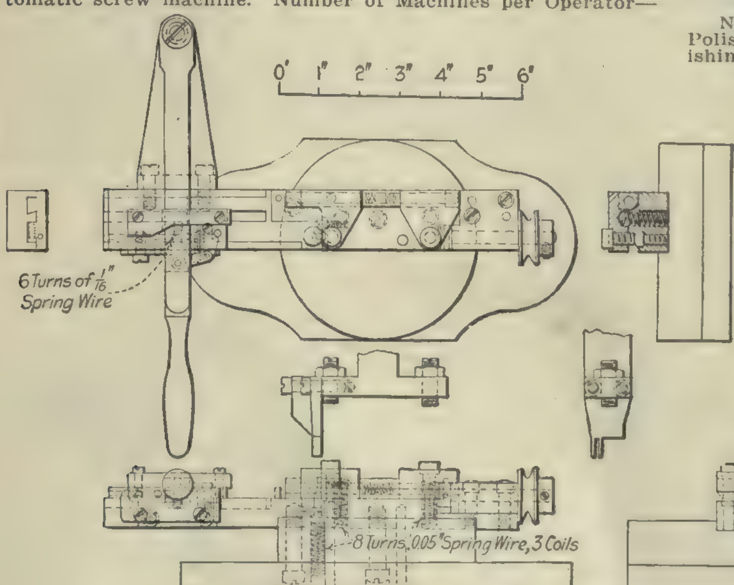


FIG. 1891

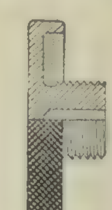


FIG. 1890

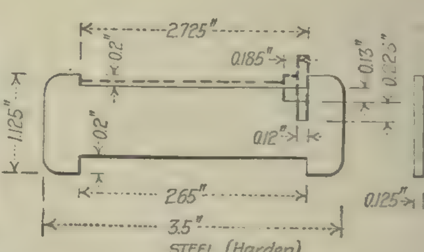


FIG. 1893

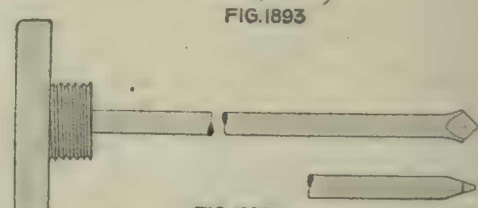


FIG. 1892
OPERATION 7

OPERATION 8. DIPPING

Number of Operators—One. Description of Operation—Washed in potash and then dipped in a solution consisting of 1 part sulphuric acid and 1 part nitric acid; just dipped and taken right out. Apparatus and Equipment Used—Wooden tanks, wire baskets.

OPERATIONS ON THE THONG WEIGHT

1 Automatic
2 Straddle-milling
3 Punching for thong
4 Countersinking
5 Polishing
7 Dipping

OPERATION 1. AUTOMATIC

Transformation—Fig. 1899. Machine Used—Cleveland, Hartford, National-Acme or Pratt & Whitney. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Hollow mill, threading die and cutoff. Number of Cuts—Three. Cut Data—1200 r.p.m.; $\frac{1}{16}$-in. feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Fig. 1900, length, diameter and rounded end. Production—200 pieces per hr.

OPERATION 2. STRADDLE-MILLING

Transformation—Fig. 1901. Machine Used—Whitney hand miller. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws. Tool-Holding Devices—Standard arbor. Cutting Tools—Two facing cutters. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1902, thickness and contour. Production—350 pieces per hr.

OPERATION 3. PUNCHING FOR THONG

Transformation—Fig. 1903. Machine Used—Snow-Brooks No. 1 punch press. Number of Operators per Machine—One. Punches and Punch Holders—Square shank. Dies and Die Holders—Held on plate screwed to bed of press. Stripping Mechanism—Steel strippers screwed to face of die. Average Life of Punches and Dies—1000 pieces. Production—1000 pieces per hr.

OPERATION 4. COUNTERSINKING

Number of Operators—One. Description of Operation—Countersinking thong hole. Apparatus and Equipment Used—Bench lathe and countersink. Production—350 pieces per hr.

OPERATION 5. POLISHING

Number of Operators—One. Description of Operation—Polishing, burring. Apparatus and Equipment Used—Polishing stand and wheel. Production—500 pieces per hr.

OPERATION 7. DIPPING

Number of Operators—One. Description of Operation—Washed in potash and then dipped in a solution consisting of 1 part sulphuric acid and 1 part nitric acid to clean thoroughly. Apparatus and Equipment Used—Wooden tanks, wire baskets.

OPERATION ON THE THONG BRUSH, TIP

Operation
1 Automatic
2 Profiling groove for wire
3 Drilling hole for wire
5 Coiling and trimming bristles

OPERATION 1. AUTOMATIC

Transformation—Fig. 1904. Machine Used—Acme No. 1 automatic screw machine. Number of Machines per Operator—Four. Work-Holding Devices—Draw-in chuck. Tool-Holding Devices—Turret of machine. Cutting Tools—Hollow mill, threader and cutoff. Number of Cuts—Three. Cut Data—1200 r.p.m.; $\frac{1}{16}$-in. feed. Average Life of Tool Between Grindings—1000 pieces. Gages—Diameter length, form of end and thread, similar to Fig. 1900. Production—250 pieces per hr.

OPERATION 2. PROFILING GROOVE FOR WIRE

Transformation—Fig. 1905. Machine Used—Pratt & Whitney No. 1 profiler. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws. Tool-Holding Devices—Taper shank. Cutting Tools—Profiler. Number of Cuts—One. Cut Data—1200 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Snap gage for size and depth of grooves. Production—150 pieces per hr.

OPERATION 3. DRILLING HOLE FOR WIRE

Transformation—Fig. 1906. Machine Used—Any drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Number of Cuts—One. Cut Data—900 r.p.m.; hand feed. Average Life of Tool Between Grindings—350 pieces. Gages—Diameter of hole. Production—150 pieces per hr.

OPERATION 5. COILING AND TRIMMING BRISTLES

Number of Operators—One. Description of Operation—Special coiling and trimming machine built at the Hill shop, Fig. 1907; the bristles are held at A by clamp B; the brush tip is held in C and the wires in D; the wire is looped through the hole in the brush tips, and the ends are caught in the chuck D; then the bristles are pushed forward between the wires, against the stop J in Fig. 1908, and cut off by the knife H; the wires are now twisted to hold the bristles in place, as in Fig. 1909, and then the stop J drops out of the way and the slide moves back so that the cutter E can trim the ends of the bristles against the knife G, Fig. 1910. Production—Average about 40 per hr.

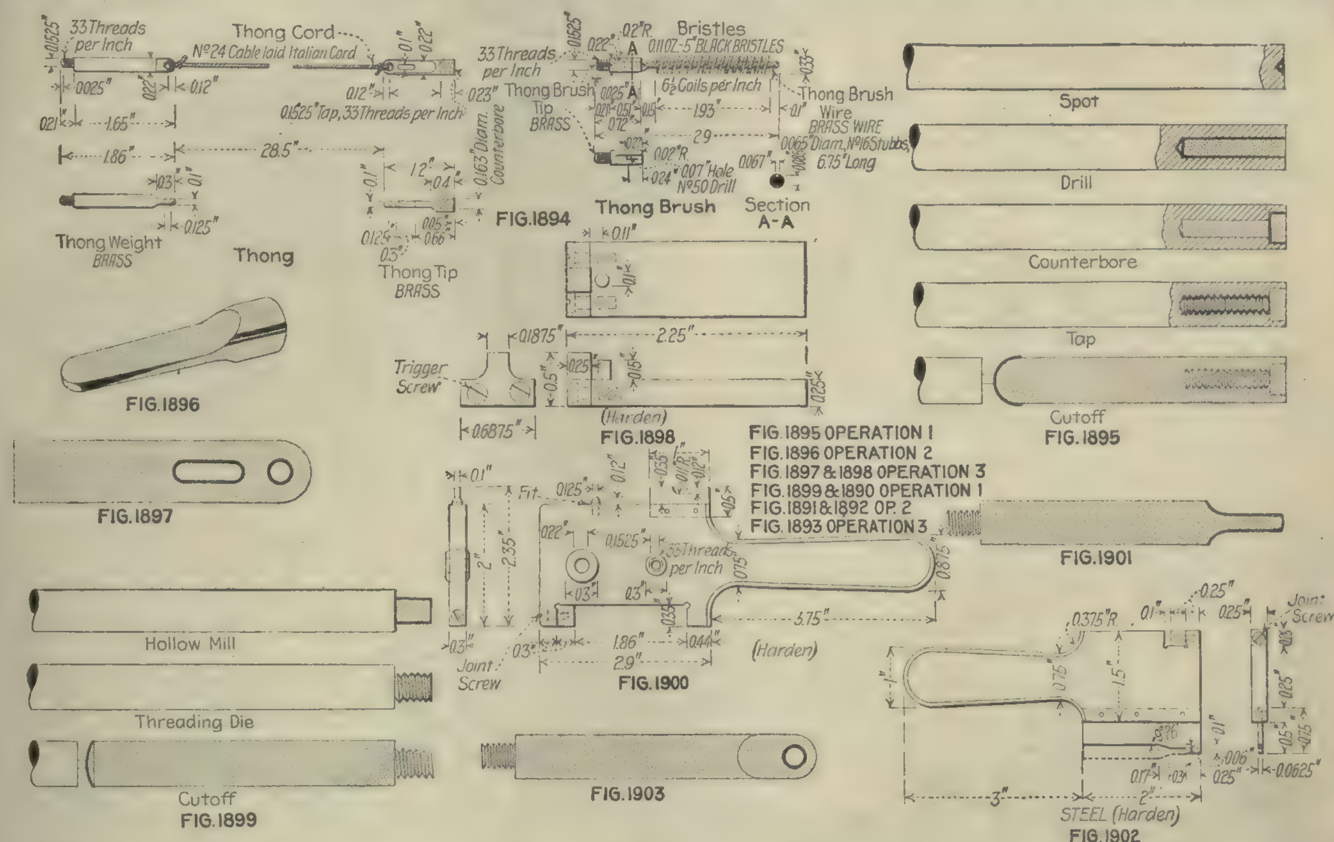


FIG. 1894, FIG. 1895, FIG. 1896, FIG. 1897, FIG. 1898, FIG. 1899, FIG. 1900, FIG. 1901, FIG. 1902, FIG. 1903

Spare-Parts Container

The spare-parts containers are made from waste wood that is unsuitable for stocks. The details are shown in Fig. 1911. The other operations follow.

OPERATIONS ON THE SPARE-PARTS CONTAINER

Operation
A Planing
B Cutting off
C Jointing
D Resawing to thickness
1 Resawing to width
2 Turning
3 Cutting off to length
4 Swaging to size
5 Drilling
6 Profiling
7 Oiling with linseed
8 Packing spares in container

OPERATION 2. TURNING

Transformation—Fig. 1912. Machine Used—Wood-turning machine. Number of Operators per Machine—One. Work-Holding Devices—Held between rolls. Cutting Tools—Fly cutters. Cut Data—3500 r.p.m.; hand feed. Average Life of Tool Between Grindings—1500 pieces per hr. Production—400 pieces per hr.

OPERATION 3. CUTTING OFF TO LENGTH

Number of Operators—One. Description of Operation—Sawing to length, 5¾ in. Apparatus and Equipment Used—Table saw; speed, 3500 r.p.m. Gages—Length. Production—400 pieces per hr.

OPERATION 4. SWAGING TO SIZE

Number of Operators—One. Description of Operation—Swaging to size. The containers are swaged to size by being forced through a round steel die about 4 in. long and of the proper diameter for the finished piece; the front end of the hole is tapered about ⅜ in. to the foot and is bolted to the bed of a old planer; the pusher, which is a stud that is fastened to th crossrail by a special forging, forces the container through the die as the table moves under the rail; these pieces are handled as fast as the planer can travel, as the operator only has to insert the end in the tapered portion of the die; this operation reduces the diameter approximately $\frac{1}{32}$ in. Apparatus and Equipment Used—As described above. Production—500 pieces per hr.

The Screwdriver

The screwdriver consists of two blades, hinged together so that one forms the handle for the other. One blade is larger than the other, and they are designated as the small and the large blade. The assembling of the complete screwdriver is shown in Fig. 1924. The blades are machined all over instead of being swaged to size and ground where necessary.

OPERATIONS ON THE SCREWDRIVER BLADE, SMALL

Operation	
0	Cutting off
A	Forging from bar
B	Annealing
B–1	Pickling
C	Trimming
C–1	Cold dropping
D	Buffing
1	Punching joint pin hole
1½	Burring operation 1
2	Milling edges and sides
3	Finish-grinding to thickness and shape
4	Burring hole

FIG. 1904 OPERATION 1

FIG. 1905 OPERATION 2

FIG. 1906 OPERATION 3

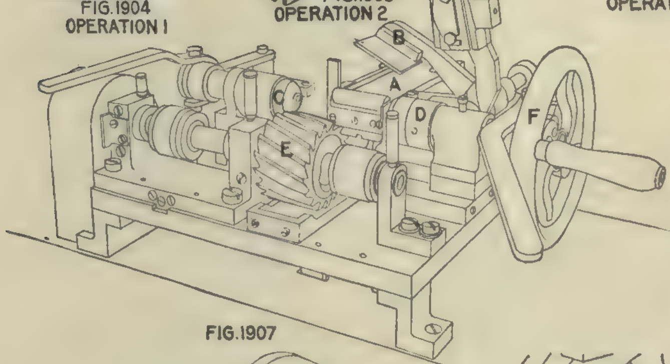


FIG. 1907

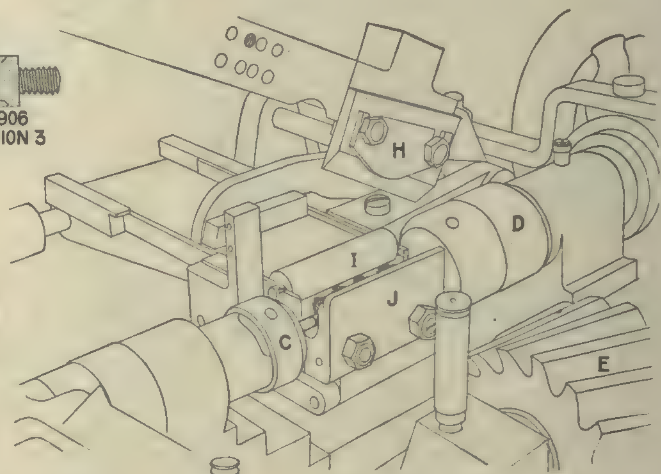


FIG. 1908

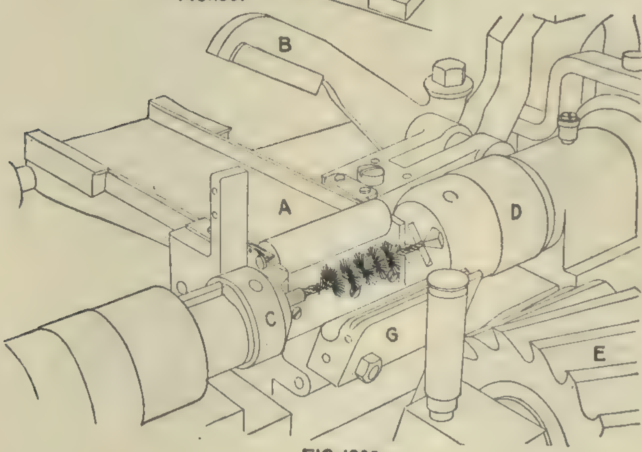


FIG. 1909

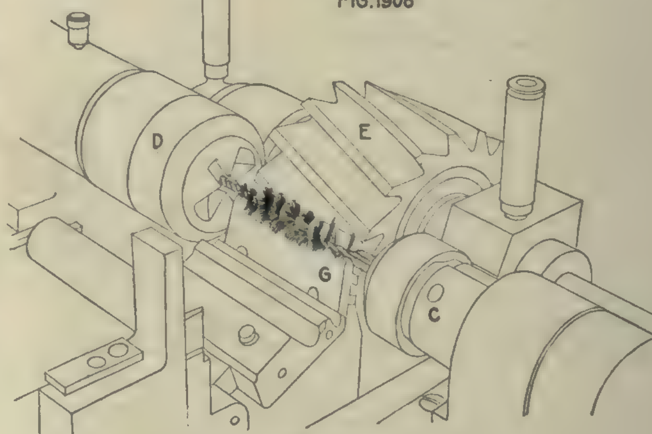


FIG. 1910

OPERATION 5. DRILLING

Transformation—Fig. 1913. Machine Used—Horizontal three-spindle drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Vise jaws on machine, Fig. 1914. Tool-Holding Devices—Taper shank. Cutting Tools—Twist drills. Number of Cuts—Three. Cut Data—3500 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Production—35 pieces per hr.

OPERATION 6. PROFILING

Transformation—Fig. 1915. Machine Used—Wood profiler. Number of Operators per Machine—One. Work-Holding Devices—Work held in rotating fixture, Fig. 1916. Tool-Holding Devices—Taper shank. Cutting Tools—Two-point fly cutters. Number of Cuts—Four. Cut Data—3300 r.p.m.; hand feed. Average Life of Tool Between Grindings—500 pieces. Gages—Use an extractor. Production—40 pieces per hr.

OPERATION 7. OILING WITH LINSEED OIL

Number of Operators—One. Description of Operation—Dipped in linseed oil and left over night to dry. Apparatus and Equipment Used—Trays filled with boiled linseed oil. Production—1000 pieces per hr.

OPERATION 8. PACKING SPARES IN CONTAINER

Number of Operators—One. Description of Operation—Packing spare parts (cooking piece, striker and extractor) in container. Apparatus and Equipment Used—Hands. Production—100 per hr.

OPERATION 0. CUTTING OFF

Number of Operators—One. Description of Operation—Cutting bars in two. Apparatus and Equipment Used—Hilles No. 2 stock shears. Production—175 pieces per hr.

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1918. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Gages—Fig. 1919, width, thickness and length. Production—160 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Same as all other annealing operations. Apparatus and Equipment Used—Same as before.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Same as all other picklings. Apparatus and Equipment Used—Same apparatus as before.

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 1 press. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—In shoe, by setscrew. Stripping Mechanism—Down through die. Average Life of Punches and Dies—15,000 pieces. Production—600 pieces per hr.

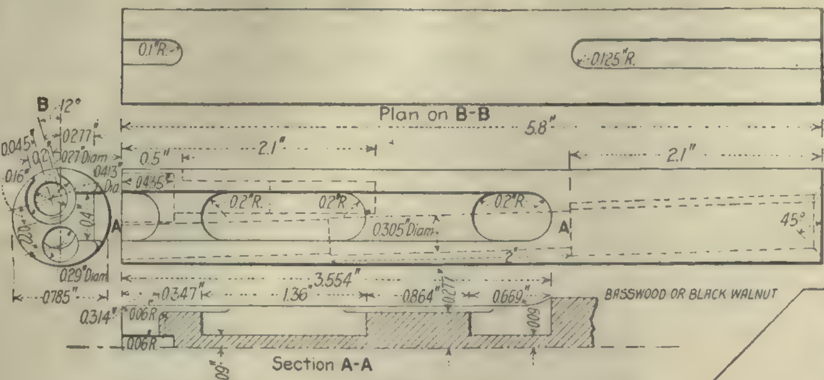


FIG. 1911

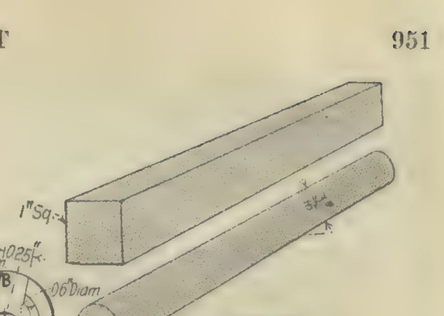


FIG. 1912
OPERATION 2

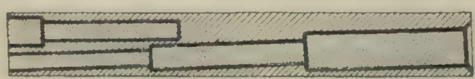


FIG. 1913

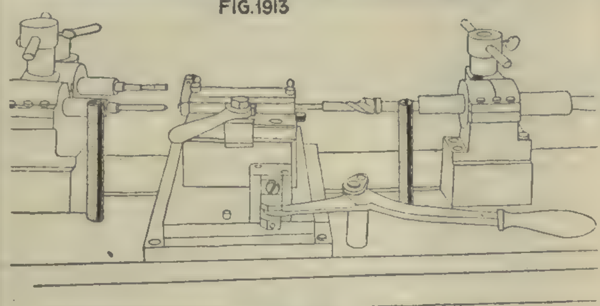


FIG. 1914
OPERATION 5

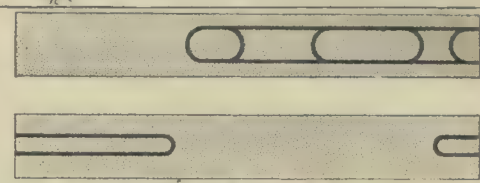


FIG. 1915

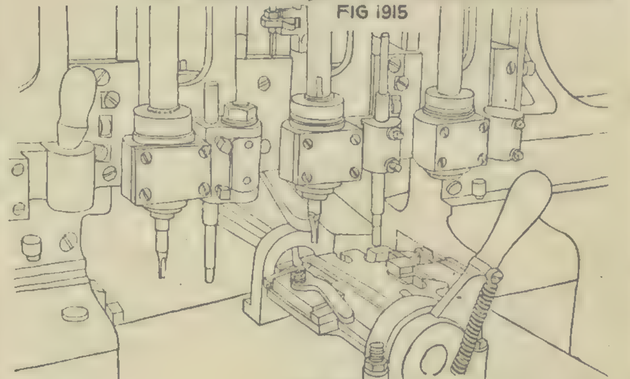


FIG. 1916
OPERATION 6

OPERATION C-1. COLD DROPPING

Number of Operators—One. Description of Operation—Straightening after trimming. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Production—700 pieces per hr.

OPERATION D. BUFFING

Number of Operators—One. Description of Operation—Buffing sides. Apparatus and Equipment Used—Buffing wheel and holder. Production—350 pieces per hr.

OPERATION 1. PUNCHING JOINT PIN HOLES

Transformation—Fig. 1920. Machine Used—Garvin press, 1-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrews. Stripping Mechanism—Steel stripper screwed to face of die. Average Life of Punches and Dies—1500 pieces between grindings. Lubricant—Oil on punches. Gages—Plug, for diameter. Production—650 pieces per hr.

OPERATION 1½. BURRING OPERATION 1

Number of Operators—One. Description of Operation—Removing burrs from operation 1. Apparatus and Equipment Used—File. Production—600 pieces per hr.

OPERATION 2. MILLING EDGES AND SIDES

Transformation—Fig. 1921. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—

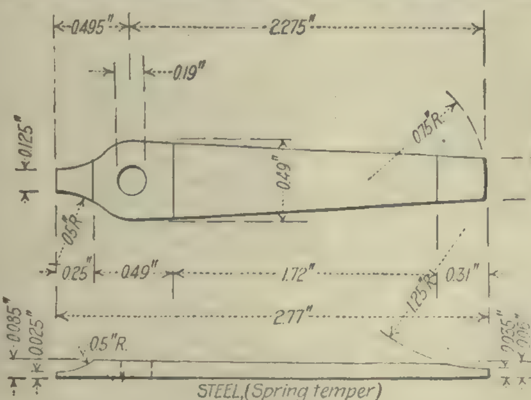


FIG. 1917

FIG. 1918
OPERATION A

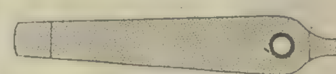


FIG. 1920
OPERATION 1

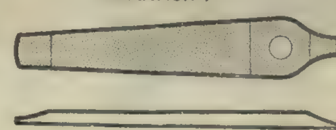


FIG. 1921

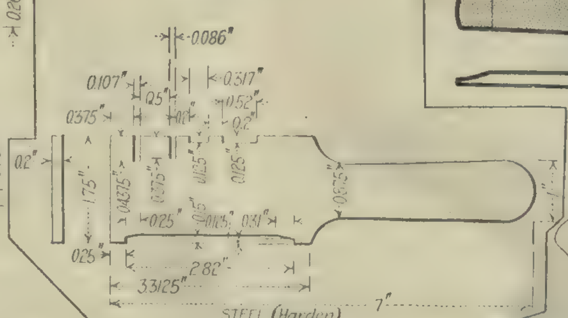
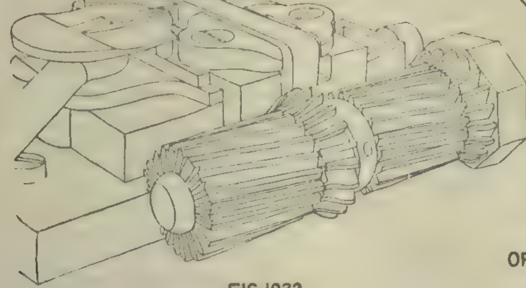


FIG. 1919



OPERATION 2

FIG. 1922

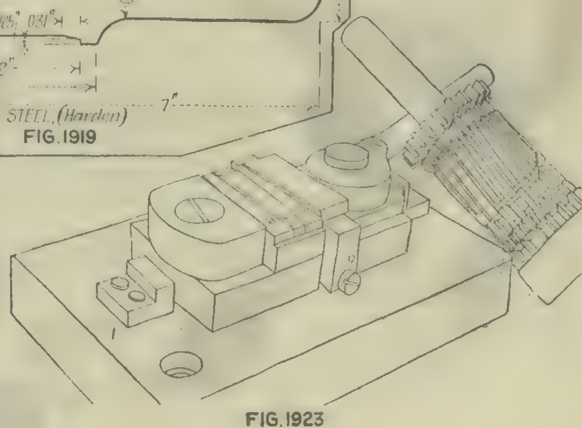


FIG. 1923

Four. Work-Holding Devices—Held by vise jaws, Figs. 1922 and 1923. Tool-Holding Devices—Standard arbor. Cutting Tools—Gang of milling cutters, Figs. 1922 and 1923. Number of Cuts—One. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1924, width, thickness and length. Production—45 pieces per hr.

OPERATION 3. FINISH-GRINDING TO THICKNESS AND SHAPE

Number of Operators—One. Description of Operation—Grinding to thickness and shape. Apparatus and Equipment Used—Polishing jack and holder, wheel. Gages—Thickness and shape. Production—90 pieces per hr.

OPERATION 4. BURRING HOLE

Number of Operators—One. Description of Operation—Removing burrs from hole. Apparatus and Equipment Used—Reamer. Production—300 pieces per hr.

OPERATION ON THE SCREWDRIVER BLADE, LARGE

Operation
- 0 Cutting off
- A Forging from bar
- B Annealing
- B–1 Pickling
- C Trimming
- 1 Punching joint pin hole

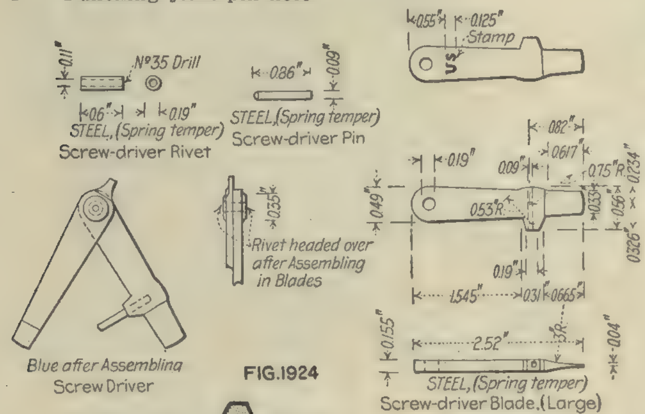


FIG. 1924

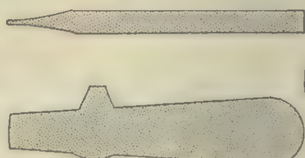


FIG. 1925


FIG. 1926

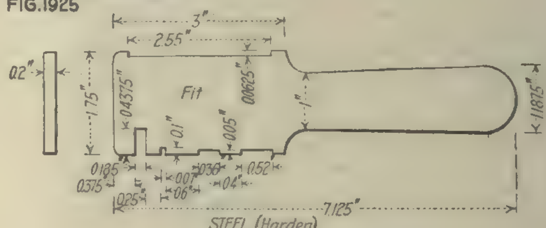


FIG. 1927


FIG. 1928

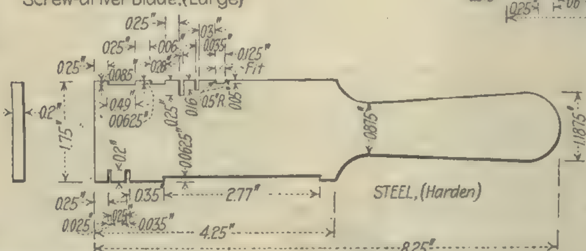


FIG. 1929A

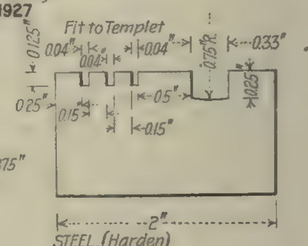


FIG. 1930

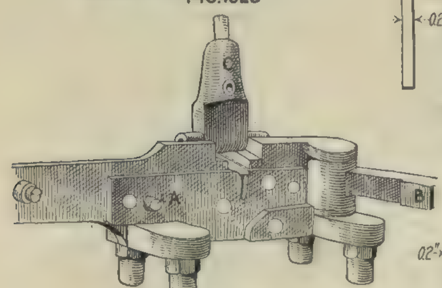


FIG. 1932

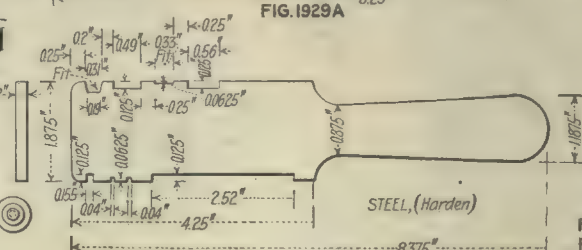


FIG. 1929 B


FIG. 1931

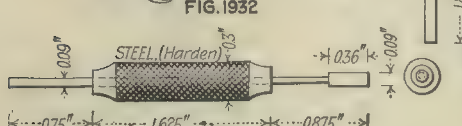


FIG. 1933

FIG. 1925 OPERATION A
FIG. 1926 & 1927 OPERATION 1
FIG. 1928, 1929 & 1930 OPERATION 2
FIG. 1931, 1932 & 1933 OPERATION 5

- 1½ Burring operation 1
- 2 Milling edges and sides of block
- 3 Stamping letters U.S.
- 4 Finish-grinding to thickness and shape
- 5 Drilling pin hole
- 8 Riveting small blade to large blade
- 9 Bluing
- 10 Assembling pin to large blade
- 11 Polishing blades

OPERATION 0. CUTTING OFF

Number of Operators—One. Description of Operation—Cutting stock in half. Apparatus and Equipment Used—Hilles No. 2 stock shear. Production—3000 pieces per hr.

OPERATION A. FORGING FROM BAR

Transformation—Fig. 1925. Number of Operators—One. Description of Operation—Shaping from bar. Apparatus and Equipment Used—Billings & Spencer 400-lb. drop hammer. Gages—Fig. 1927. Production—125 pieces per hr.

OPERATION B. ANNEALING

Number of Operators—One. Description of Operation—Same as all other annealings. Apparatus and Equipment Used—Same as before.

OPERATION B-1. PICKLING

Number of Operators—One. Description of Operation—Same as other pickling operations. Apparatus and Equipment Used—Same as before.

OPERATION C. TRIMMING

Machine Used—Snow-Brooks No. 1; 1½-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—In shoe, by setscrews. Stripping Mechanism—Down through die. Average Life of Punches and Dies—15,000 pieces. Production—60 pieces per hr.

OPERATION 1. PUNCHING JOINT PIN HOLE

Transformation—Fig. 1926. Machine Used—Stiles 1-in. stroke. Number of Operators per Machine—One. Punches and Punch Holders—Round shank. Dies and Die Holders—Held in shoe by setscrew. Stripping Mechanism—Steel strippers screwed to face of die. Lubricant—Punches oiled with cutting oil. Gages—Fig. 1927; also plug gage for hole. Production—650 pieces per hr.

OPERATION 1½. BURRING OPERATION 1

Number of Operators—One. Description of Operation—Removing burrs from operation 1. Apparatus and Equipment Used—File. Production—650 pieces per hr.

OPERATION 2. MILLING EDGES AND SIDES OF BLOCK

Transformation—Fig. 1928. Machine Used—Pratt & Whitney No. 2 Lincoln miller. Number of Machines per Operator—Four. Work-Holding Devices—Special vise jaws, similar to Figs. 1922 and 1923; work located on pins in punched holes, held by cams. Tool-Holding Devices—Standard arbor. Cutting Tools—Formed milling cutters; see Figs. 1922 and 1923. Number of Cuts—Two. Cut Data—70 r.p.m.; ⅝-in. feed. Coolant—Cutting oil, put on with brush. Average Life of Tool Between Grindings—5000 pieces. Gages—Fig. 1929, length and form. Production—125 pieces per hr.

OPERATION 3. STAMPING LETTERS U.S.

Number of Operators—One. Description of Operation—Stamping U.S. Apparatus and Equipment Used—Hand stamp and hammer. Production—500 pieces per hr.

OPERATION 4. FINISH-GRINDING TO THICKNESS AND SHAPE

Number of Operators—One. Description of Operation—Grinding side to finish. Apparatus and Equipment Used—Polishing jack and wheel. Gages—Fig. 1930; thickness and width of blade. Production—120 pieces per hr.

OPERATION 5. DRILLING PIN HOLE

Transformation—Fig. 1931. Machine Used—Pratt & Whitney 16-in. upright drilling machine. Number of Operators per Machine—One. Work-Holding Devices—Drill jig, Fig. 1932; work is located on pin A, held by clamp B, while drill bushing is in the swinging arm C. Tool-Holding Devices—Drill chuck. Cutting Tools—Twist drill. Number of Cuts—One. Cut Data—750 r.p.m.; hand feed. Coolant—Cutting oil, $\frac{1}{16}$-in. stream. Average Life of Tool Between Grindings—250 pieces per grind. Gages—Fig. 1933, diameter and depth. Production—125 pieces per hr.

OPERATION 8. RIVETING SMALL BLADE TO LARGE BLADE

Number of Operators—One. Description of Operation—Riveting blades together. Apparatus and Equipment Used—Hammer, header and block. Production—125 pieces per hr.

OPERATION 9. BLUING

Number of Operators—One. Description of Operation—Same as all other bluing operations.

OPERATION 10. ASSEMBLING PIN TO LARGE BLADE

Number of Operators—One. Description of Operation—Putting pin in side of large blade. Apparatus and Equipment Used—Hammer. Production—150 pieces per hr.

OPERATION 11. POLISHING BLADES

Number of Operators—One. Description of Operation—Polishing blade. Apparatus and Equipment Used—Polishing jack, wheel and modern holder. Production—800 pieces per hr.

Storage of Broaches

By Walter G. Groocock

The question of how to store broaches is one that deserves and must receive a good deal of thought, if efficient service, coupled with long life is required from them. Apart from the constant attention that they must receive to keep them working efficiently, they must be stored in such a manner that no damage to their cutting edges can take place while the broaches are not in service.

One common source of trouble with broaches is snipping of the cutting edges of the teeth, due to mishandling. This is particularly true of spline broaches of the heavier

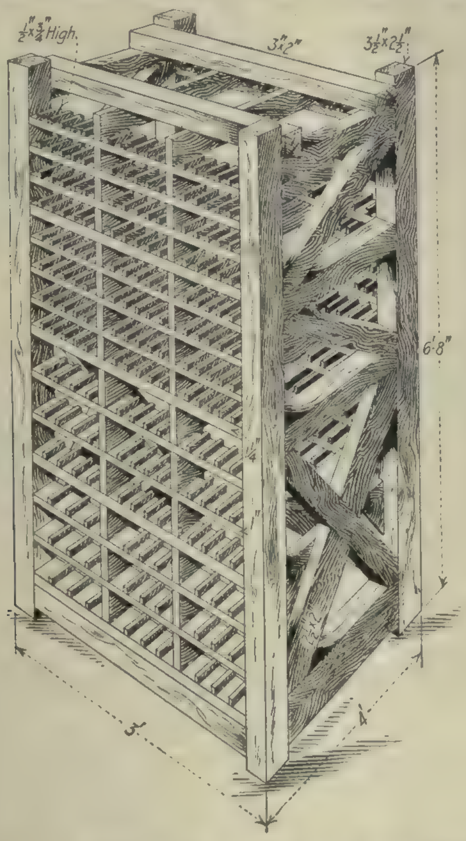


FIG. 1. STORAGE RACK FOR BROACHES

types. Undoubtedly, much of the damage that takes place is the result of the cutting edges coming sharply into contact with some metallic object, such as the frame of a machine or, in many cases, other broaches. Knowing this, it is imperative that wooden racks be provided for storage. The design of these racks should be such that the individual broaches can never touch each other.

For storing broaches when not in use, the rack shown in Fig. 1 will be found to be both cheap and efficient. It is a particularly useful style of rack for plants where the broaches vary largely in size and where the number is constantly being added to. It will be seen that the rack consists of a series of wooden shelves, each shelf having a number of spacing strips to keep the broaches apart. The shelves are supported on two substantially constructed ends that are well braced to insure rigidity under the load that they will have to carry. The sizes of the various members used in the construction of the rack, together with the overall dimensions, are given on the illustration.

Where possible, such a rack should stand so that broaches can be put in at one side and pulled out from the other. The teeth, being sharp, catch in the wooden shelf and cut chips, if the broaches are withdrawn from the rack in the cutting direction of the teeth.

A variation from this form of rack, which will be found useful when the broaches have become standardized, is one with a series of trays, each of which is fitted with spacers to accommodate one set of broaches. The rack then has no small spacers, but each tray has a pocket to itself. The trays should be fitted with two handles to facilitate carrying them about. When a set of broaches is required at the machine, the operator draws from the rack the tray containing them and takes both tray and broaches to his machine, returning them when the job is complete.

This system undoubtedly helps to preserve the edges of the broaches, because many of the knocks that broaches receive may be traced to the fact that the trays on broach-

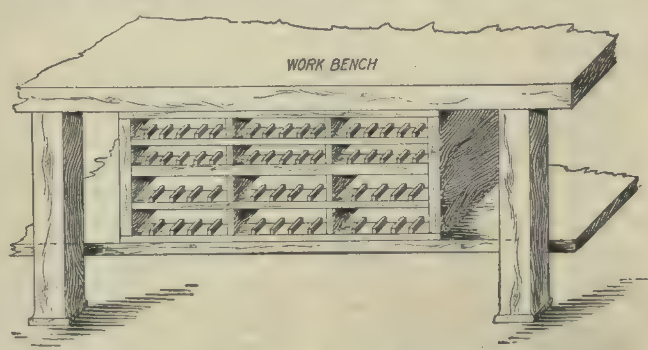


FIG. 2. TOOLROOM RACK FOR BROACHES

ing machines are iron, without a wooden covering. If wooden trays are not in use, then a wooden shelf should be provided at the machine so that when the broaches are laid down they will not get damaged. While the tray system of storage is a good one, it is limited to the smaller sizes, owing to the weight of a complete set of the larger types of broaches.

While the rack illustrated will accommodate many broaches, it could of course be built half the size shown. In view, however, of a possible increase in the number of broaches it is advisable that a rack for half the number should have the same length as the one shown; that is, the variation should be in the height. By starting thus, expansion is possible by duplicating the rack and securing the second rack on top of the first. Another point that should be mentioned is that, owing to the constant sharpening that is required to keep broaches in good order, they are quite frequently in the toolroom. As they cannot always be dealt with offhand, a rack should be provided to keep them from being damaged while waiting to be ground. A handy form of rack for the toolroom is shown in Fig. 2. This can be made as a complete unit and of a suitable size to slip under one of the work

benches, thus utilizing space that is rarely of any advantage.

The toolroom rack should be built of sufficient size to take not only those broaches that are waiting to be ground, but also those partly finished broaches that must be always floating through the toolroom of a plant where broaching is the rule and not the exception. Further, it is advisable to store in the toolroom all new spare sets of broaches made as a reserve, so that they will actually be kept as a spare set.

If this is not done, all the sets will get used indiscriminately; and quite probably all will go wrong together. Apart from this, if several sets of the same size are used on and off, it will be difficult to form any idea as to the number of holes that any set has produced. From this consideration it will be seen that the storage required in the toolroom may under certain circumstances be quite large. It is well in any case to have plenty of empty bins, so that at any time there is a place to store every broach where it will be safe from the accidental knocks that are so fatal to the life of a broach.

War-Standardization Work of the Society of Automotive Engineers

The Society of Automotive Engineers is coöperating with the Government in the establishment of standards in the respective engineering fields, and also preparing to formulate rules and regulations for the operation of the various automotive apparatus and for the training of the necessary drivers and mechanicians, in order to meet any emergency demands that may arise during the war.

Many matters essential to the sufficiently rapid manufracture of aircraft and other apparatus are being considered, all the actions having a bearing on Government operations being subject to the approval of the various Federal departments. In connection with aëronautics standard forms of control of airplanes will be proposed, the Deperdussin and stick controls being under consideration. Tire and rim sizes for airplanes will be recommended, as well as detail construction of a number of elements, such as hubs and spokes, loops for hard wires, flexible cable ends, galvanized nonflexible cable ends, thimbles, turn-buckles, spark-plugs, tachometer-shaft drive and safety belts. A system of marking airplane gasoline pipes and oil pipes so that they will be readily distinguishable at all times has been indorsed.

Although a harmonious decision has not been arrived at with the National Division of Aëronautics with regard to the definition of engine rotation, a table of dimensions involved in interchangeable mounting of engines in airplanes has been determined upon with the Government. With regard to the basic system of measurement to be employed (that is, the English or the metric) in dimensioning airplane parts, the Aëronautic Division feels that inasmuch as the Army and Navy Departments are not both in favor of adopting the metric system, and it is necessary to determine standards which will involve the least possible delay in the production of airplane parts, the English system should be used except in isolated cases such as spark-plug threads where the metric system is desirable in order to effect interchangeability with some well established standards.

The Engine Division has collected data on poppet valves and submitted to manufacturers suggested standards for valves in detail. It has finally been thought best to recommend for standardization only a few of the basic dimensions of the valve, although there has been considerable demand for going into additional details. The adoption of the standardization as formulated will mean quicker and more economical production of valves and simplification of stock supplies and great convenience to car repairmen and users.

The Marine Standards Division of the Committee has approved as applicable to marine practice many of the long established standards promulgated for use in automobiles. These include the S. A. E. ⅞-18 spark-plug shell, rod and yoke ends, cotter-pin sizes, screw threads, square and splined broached fittings, steels and heat treatments, bearing metals, aluminum alloys, test specimens, carburetor flanges, piston ring groove dimensions, and many other items.

The starting battery installed on gasoline cars has been considered of sufficient importance to justify the establishment of a Division of the Standards Committee for the purpose of harmonizing detail practices with benefit to car and battery manufacturers and users.

It is considered by the Government authorities that it is essential that the solid tires with which the military trucks will be equipped shall be of the demountable type. The pressed-on type of solid tire is of course most used on commercial trucks, and the dimensions of fastenings for the demountable type have not been standardized to any great extent so far as interchangeability of several different makes of tire on the same wheel is concerned. In view of this situation the S. A. E. Tire and Rim Division has been doing strenuous work to get the tire manfacturers to so modify their design that their products of different makes will interchange. The Division has decided to recommend standard specifications for demountable tire and rim equipment and fastenings for 1½- and 3-ton military trucks, the felloe bands and tire diameters conforming to present S. A. E. Standards specifications. A type of tire channel is to be used which will permit of one size of wedge ring being used for both single and dual equipment regardless of sectional sizes; also one standard section of center wedge ring for use between dual tires of sectional sizes. Side flanges having S. A. E. standard bolt circles are to be used.

Repairing a Split Nickeling Tank

By George M. Little

At a time when the work would not permit a long delay for repairs a leak was discovered in a large wooden tank lined with pitch and used for holding nickel-plating solution. Upon examination it was found that a bottom plank had "season-cracked," parting the lining and thus causing the leak.

The solution was removed, and a piece of heavy canvas large enough to cover the entire bottom inside and reach up on the sides and ends about 6 in. was cut at the corners so that when the sides and ends were folded up box shape they lapped over about an inch. A blow torch was used to soften the pitch lining of the tank, and the canvas was put in place and carefully smoothed down with an electric iron, the heat from which caused the pitch underneath to soak into the canvas and thus hold it securely in place. The canvas was then given a thick coat of pitch and the solution was poured back.

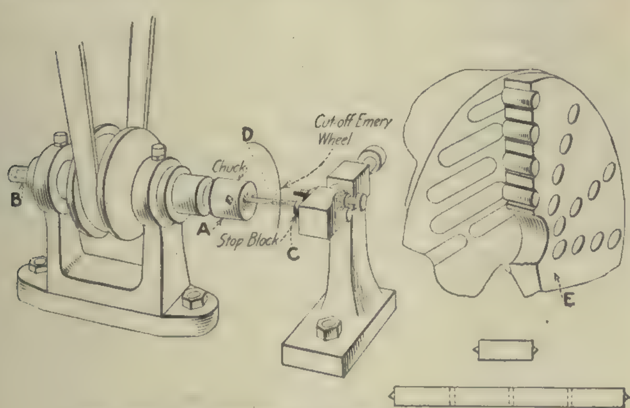
Grinding Rollers

By W. Hartel

At the plant where I am employed a new-model roller bearing called for rollers that must be perfectly round, and straight to a close limit. The limit for taper was 0.0001 in.

The small rollers were oversize 0.010 in. to finish to length and diameter. They had a small male center on each end, as with female centers about 30 per cent. of the rollers cracked in hardening. Also, female centers were used on the grinder, and the rollers had two small V-shaped punch marks on one end to engage two small prongs on the driver.

When I gave the spring enough tension to get a cut about 0.001 in. deep, it would offset the spring in the tailstock and I would get one roller about right, the next about 0.0002 in. taper one way or the other, the next about 0.0002 in. out of round, etc. If the tension was released so as to take a cut about 0.0003 in. deep, I could get a fair job. But as there was 0.010 in. stock to grind, this took too long.



METHOD OF FINISHING BEARING ROLLERS

We then had the rollers made in rods long enough for four rollers, ground them and with a $\frac{1}{16}$-in. elastic wheel cut them to length, allowing 0.010 in. for face-grinding the ends. Drill rod was used just as it came, with the exception of turning a small center on each end in the screw machine. Care was taken that both centers were close to the same size, as the pieces were reversed for grinding the diameter. After this they were hardened, and few required to be straightened. The outside diameter was then ground between female centers, using a Norton machine with a wheel 14 x 2 in., 46-M.

We first grind within 1 in. of the end, then turn the work over and grind the remaining 1 in.; with the centers in good condition the cuts will run into each other. Should a center sometimes be a little off and a light shoulder remain, this will do no harm, as the cutoff cut is taken through the center of the shoulder, which leaves the rollers on each side perfect.

The next operation is to cut the bars into four pieces, allowing 0.010 in. for face-grinding the ends. A No. 2 Universal Machine Co.'s grinder is used with a small drill chuck *A*, which is fitted with a special shank to fit the taper in the headstock. The chuck shank is drilled through to receive the tubing *B*, which is a sliding fit in the headstock spindle and screws in the chuck shank. This makes a straight hole through which the roller bars are fed from the back through the drill chuck against a stop *C*.

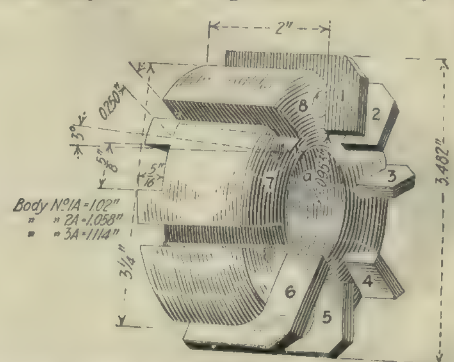
An 8 x $\frac{1}{16}$-in. elastic wheel *D* and plenty of water are used for cutting. We next grind the centers from end pieces, free hand. The finish cut to length is made on a Heald grinder having a rotating magnetic chuck. A plate *E* is used. It is $\frac{3}{8}$ in. thick, 7 in. in diameter and has reamed holes to receive the rollers.

By having the holes in the plate a good sliding fit and by using the revolving magnetic chuck, a good square and smooth face is obtained. As 146 pieces are ground at one setting, it makes a pretty fast operation. Taking it all the way through, we are getting a better job at less cost by doing away with that friction drive.

An Inserted-Blade Reamer

By G. B. Holben

In line with the saving of high-speed steel, the reamer body shown in the illustration is designed to use the blades, after they have been ground, until they are undersized and can no longer be set up to the required size in the ordinary type of reamer body with blade slots of equal depth.



THE REAMER WITH BLADES IN POSITION

Three bodies are made up with slots cut 0.007 in. shallower progressively. When the blades are set out to the capacity of the slot in their original setting they are removed, moved around one slot, and a new blade added. Thus the reamer is put back where it started, with its full range of adjustment to draw on.

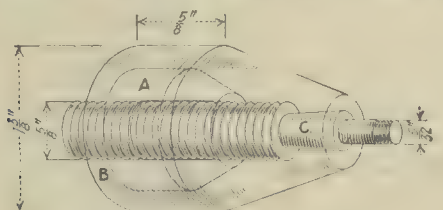
Each blade gets the full range of adjustment of the slots several times instead of only once. Having completed the cycle in body No. 1, the blades are inserted in body No. 2, whose slots are started 0.056 in. shallower; and the same process is gone over again. This design is preferable to shimming and gives better results.

Adapter for Holding Small Parts for Grinding

By Charles E. Smart

Some time ago I had some pieces to polish that required an emery wheel $\frac{1}{2}$ in. in diameter with a $\frac{5}{32}$-in. hole. There was no grinder head available with a $\frac{5}{32}$-in arbor, so the adapter shown in the illustration was made. This screwed onto the regular $\frac{5}{8}$-in. arbor.

The piece *A* was made of tool steel and hardened, and the hole was lapped to make a good sliding fit on the spindle arbor. Then the piece *B* was bored out



DETAILS OF THE ADAPTER

to fit the angle on *A* and threaded to be an easy fit on the spindle. The adapter *B*, which was made of machinery steel and pack-hardened, was reamed with a taper-pin reamer and the arbor *C*, which was made of tool steel and drawn to a dark straw color, was turned to fit it.

How Do You Harden Circular Forming Tools?

By J. A. Raught

For the benefit of one who asked how to harden circular forming tools, I will give my experience. I assume that he wishes to harden high-speed milling cutters and similar tools with delicate edges that must not come in contact with coke or a stiff flame that might distort them.

Use an iron tube (cast iron or heavy gas pipe) somewhat larger than the piece to be hardened; close the back end and put a center point in it. Bury the tube in the fire and cover completely with coke or coal. Take an iron rod a little smaller than the hole in the cutter, put a center in the end of it, slip the cutter over the rod and hold it in the tube with the rod against the center. Keep the cutter turning in the tube until it is full of fine blisters. The edges of the cutter are then about as soft as tallow and should not be dashed in the oil, but let down very carefully. Other readers will probably give more modern ways of doing this work, but I have found the foregoing method a good practical way when modern equipment is not available.

Multiple Circularizing of the Same Firms

By E. R. Plaisted

On page 526 appeared an article on the conservation of paper products. Thirty years ago I came here as a "cub" in the machine shop, and after many years in the drafting room it has for the past eight or nine years been one of my duties to sort the firm's correspondence and reply to the mechanical portion of it. This has brought to my notice the fact that we often get circulars in duplicate, occasionally in triplicate, and not many weeks ago we received three copies of a certain form letter or circular in one mail and two more in the next—or five copies in all—all alike.

So long as mailing lists are used in this fashion, so long will there be chance for further "conservation" in papers and inks, no matter whether we are at war or at peace.

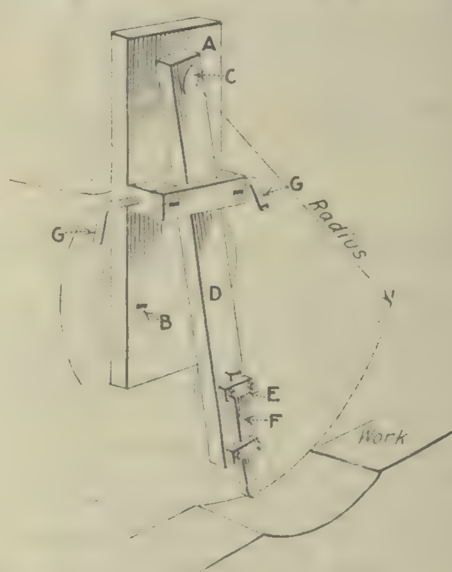
[This trouble is usually caused by a firm buying several different mailing lists and circularizing all the names on each list without checking them for duplicate names.—Editor.]

Shaping a Radius

By R. F. Pohle

It was desired to machine a press anvil to a radius of 27 in., which was too large for any lathe at hand. The following method was adopted, and it gives good results.

The standard *A* is fastened to the shaper head by the screws *B*. It is provided with a fulcrum stud *C*, at approximately the desired radius, upon which is hung the toolholder *D*, to which the cutting tool *F* is attached by the screws and straps *E*. The feed of the tool is controlled by the screws *G*, one being loosened, the other turned to follow. Concave and convex surfaces may both be handled with this fixture.



THE WORK AND FIXTURE

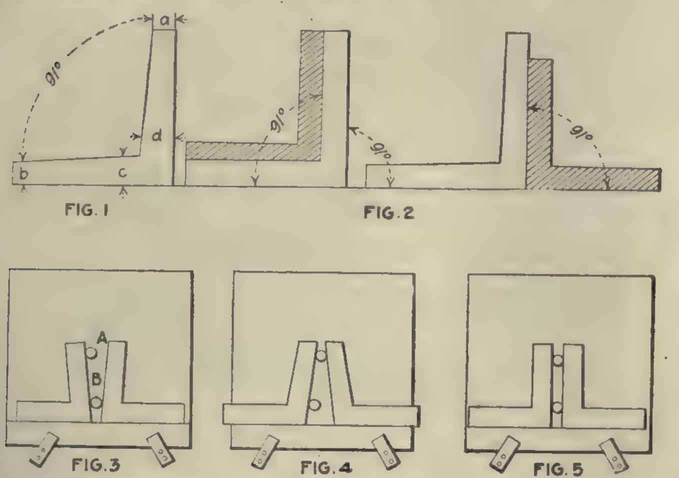
Accurate Angle Plates

By M. Jacker

It was interesting to read, on page 473, Vol. 45, how R. A. Gee squared up his angle plates. He does not say just how he squared up the plate after grinding away at *D*, but I presume he filed and scraped the edge at *A*.

He shows a method of verifying the truth of a square, failing to mention that the blade and foot piece comprising the square must be absolutely parallel pieces; otherwise, it is impossible to prove up to close limits.

Suppose a micrometer shows the extremities of the square at *a* and *b*, Fig. 1, to measure 0.0005 in. less when at *c* and *d*. In Fig. 2, exaggerating the error illustrates better how one would be deceived in proving up with a square like this. Although the square hugs the angle plate in both tests, neither one is true. If



FIGS. 1 TO 5. PRODUCTION OF ACCURATE ANGLE PLATES

a master square is not at hand, the nicest way to test and true up a square is with the aid of a pair of toolmaker's buttons, a surface plate and a straight-edge. In Figs. 3, 4 and 5 are shown several positions of the square in contact with the buttons and the straight-edge, which is clamped down on the edge of the surface plate. The square is slid along the straight-edge until contact with both buttons is obtained. The result will be as in Fig. 3, 4 or 5.

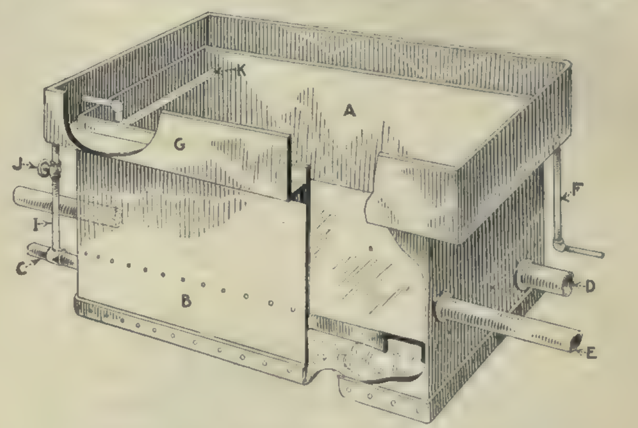
With tissue-paper feelers between both buttons and the square at the same time, it will be noticed, in Fig. 3, that the tissue paper at *A* is loose, while that at *B* is tight. This shows that our square must be scraped at *B*, after which it should be brought up against both buttons again; then the square should be brought up on the other side of the buttons. Again testing with the two tissue papers, we may find that there is still a little more to be scraped off at the same point; or possibly we have scraped off too much, in which case it will show up as in Fig. 4 and we must scrape the square at *A*.

If the tissue-paper feelers show an equal friction at each button, our square is about as nearly perfect as it can be made in relation to the scraped spots opposite the buttons. Next, it is an easy matter to scrape the whole edge of the square true by the aid of the surface plate, being careful not to get below the two scraped spots. It is not necessary to tap into the surface plate for the buttons. They can be braced down nicely with two light wires from a stick nailed to the bench wall.

Cleaning Tank for Metal Goods

By F. C. Mason

Articles that are to be finished by japanning or plating must be cleaned thoroughly and cheaply. In order to clean work thoroughly one must have at least two tanks—one for the cleaning and the other for rinsing. A great deal depends upon the tank, which can be of any size to suit requirements. The illustration shows a satis-



TANK FOR CLEANING METAL GOODS

factory tank. There is an outside guard to prevent overflowing when work is boiled too hard. These features are all novel, so far as I know.

At *A* is the tank proper; at *B* the steam bottom, which is of first-class boiler construction and should be tested to 150 lb. at least. About 75 lb. steam pressure will give satisfactory results. At *G* is shown the outside guard and scum trough; at *C* and *D* the steam intake and outlet. At *E* is the drain from the trough, which is connected to the drain pipe, not shown.

The skimming is accomplished by the use of steam jets just under the water level in the tank, which keep the surface of water moving continuously toward the far end of the tank. The pipe marked *K* extends across the tank with steam jet holes, about $\frac{1}{16}$ in. in diameter and 2 in. apart, drilled the whole length. This jet head is fed by the pipe *I*, regulated by the valve *J*. By having the tanks end to end, with a monorail above and either an electric hoist or a chain block, the work can be handled in baskets in quantities. By using the proper cleansing compound one can thoroughly clean work in 3½ to 4 min.

Hiring Men Away from Other Shops

By W. F. Rockwell*

Mr. Brophy's article, in which he discusses the ethics of "Hiring Men Away from Other Shops," is very timely. It hardly seems possible that any machine-tool purchaser favored with the free services of a mechanic would try to employ him without consulting the company that he represents.

We use a variety of semi-automatic machine tools and frequently require the services of demonstrators. We have never approached these demonstrators, and we never would do so without first getting in touch with their employers. Where we have a large number of machines of this nature which have been purchased from one manu-

*Factory Manager, Torbensen Axle Co., Cleveland, Ohio.

facturer, we would give preference to a man who had been employed by the manufacturer. For example, we have a large battery of Cleveland automatics, and several men employed in that department were formerly with the Cleveland Automatic Machine Co. Needless to say, none of these men was ever sent to our shop as a demonstrator. We would not employ a demonstrator without communicating with the Cleveland Automatic Machine Co., and any demonstrator who attempted to secure a position with us when sent here by his company would be considered untrustworthy, and therefore undesirable as an employee.

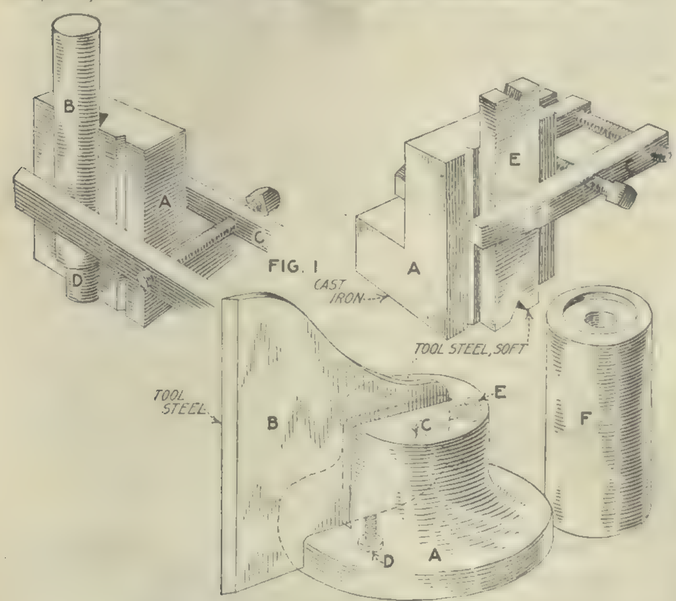
Our attitude in this matter conforms to Mr. Brophy's. We think, however, that there are some gains to offset the loss when a good man leaves under honorable circumstances to accept a position elsewhere. Our several Cleveland automatic men mentioned above have been thoroughly trained. They know Cleveland automatics, and their presence here has enabled us to get along without demonstrators at various times. The excellent production maintained has frequently caused visitors to express surprise, and we know that in several instances it has helped promote sales for the Cleveland Automatic Machine Co.

No one, particularly the machine-tool builder, should have only regret when one of his workmen leaves to go to another shop. Both employees and management usually know where the man came from; and if he is a good workman, they receive a good impression of the shop from which he came. If it so happens that he takes charge of semi-automatic machines with which he is familiar and which had been troublesome, due to inexperienced operators, he is sure to be of great value to his former employer.

Accurate and Convenient Angle Plate and Square

By Joseph Herdina

The illustrations show some convenient tools that I have in my kit. At *A*, Fig. 1, is shown an accurate angle plate made of cast iron and finished all over. I



ACCURATE AND CONVENIENT ANGLE PLATE AND SQUARE

use it on the surface grinder for grinding end measuring rods *B* and similar work. The rod *B* is held in the V-groove by a tool makers' clamp *C* and rests on a parallel or block gage *D*.

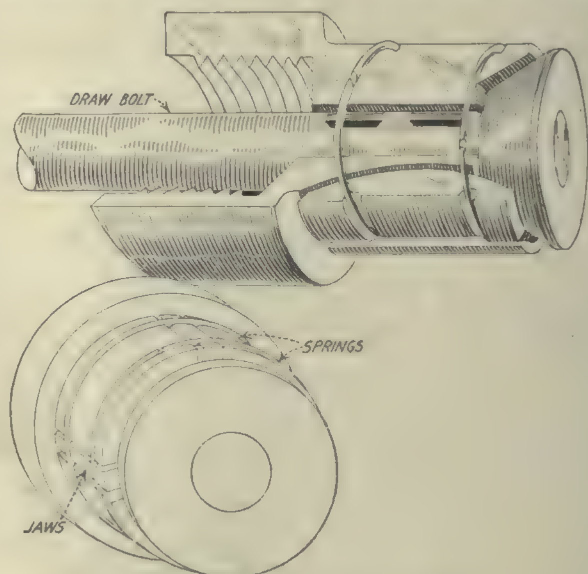
The same angle plate *A* is shown used in conjunction with the piece *E* as a jack for supporting long, slender work in the miller.

In Fig. 2 is shown an adjustable knife-edge bench square. The body *A* is made of pack-hardened machine steel. The blade *B* is made of tool steel hardened, ground and lapped. It is pivoted at *C* and provided with two adjusting screws *D* and *E*. For setting this and other squares I have made the test cylinder *F*. This is of tool steel hardened, ground and lapped all over and recessed at both ends.

Expanding Arbor for Use in Lathe Work

By H. E. McCray

We have adopted the expanding arbor or mandrel shown herewith as standard construction over the six-pin and other similar types, as it has a number of features to



EXPANDING LATHE ARBOR

commend it in hard service. The three expanding jaws are made in the form of Woodruff keys, relieved in the center, the points turned to the proper radius, knurled, then hardened.

The front expanding wedge is operated by a draw bolt, worked with a handwheel or air cylinder, as desired. The jaws are contracted by two small spiral springs fitting in suitable recesses and extending entirely around the slotted spindle nose.

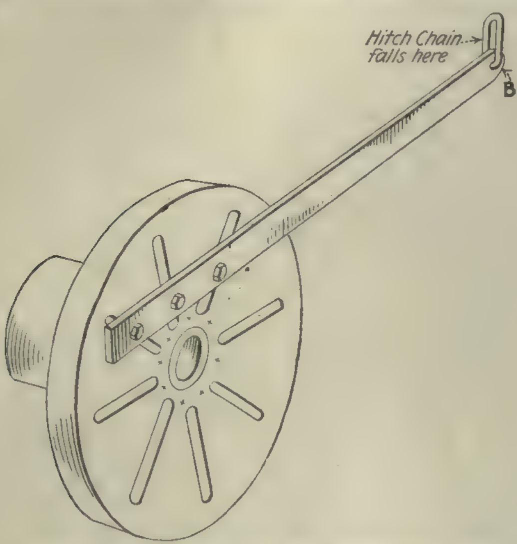
In milling, care must be taken to mill the slots to uniform depth and length, as a variation in length does not give equal expansion. The jaws must also be expanded against a collar and ground in place on the spindle nose to insure true running.

In my opinion, where it can be used, there is no better device, as the size of the work may be varied within limits; it has few parts, and the parts that wear may be replaced easily and cheaply. The casting, or bushing, is always forced back against the shoulder. Last but not least, it can be made up at very small cost, which is a decided point in its favor.

Removing a Faceplate

By O. D. Carter

Taking off a faceplate by the method described on page 214 seems rather drastic. A better way would be to bolt a long bar across the faceplate and hitch the chain falls



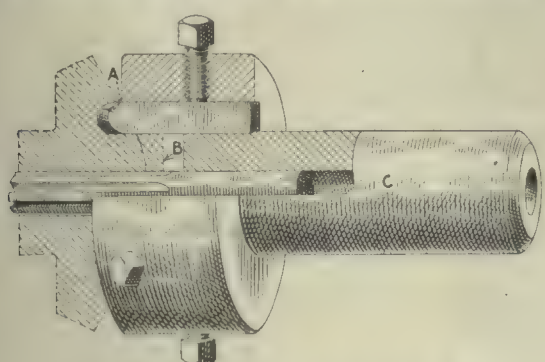
RIG FOR REMOVING THE FACEPLATE

near the outboard end, as shown in the illustration. When a good tension is applied, a series of sharp blows with a light sledge at the points *X* will tend to set up vibration, which will overcome the frictional resistance. Light blows at *B* below the chain falls, in time with those on the flange, will give material assistance.

Recessing Tool

By Ross Lewis

A certain factory in the Middle West had trouble in the Potter & Johnston department in machining that part of the lift gear marked *A* in the illustration. The



TOOL FOR MACHINING A LIFT GEAR

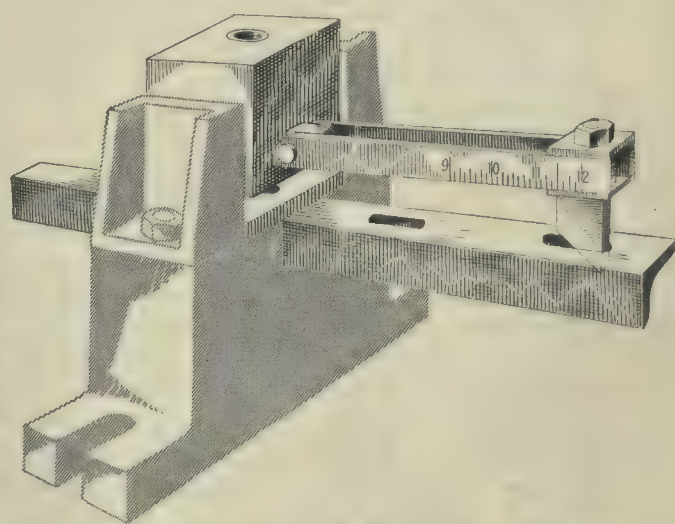
metal had a tendency to pile up on the tool. As in most automatics, the feed continued, and the tools invariably broke. The tool shown at *C* worked well.

A soft-steel shank was made with a counterbore to clear the hub *B*. A hole through this blank held a solid sizing reamer. On opposite sides two square tool bits were inserted, one with a circular cutting edge slightly forward of the other, which had a square cutting edge. A space immediately in front of the tools can be cut away to allow more chip room.

Slot Punch and Die for Hydraulic Press

By George Wright

The accompanying illustration shows a punch and die used with a hydraulic press for punching bolt slots 1½ in. long by $\frac{7}{16}$ in. wide in 2 x 2 x ¼-in. mild-steel angles. As the center distances of the slots vary for the various sizes of machines on which they are used, an adjustable locating stop drops into a previously punched slot. In this way the time required to lay out the slots is saved. The punch and die block are made from close-grained hard cast iron, machined where necessary. The die block has suitable lugs cast on it for fixing it to the moving platen of the hydraulic press. To secure the punch block, a ⅝-in. setscrew is inserted from the outside of the stationary top platen in the tapped hole provided for it in the punch block. With this arrangement it is evi-



SLOT PUNCH AND DIE, WITH ADJUSTABLE STOP

dent that, unlike general practice, the die forms the moving part, while the punch remains stationary throughout the operation.

The adjustable locating arm is made from two pieces of 1¼ x $\frac{3}{16}$-in. flat mild steel, fixed together as shown. It is hinged at one end so that it moves upward with the stroke of the die, should the beveled finger fail to locate itself correctly in the previously punched slot. The hinged arm can be swung up out of the way and the dies can be conveniently used for punching slots with varying centers, after they have been laid out in the ordinary manner.

In operation the first slot is punched at a given distance from the end of the angle; then by means of the locating arm the remainder are located. When the die is at the bottom of its stroke, the finger attached to the hinged arm is not quite clear of its relative slot; the angle is pushed forward till the side of the slot engages the beveled edge and lifts the arm. The angle is then pushed along until the finger falls into the previously punched slot; it is then pulled back hard against the vertical edge of the finger and is ready for the next punching operation.

This die may not compare favorably with modern power-press methods: but as no power press was available, the hydraulic press was used. Before its use these slots were milled.

Why I Am Buying My Bond

An Editorial

From a Machine-Tool Builder—

WHEN you ask why I am buying Liberty Bonds, I take it you are interested in reasons other than the patriotic ones common to all of us. In my own case, it is enough that this is an American war loan and that I call myself an American. But as the head of a machine-tool building plant, I see additional reasons for buying these bonds.

This loan is to be the means of financing our Government war purchases, and nine-tenths of it will be spent in our own country. At least one-half of our total appropriations will be spent for mechanical products, battleships, guns, rifles, automobiles, ammunition, railroad cars and locomotives, airplanes, submarines and the like. This first appropriation of seven billion dollars, of which this loan of two billion dollars is a part, is only a starter. As Frank A. Vanderlip says, "There will be other loans following this as soon as this is out of the way."

The total export of metal-working machines in our banner year of 1916 was less than eighty million dollars. The average annual output of mechanical products from all the machine shops of the United States is in the neighborhood of five billion dollars. What is going to happen, then, when several billions of good healthy American dollars are turned loose in the machine shops of this country? We will have to get busy as we have never got busy before!

Every dollar of the billions appropriated and to be appropriated will pass, directly or indirectly, through American machine shops. Every dollar will make its contribution to the activity of machine-tool builders and to the activities of the men who work with them to build these tools. As a plain matter of good business, it is up to me to help underwrite this Liberty Loan.

From a Turret-Lathe Operator—

PERHAPS some of your readers may be interested in hearing why a turret-lathe operator is buying his Liberty Bond. Trusting that this may be so at any rate, here goes:

In the first place, let me say that I am a real live American. At least I believe so and hope so. The work that comes from my mill is done right, because I take an interest in it and a pride in it. If all I had to live for was what the pay clerk hands me on Saturday (and believe me, I get as much as any of them), I would consider it time to die.

I belong to the shop bowling team and the shop baseball team. And let me tell you, when we go up against the other shop teams in an argument, I do my bit to help our boys bring home the bacon.

I went down to the recruiting station a month ago to join Uncle Sam's soldier boys, but the Super got wind of it and had a word with the recruiting officer and then had a talk with me. He said that I could help more in the shop making shells than by stopping them at the front, and I guess he was right.

But I can't stand still and see Kaiser Bill with his thumb up to his nose grinning at Uncle Sam. So, believe me, I am whooping this old mill of mine up to the limit on six-inch shells, and I hope that each one of them sinks a submarine. And I am helping Uncle Sam send some boys across too. For I have taken a hundred out of the old sock and bought my Bond!

From a Machine Designer—

A MACHINE DESIGNER is not apt to be sentimental, because his training makes him look very closely to see what makes the wheels go around. So in telling why I am buying Liberty Bonds,

Copies of this editorial for distribution will be furnished on request

I want to disclaim any emotional reasons. I don't even wear a flag on my coat lapel.

As a designer, I have been trained to admire truth, work constructively and look beyond the machine to the work that it performs. A beautiful smooth-running machine may produce terribly bad work.

I have always admired the smooth-working efficient machine that Germany actually is—until I have during the past three years seen the terrible work that this machine was really designed to do. I realize now that all the workmanship spent in building this great machine—the science and art and skill—was not for constructive, but for destructive purposes. I have seen that Kultur is not Truth, but a Lie!

If a machine that I designed should not do good work, I would be among the first to seize a sledge hammer and smash it. To my mind this Liberty Loan is really the sledge hammer that is going to smash the terrible German war machine—the machine that grinds up helpless women and children as well as strong men and then spews them out as human refuse.

That is why I feel it is up to me, as a designer of good machines, to buy a Bond and help to smash this bad one!

From a Machine-Shop Foreman—

EVER SINCE I was a little shaver, I have had two ambitions. One was to get married, and the other was to save money. What has the Liberty Bond got to do with these? Nothing with the first, for I got married six years ago; but a whole lot to do with the second.

I have two of the finest kids that ever wore out shoe leather, and a wife that is the best that ever was, except in one way—she can't save money. Every raise in pay that I get is lived up to. Sometimes I manage to get a few hundred away in the savings bank; but as soon as the wife finds out about it, there is something needed in the way of furniture or a trip.

But here is my chance, and I'm going to grab it. I am going to do my saving for the coming year in advance—now! I am going to buy a thousand-dollar bond on the installment plan. The two hundred in the bank will go as first payment, and I find that the firm will carry the balance for me over the year, taking weekly payments out of my envelope. We won't be as apt to spend this bond as we would money in the bank; and yet if we need money at any time, the bond is as good as gold. I'd like to see the savings bank that is as safe as the United States Treasury!

What we don't have in my week's pay we can't spend, and I figure one year of this is going to give us the saving habit that will take care of the home and the kids in the years to come.

So when I have this chance to help myself in addition to helping my country, you can hardly wonder that I am enthusiastic about it.

From a Machine-Shop Owner of German Birth—

I AM BUYING Liberty Bonds because I am a real American—not by birth, for I was born in Germany—but a real American at heart.

Twenty-two years ago I came to America with just enough money to get me past the immigration inspectors, and just enough words of English to get me a job as a machinist's helper.

My birth as an American did not take place on the day I received my citizen papers. It went back seven years before that to the day that my desire for American ideals and opportunities overcame the home ties and relations of the Fatherland. Since that day the pleasant recollections of the Fatherland have been fading, but in the last three years its wrongs against humanity have stood out blacker and blacker.

All that I have has come from America. She has clothed and fed me and given me shelter. Under her care I have grown in twenty-two years from a machinist's helper to owner of a large shop.

A child by adoption does not necessarily love a good mother less than a child by birth. America is my mother country. For twenty-two years I have needed her, and now she needs me. That is why I am buying Liberty Bonds.

Copies of this editorial for distribution will be furnished on request

Shop Equipment News

Adjustable Reamer

The Mantell reamer, shown in Figs. 1 and 2, has several points of interest, the first being the method of securing a parallel movement of the reamer blade. This is accomplished by means of small inclined planes, or

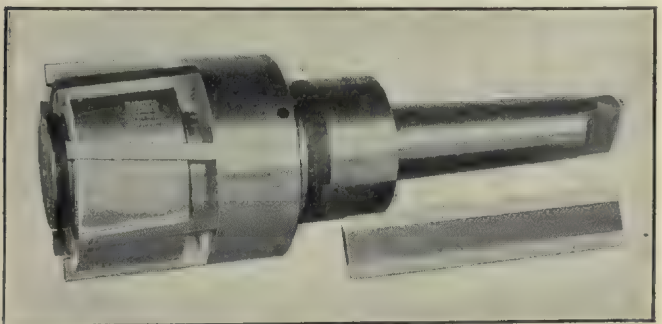


FIG. 1. MANTELL ADJUSTABLE REAMER

wedges, that fit into the slot at each end and are prevented from moving by means of the small studs. These slots are ground a half-degree hollow at one end to prevent any rocking of the wedge. This provision, together with the ease of grinding the angles accurately both on the wedges and on the blades, makes it possible to secure uniform and parallel adjustment well within the tolerances demanded by commercial work. The range of adjustment is ⅛ in. in diameter, which makes it very convenient for oversize holes.

The blades are set at opposite angles, two in one direction and four in the other, but so arranged as to give the advantages of uneven spaces and of being able to caliper any pair of blades at any point. The adjustment is made by the fine-threaded graduated nut at the end, the stationary zero mark having quarter-thousandth

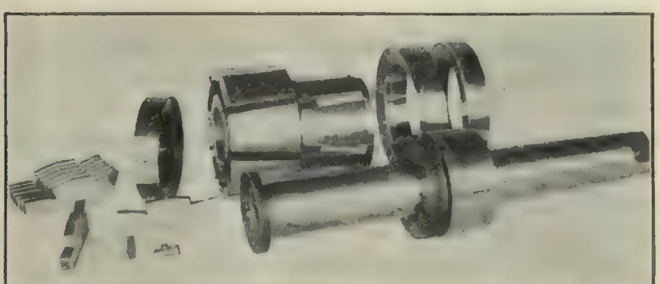


FIG. 2. DISASSEMBLED REAMER, SHOWING DETAILS

graduations. This zero setting stop is adjustable by means of five teeth on the under side, so that any adjustment for grinding or for temperature or other changes can be readily made by shifting it to a new point.

For aligning crankshaft bearings, as in automobile crank cases, a bar with special supporting bushings is used. They consist of an outer bushing with a fine thread on the outside of a cone for centering it in the bearing, and an inner sleeve that fits the bar itself. The inner and outer portions are eccentric to each other, so that they can be adjusted to make the hole either concentric with the outside or eccentric to about ⅛ in. This arrangement allows the bar to be lined up at will and to be supported at as many points as desired, as may be seen in Fig. 3, the supporting bushings being shown at *A*. These

FIG. 3. METHOD OF USING REAMERS IN A CRANK CASE

bushings can be backed out of the way as the reamer approaches them.

In the case shown, the crank bearings are being aligned from the two camshafts by means of the rigid end supports; in some other cases the crankshaft bearing is adjusted by these bushings to give the desired meshing of gears, which is done by placing a gear on the bar of the reamer and adjusting the bar until this gear meshes properly with the gear or the camshaft. This can be readily done by means of the eccentric bushings.

These reamers are now being developed for hand use as well as for bars. They are of various sizes, one large set being made for a crankshaft with 8-in. diameter bearings. The reamers are made by the Taft-Pierce Co., Woonsocket, Rhode Island.

Frosting and Spotting Tool

The Jones-Mowry Co., Jackson, Mich., has placed on the market the tool shown herewith, which has been designed for the purpose of frosting or spotting machine

TOOL FOR FROSTING AND SPOTTING

parts. It consists essentially of a rod, holding the cutting tool, and two steel tubes.

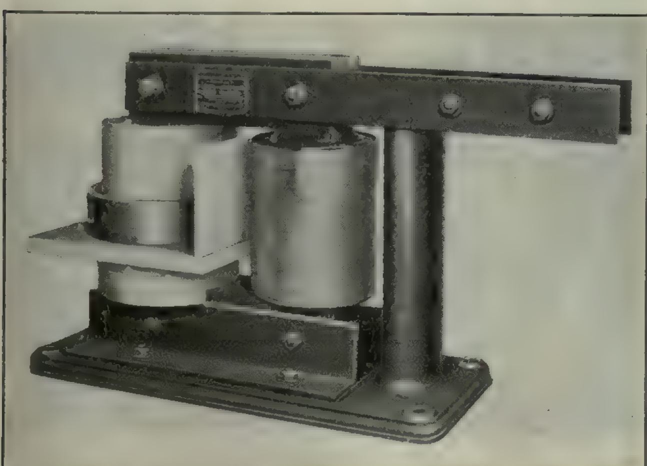
The outer tube is knurled to afford a suitable hand hold, while the inner tube has an angular groove in which runs a pin fastened to the central rod. An up and down motion of the outer tube, while the tool is resting on the work, gives the blade the necessary vibrating movement for cutting. The inner tube is hardened to prevent undue wear.

Shell-Band Heater

The Canada Cement Co., Ltd., Montreal East, Quebec, is now marketing the Burnett & Brunning electrically operated shell-band heater shown in the illustration. The device consists essentially of a transformer for single-phase alternating current, the ring to be heated forming the secondary. The resistance to the current induced in the ring is sufficient to bring the ring to the proper temperature to enable it to be pressed into place on the shell.

The transformer consists of a base supporting two uprights around which the primary winding is placed. A movable armature connecting the two uprights is hinged to a third upright and counterweighted at its outer end, in order to allow it to be easily raised for placing or removing the copper rings. A refractory material is placed around the coils, which are protected still further by a draft of air, from a high-pressure blower or compressed-air system connected to the base of the coil chamber. A ledge of refractory material is provided for holding the ring while it is being heated.

The advantages claimed for the electrically operated heater are that the heating is under perfect control, the formation of scale is avoided, the heating is uniform, and there is no loss through burned rings. The time required for heating is from 4 to 5 minutes, two heaters being used for each hand press. The current consumed is approximately



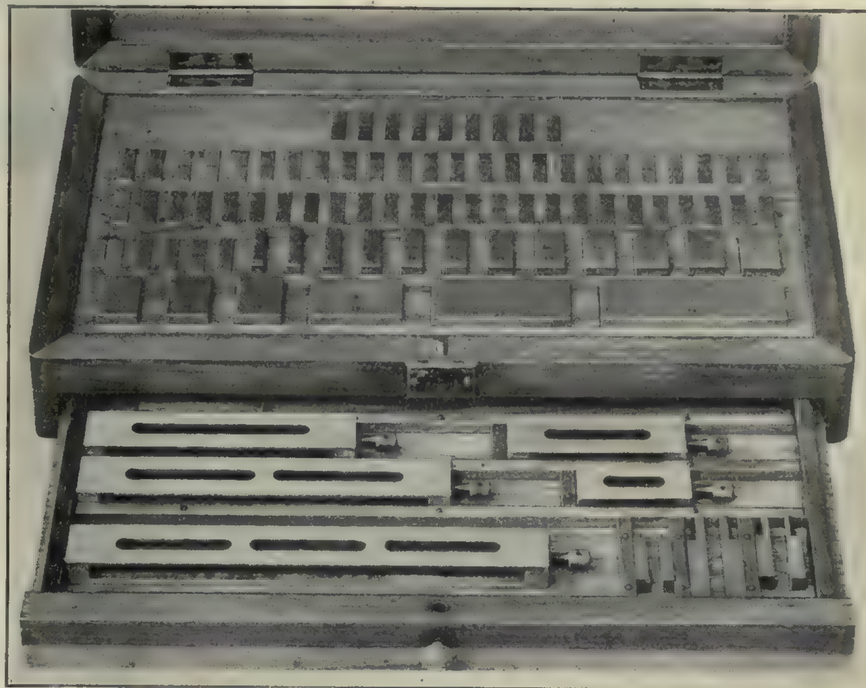
ELECTRIC SHELL-BAND HEATER

35 watt-hours per pound of copper heated. The heaters are made for any commercial voltage from 220 to 550; and for rings for 8-, 9.2- and 12-in. shells.

Gage Standards

Gage standards are now being manufactured by another firm in this country, Schuchardt & Schütte, 90 West St., New York City, having entered this field. The standards are made from blocks of high-carbon steel, have highly polished parallel surfaces and have the size marked on each block.

The blocks are subjected to a secret tempering process of long duration, which, it is claimed, overcomes the tendency for the blocks to change their shape and dimensions after they are made, except of course for the variations in dimensions due to normal temperature changes. The blocks will adhere to one another if only portions of the surfaces are in contact, thus allowing different combinations to be checked against each other. The makers guarantee that any combination up to four blocks will be correct within ± 0.00004 of an inch.



GAGE STANDARDS

The gages are made up in a number of different sets, depending upon the needs of the customer, each set being arranged in a wooden case, as shown in the illustration. The set pictured consists of 81 gage units; three pairs of jaws, 2, 4 and 5 in.; and four holders, 1, 2, 4, 6 and 8 in. The sets may be had to measure in thousandths, ten-thousandths or sixty-fourths of an inch.

Precision Grinders

The Slocum Avram & Slocum Laboratories, 531 West 21st St., New York City, are now marketing the internal and external precision-grinding attachments shown in the accompanying illustrations, which are easily adapted to any bench lathe and are universally adjustable with relation to the work. They are equipped with conical spindle bearings that are adjustable for wear. The bearings and spindles are of hardened tool steel, finished by lapping. Oil reservoirs are provided for purposes of lubrication.

Fig. 1 shows the external grinder, which is attached to the slide rest by means of the vertical T-head screw shown at the front. After this screw is fixed on the slide rest, the grinder may be adjusted with regard to height and angle by the locknuts above and below the lug on the grinder head.

Fig. 2 shows the internal grinder, which is fastened to the slide rest in the same manner as the external-grinding head. The spindle slides inside of the internal members of the bearings, being operated by means of a swivel knob on the rear end of the shaft. This feature

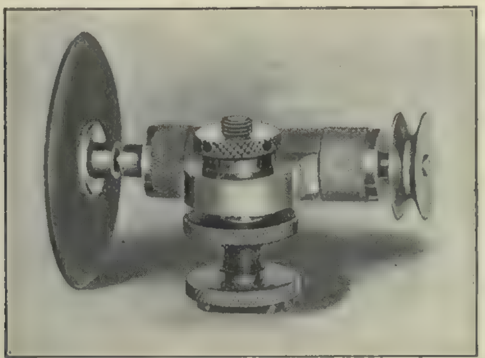


FIG. 1. EXTERNAL-GRINDING ATTACHMENT

eliminates practically all wear on the spindle and allows the wheel to be fed to the work either by means of the spindle or the carriage movement. The internal grinder is also equipped with a graduated swivel base. If the sliding spindle is used in connection with a compound rest, grinding may be done at two different angles—one by means of a movement of the slide, and the other by means of a movement of the spindle. The drive is by a round belt.

The grinding head of the internal grinder is hinged to the swivel base. This permits of the quick withdrawal

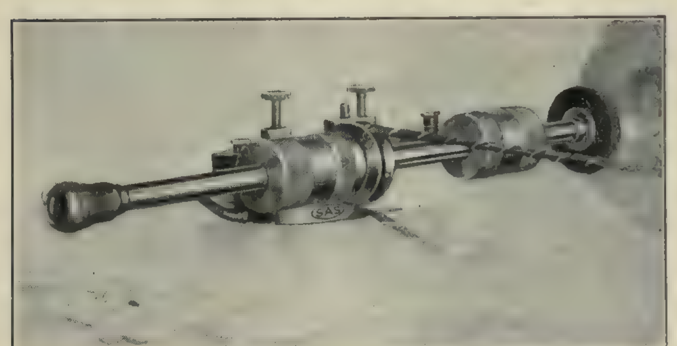
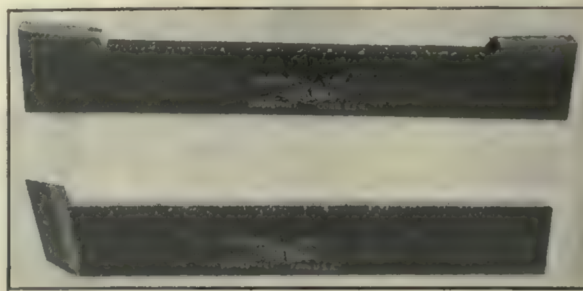


FIG. 2. INTERNAL-GRINDING ATTACHMENT

of the grinding wheel from the work for measuring purposes without disturbing the original setting of the attachment. When in position for grinding the head is fastened by means of a hinged screw, which clamps it to the swivel base in the exact original position.

Welded Stellite Tools

The Ready Tool Co., Bridgeport, Conn., has recently placed on the market a line of welded stellite tools designed to eliminate the excessive waste of this material. The upper of those shown is a double-ended tool with flat pointed stellite tip, while the lower is a single-ended turning tool. The tools are made by the electric butt-welding process in a variety of sizes, single or double ended, and either straight or offset. The company is also manufacturing stellite tool bits with butt-welded carbon-steel shanks. These are made in standard square and rectangular sizes, as well as for turret and Lo-Swing lathes and screw machines. If so desired, tools will be

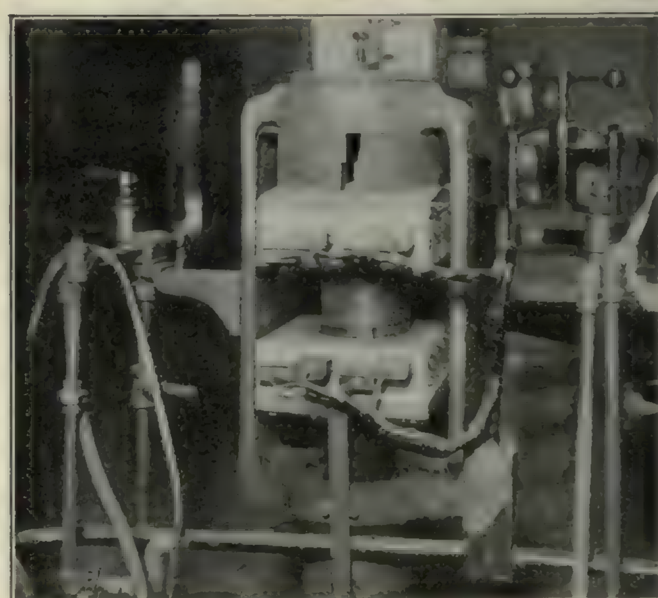


WELDED STELLITE TOOLS

made up from short ends of stellite from the customer's supply of scrap, thus obviating the expense involved if new material were used.

Electrically Heated Molding Press for Composition Material

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., has recently introduced electricity as a heating medium for presses used in heating molds for the manufacture of parts of composition material. The presses were formerly heated by steam. The heat is furnished by two plates, 12 in. square and 3½ in. thick, the exposed surfaces of which are covered with magnesia



ELECTRICALLY HEATED PRESS FOR COMPOSITION WORK

material to reduce heat losses by radiation. There are four heating units in each plate, each unit being rated at 300 watts.

The units are made up of a flat ribbon resistor assembled in a mica sheath, the whole being inclosed in a steel casing. The upper plate is stationary and carries a thermometer, while the lower plate moves vertically to apply pressure to the work. The operating controller is provided with 15 contacts by means of which voltages varying from 150 to 220 may be impressed across the heaters, the heat being thus kept at the desired point.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., May 26, 1917—One of the most frequent of the difficulties that have beset those who come to Washington to offer their services, and to some extent those who come by special request, is to find the right man to see in regard to their particular problem. The addition of new departments and of new men to handle the various functions of the work now being done makes such a vast array of new names and new offices that the information guards who have sufficed in times of piping peace are all at sea and are having a difficult time. Then too, there are so many changes from day to day, new men coming in, offices being transferred from one room to another or even from one building to another, that it is a difficult task to keep track of all the changes.

This confusion makes it almost impossible to publish a list of men in charge of different phases of the work, as such a list might be of no value when you came to use it. In taking up this matter with George Creel, chairman of the Committee of Public Information, he suggested that time can probably be saved by coming directly to his office, 10 Jackson Place (Jackson Place runs directly between the White House and the War, State and Navy Building), or by getting into communication with it. This committee can probably give you exactly the information desired, without the undue loss of time that generally occurs when other methods are followed in searching out the proper parties.

The Vital Question of Ammunition

Our inability to make guns in quantity, either rifles or larger guns for artillery use, forces us to the necessity of taking such guns as we can get in the emergency. Hence, the wise decision to adopt the Enfield rifle, which we can secure in large quantities as soon as production begins. It is definitely settled now that the Enfield rifle is to be altered to take our Springfield ammunition. Why there should have been the slightest hesitation in determining this point, or why using the British ammunition should have been advocated, is not clear. Of course, some changes in tools, fixtures and gages will be necessary and will cause a slight delay in manufacturing.

This fact, however, seems to sink into insignificance when we realize that, even with the changes, we can get rifles as quickly as we have troops to use them. And we surely do not wish to send our troops into battle armed with a rifle that we know is inferior in every way to those of the Germans, so far as shooting quality goes. With the Enfield adapted to take our ammunition, we have a rifle that compares very favorably with the Springfield in most ways and that shoots much harder than the British rifle now being used. These changes only require the bore to be 0.003 in. smaller, the chamber to be enlarged for the Springfield cartridge, and the magazine modified to take the new ammunition, which is a comparatively simple change.

These alterations give a rifle with a muzzle velocity much higher than that of the British Enfield, as can be seen from the following table. While it is still lower than that of the German rifle, it is the best we can do under the circumstances. But let us as least do the best we can.

	Muzzle Velocity, Ft. per Sec.	Muzzle Energy, Ft.-Lb.
United States, 0.30 Govt., '06	2700	2429
British Mark VII, 0.303	2440	2300
German Mauser, 7.9 mm	2882	2830

The 0.303 a Low-Power Cartridge

We must also bear in mind that previous to the war the British had intended to discard the 0.303-caliber bullet, replacing it with a high-powered cartridge of 0.276 caliber and having a muzzle velocity of 2790 ft. per sec. In fact, the first drawings for Enfield rifles which came to this country were for this type of ammunition. Furthermore, the British 0.303 cartridge is of the old rim type, while, with the exception of the Russian, every other army is equipped with the rimless cartridge that functions much more satisfactorily in every way in connection with the magazine and the bolt action. It was this head, or rim, that caused much of the grief to the makers of the Enfield rifles in securing proper functioning, and it represents the practice of the past rather than of the present.

Rifle experts claim that the higher velocity of the German rifle greatly reduces the life of the arm, that it is practically worn out after 1500 to 2000 shots and that the advantages do not compensate for the difficulties involved. But in any case this is not the question, as it is a choice between the British or United States ammunition, with practically every argument in favor of the latter. The Springfield cartridge is enough easier to manufacture in large quantities to offset any changes that might have to be made, as the British bullet is a built-up affair, consisting of a lead slug with an aluminum tip at the extreme point held together by the cupro-nickel jacket. Not only is the rimless cartridge better in the rifle, but it is infinitely superior to the rim cartridge in machine-gun work, where the operation of the gun is of vital importance and jamming may spell disaster.

The one and only advantage in using the British ammunition is that of interchangeability on the field. While it is a disadvantage not to be able to interchange ammunition, the French and British ammunition do not interchange, and both have given a good account of themselves and seem to be able to overcome the difficulty. Knowing

this, can there be any excuse for sending our troops abroad armed with a rifle that takes obsolete ammunition—ammunition that the British themselves would gladly abandon if they could? Do not our troops deserve the very best we can give them in the way of equipment instead of handicapping them with a rifle of shorter range and less stopping power?

Another argument that has been advanced in favor of using the British ammunition is that it could be supplied by the British ammunition factories at the front or elsewhere. But is it not better to be entirely independent in the supply of ammunition as well as in other things, when such an arrangement is perfectly easy? The making of the ammunition is a comparatively simple matter; and if we can transport troops successfully, we can also get ammunition to them.

After the War Is Over

Lastly, when the war is over, we shall then have a supply of rifles that are as modern as those of any army, instead of being supplied with arms and ammunition that will have to be discarded just as the Krags were some years ago. In fact, these rifles with the old ammunition will not be enough better than the Krags of 1898 to do any bragging about. And no one would think of recommending the adoption of Krags.

We have been sadly negligent in not having a large supply of Springfields and in not being in better position to turn them out in much greater quantities. According to Congressman Tilson and others, there is some question as to who is at fault. However, it is no use to cry over spilled milk and the only thing to do is to get the best rifles and ammunition we can for our troops. We can find out afterward who spilled the milk. But let us be sure we do get the best ammunition for the boys who are to go to France, and at the same time have rifles that will be of service after the war is over, although we all hope that no further need may be found for them. Do not let us abandon a high-powered, modern ammunition for one that is admittedly poorer in every way, for a mere matter of convenience and expediency. Nor must we forget that the time it will take to raise our new army to its proper strength will give us ample time to secure the Enfields modified for our own ammunition, if we but make a beginning and get started on the problem. This work is already under way, experimentally at least, in one large factory, and there is no reason why there should be any delay in securing the rifles fitted for our ammunition in ample time for the troops that are to use them.

Fairy Stories of Russian Rifles

In this connection it is interesting to note some of the points brought out in the speech of the Hon. John Q. Tilson, of Connecticut, on May 7, as well as to see, by some of the questions asked him, how utterly ignorant of the manufacturing of rifles or anything else the average Congressman seems to be. Mr. Tilson began by saying that modern warfare is a contest of metals more than of men, which bears out all that we have been trying to say in the *American Machinist* about the importance of the machine builder and particularly the builders of machine tools. Without them we shall have no armies equipped with more than the pike and lance of the olden day; we shall have no fleets of either the air or the sea, no transport but the horse, and no means of distant communication but the beacon fire or the waving of smoke signals.

Mr. Curry, of California, said that he had been told by an employee of the Westinghouse works that they had manufactured 1,000,000 Russian rifles within three months after receiving the order and did not see why it took so long to make the Springfields. Those who are at all familiar with the rifle contracts know the utter absurdity of such a statement, although Mr. Curry naturally had no means of realizing this. Another Congressman questioned the advisability of telling people how deficient we are in the supply of rifles, to which Mr. Tilson very properly replied: "Everybody knows it except ourselves. All our enemies know it, and we need not try to keep it a secret. We had better meet the situation squarely."

The rifle is not the only arm that must be modified in order to get quantity production: the larger guns are even more of a problem, and we shall have to use some of the British designs for field artillery. The British 18-pounder is said by ordnance officers to be a very good gun, although probably not as efficient as the famous French 75's. It is unfortunately not possible to get these, as none are being made in this country, while a few firms are at work on guns of this size and larger sizes for the British army.

The Question of Fuses

The fuse proposition is also in an uncertain state, owing to the lack of capacity of the arsenal. Probably it will be necessary to adopt either the modified British or the Russian time fuses, regardless of the merits of the United States fuse. These foreign types have been made very successfully in large quantities, so that, once the matter is decided, the fuses can be turned out in extremely large lots by a number of firms in several sections of the country. The same holds true of the detonator, or exploder, for high-explosive shells, and this change modifies the shell itself from the closed-point and open-base shell to the closed-base and open-nose shell of the British or Russian type. Indications point to the adoption of the Russian exploder for these high-explosive shells; and as these have been made in large quantities in several plants, here too the outlook is extremely hopeful. We must not sacrifice a single advantage for the sake of sticking to our own style of gun or ammunition; but when, as in the case of the rifle, it was proposed to take a distinctly backward step, vigorous protest should be made.

Registration, Selection and Exemption

There seems to be some confusion between the registration of eligibles and the selective draft. They are distinct in every way. Registration is simply the enrolling of all male residents of the United States between the ages of 21 and 30 years inclusive. Every male resident between those ages must register before the date set, unless he is in the regular army, the navy, the national guard or naval militia actually in Government service. The later process of selection will be made by lot from names on the registration rolls.

In this connection many are asking what will be done in the matter of exemptions for those who are more valuable to the country in their present occupations. No one seems to know just what the procedure will be or to whom the requests for exemptions are to be made. This information will be made public in due time. It seems a wise move to make up a list of those in your employ whom you consider vital to the carrying on of the business to

its best advantage, not to yourself, but to the country, which may or may not be the same thing. By making up such a list now, before the selection is made, you cannot be accused of trying to exempt for personal or other reasons someone who has been called. This list might well cover all ages rather than only those between the ages of 21 and 30, as other ages may be called later. By making out such a list in duplicate, having these lists sworn to as to date and names and filing them for future reference, you would have very good evidence of your desire to play the game squarely in every particular. There is as yet no provision for filing such exemption lists with the Council of National Defense, but a duplicate list sent to the council would be taken care of.

The Question of Man Power

The mobilization of man power is one of the necessities of prosecuting a successful war, and the mobilization must be preceded by a careful registration or inventory of this force. This work has never been done in this country, but it must be done to secure best results, not only for the present, but for peaceful pursuits in the future. Now that the different states are to take up the work of securing further inventories of their shops and productive capacities, this feature is one that they should consider very carefully. The taking of such a census must be done judiciously in order to have it of the greatest value. The great tendency in any questionnaire is to ask too many questions, to attempt to secure a lot of minute details that are not only difficult to get, but that are of little value after we have them.

Among the things we need to know is how many kinds of work the man can do with more or less skill. In other words, what different trades has he followed during the past few years? There are many men who, from force of circumstances over which they have no control, are doing a much lower-grade work than they are capable of handling. If we know what kinds of work a man has done, he can be placed in the class in which he is most needed and where he will be of the greatest use to the country at this time. When an inventory of this kind has been compiled, it will be surprising to see how many different kinds of labor many of our workmen have been engaged in during the past few years.

In this connection it is interesting to note that the Government employment bureaus, which were organized about two years ago, are being utilized to secure labor for the building of the new ships and for other needed industries. This bureau now has 20 zone headquarters ranging from Boston to Los Angeles and, at the time of the last annual report, had 62 sub-branches. There are bureaus at Boston, New York, Newark, Philadelphia, Baltimore, Norfolk, Jacksonville, New Orleans, Galveston, Seattle, Portland, San Francisco and Los Angeles, with sub-branches at Portland (Maine), Providence, New Bedford, Buffalo, Pittsburgh, Wilmington (Del.), etc., all of which can be of great service in securing men for this important work.

Airplanes To Be Made Here

The daily papers have had another spasm in the airplane line, but those directly connected with the airplane work here in Washington know nothing of the order for 1800 French machines, which is supposed to have been placed. This contract, according to the papers, was only a starter, and thousands of airplanes were to be ordered from France because machines of American manufacture had failed completely to meet the army tests.

Personals

Keith R. Rodney, formerly of the Midvale Steel Co. and the Winchester Repeating Arms Co., has joined the staff of the Bullard Machine Tool Co. as metallurgist and special counselor in the selection and treatment of steels.

F. Quattrone, chief engineer of the Italian State Railways, has returned to the United States as a special delegate of the Italian State Railways to be attached to the Italian embassy at Washington. He will have charge of the purchase and shipment of all materials contracted for by the Italian Government.

Business Item

The Zenith Metal Co., Indianapolis Ind., is building a large addition to its factory and plans to double its present capacity for stamped steelwork.

Trade Catalogs

Link-Belt and Sprocket Wheels for Sawmills. Link-Belt Co., Chicago, Ill. Book No. 260; pp. 56; 6 x 9 in., illustrated.

"Little David" Pneumatic Drills. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 8507; pp. 40; 6 x 9 in.; illustrated.

"Imperial X" Duplex Steam-Driven Compressors. Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3311; pp. 20; 6 x 9 in.; illustrated.

Forbes Pipe Cutting and Threading Machines. The Curtis & Curtis Co., 66 Garden St., Bridgeport, Conn. Set of circulars hand and power machines. Illustrated.

"Willey" Electrically Driven Tools, Dynamos and Motors. James Clark, Jr., Electric Co., Louisville, Ky. Catalog No. 26; pp. 44, 6 x 9 in., illustrated. This describes grinders, drills, etc.

Heat Treatment of Steel. Tate-Jones & Co., Inc., Pittsburgh, Penn. Pp. 39; 4¾ x 7¼ in.; illustrated. This booklet contains much information in regard to the heating, hardening and tempering of steel.

Chidsey's Challenge. The C. J. Root Co., Bristol, Conn. This is the title of a booklet written by J. T. Chidsey, president of the company, calling attention to the merits of Root revolution counters. Pp. 16; 4 x 9 in.; illustrated.

Commercial Gear Cutting. The Fellows Gear Shaper Co., Springfield, Vt. This is the fifth edition of this treatise, revised and enlarged, dealing specially with the commercial production of spur, helical and internal gears. Pp. 94, 6 x 9 in., illustrated.

Link-Belt Silent Chain. Link-Belt Co., Chicago, Ill. Data Book No. 125. Pp. 128, 6 x 9 in., illustrated. This contains information and tables presented in such form that engineers and power users may select their own drives and determine their cost.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice-president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The National Gas Engine Association will hold its tenth annual meeting at the Hotel Sherman, Chicago, Ill., June 5 to 7.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeting at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio, on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Quotations were current as follows at the points and dates indicated:

	May 25, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham	$40.00	$35.00	$15.00
No. 2X Northern foundry, New York	44.00	41 50	20.75
No. 2 Northern Foundry, Chicago	45.00	39.00	19.00
Bessemer, Pittsburgh	45.95	42.95	21.95
Basic, Pittsburgh	42 00	40.00	18.95
No. 2X, Philadelphia	44.00	42.50	20.50
No. 2, Valley	43 00	40.00	18.50
No. 2, Southern Cincinnati	42.90	·37.90	17.90
Basic, Eastern Pennsylvania	42 00	38.00	20.50
Gray forge, Pittsburgh	40.95	38.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	May 25, 1917	One Month Ago	One Year Ago	May 25, 1917	One Year Ago	May 25, 1917	One Year Ago
Structural shapes	5.00	4.10	3.50	5.00	3.25	4.50	3.10
Soft steel bars	4.75	4.00	3.55	4.50	3.25	5.00	3.10
Soft steel bar shapes	4.75	4.00	3.50	4.50	3.25	4.50	3.10
Plates	7.00	5.15	4.10	7.00	3.65	6.50	3.50

BAR IRON—Prices in cents per pound at the places named are as follows:

	May 25, 1917	One Year Ago
Pittsburgh, mill	4.00	2.65
Warehouse, New York	4 60	3.25
Warehouse, Cleveland	4.50	3.25
Warehouse, Chicago	4.50	3 10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		May 25, 1917	One Month Ago	One Year Ago	May 25, 1917	One Year Ago	May 25, 1917	One Year Ago
*No. 28 black	7.25	9.25	7.50	3 65	8.25	3.20	7.50	3.20
*No. 26 black	7.15	9.15	7.40	3.55	8.15	3.10	7.40	3.10
*Nos. 22 and 24 black	7 10	9.10	7.35	3.50	8.10	3.05	7.35	3.05
Nos. 18 and 20 black	7.05	9.05	7.30	3.45	8.05	3.00	7.30	3.00
No. 16 blue annealed	7.25	8.70	6.70	4 70	7.95	37.0	7.70	3.60
No. 14 blue annealed	7.00	8 60	6.60	4.60	7.85	3.60	7.60	3 50
No. 12 blue annealed	6 75	8.55	6.55	4.50	7.80	3.50	7.55	3.45
No. 10 blue annealed	6.50	8.50	6.50	4 55	7.75	3.55	7.50	3 40
*No. 28 galvanized	8.25	11.00	9 25	5.65	10.00	5 50	9.50	5.50
*No. 26 galvanized	7.90	10.70	8 95	5.35	9.70	5.20	9.20	5 20
*No. 24 galvanized	7.80	10.55	8.80	5.20	9.55	5.05	9.05	5.05

*For corrugated sheets add 25c. per 100 lb. Note—No mill quotations.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	May 25, 1917	One Year Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 10%
Chicago	List plus 5%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	50%
Cleveland	50%	55%
Chicago	45%	50%

Note—For 7/16-in. and larger the discount is 45% for standard.

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	May 25, 1917	One Year Ago
New York	$13.00@19.00	$6.00
Cleveland	12.00	6 30
Chicago	11.50	5.25

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*

⅜, 11/32, 5/16, ¼, 7/32, 3/16	19.00
No. 8, 5/32 and No. 10.	20.00@30.00
⅛	
No. 12	
3/32, No. 14 and 1/16	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods

3/16 by 12 in. long	16.00
¼ by 19 in. long	14.00
⅜ by 19 in. long	12.00
½ by 21 in. long	12.00

*Special Welding Wire

⅛	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York May 25, 1917	Cleveland May 25, 1917	Chicago May 25, 1917
Tire	4.80	4.50	4.50
Toe calk	4.75	5.00	4 75
Openhearth spring steel	6.50@ 7.00	7.00	7.50@8.50
"Crucible" spring steel	8.25	11 00	12.00
Best cast steel, base price	10.00@11.00	12.00	...
Special best cast steel	15.00@18.00	19.00	...

*In bars.

PIPE—The following discounts are for carload lots f.o b. Pittsburgh, basing card in effect May 1, 1917:

BUTT WELD

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
⅛, ¼ and ⅜	42%	15½%	¾ to 1½	38%	22%
½	46%	31½%			

LAP WELD

2	42%	27½%	1¼	23%	8%
2½ to 6	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4	33%	20%
			4½ to 6	33%	20%

BUTT WELD. EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	38%	20½%	¾ to 1½	38%	23%
½	43%	30½%			
¾ to 1½	47%	34½%			

LAP WELD. EXTRA STRONG PLAIN ENDS

2	40%	28½%	1¼	24%	8%
2½ to 4	43%	31½%	1½	30%	16%
4½ to 6	42%	30½%	2	32%	19%
			2¼ to 4	34%	22%
			4½ to 6	33%	21%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	44%	28%	43%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	May 25, 1917	One Month Ago	One Year Ago
Copper, electrolytic (carload lots)*	29.50	37.00	30.00
Tin	65.00	54.50	48.00
Lead	11.50	10.75	7.50
Spelter	9.50	11.00	15.00

*Third-quarter copper.

ST. LOUIS

Lead	11.00	10.50	7.37½
Spelter	9.25	10.75	14.75

At the places named, the following prices in cents per pound prevail:

	New York			Cleveland		Chicago	
	May 25, 1917	One Month Ago	One Year Ago	May 25, 1917	One Year Ago	May 25, 1917	One Year Ago
Copper sheets, base	42.00	44 00	37.50	42.00	37.50	43.00	37.00
Copper wire (carload lots)	39.50	39.50	37.50	41.00	32 50	40.00	37.50
Brass pipe, base	47.50	47.50	44.50	50.00	38.00	47.50	38 50
Brass sheets	45.00	45.50	46.50	43.00	44.00	43.50	46.00
Solder ½ and ½ (case lots)	40.37½	33 87½	44.50	39.50	38.00	39.00	38.50

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill. 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	May 25, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	....
New York	45.50	45.50	$44.50
Cleveland	42.00	42.00	38.00
Chicago	42.50	42.50	40.00

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill 19.00

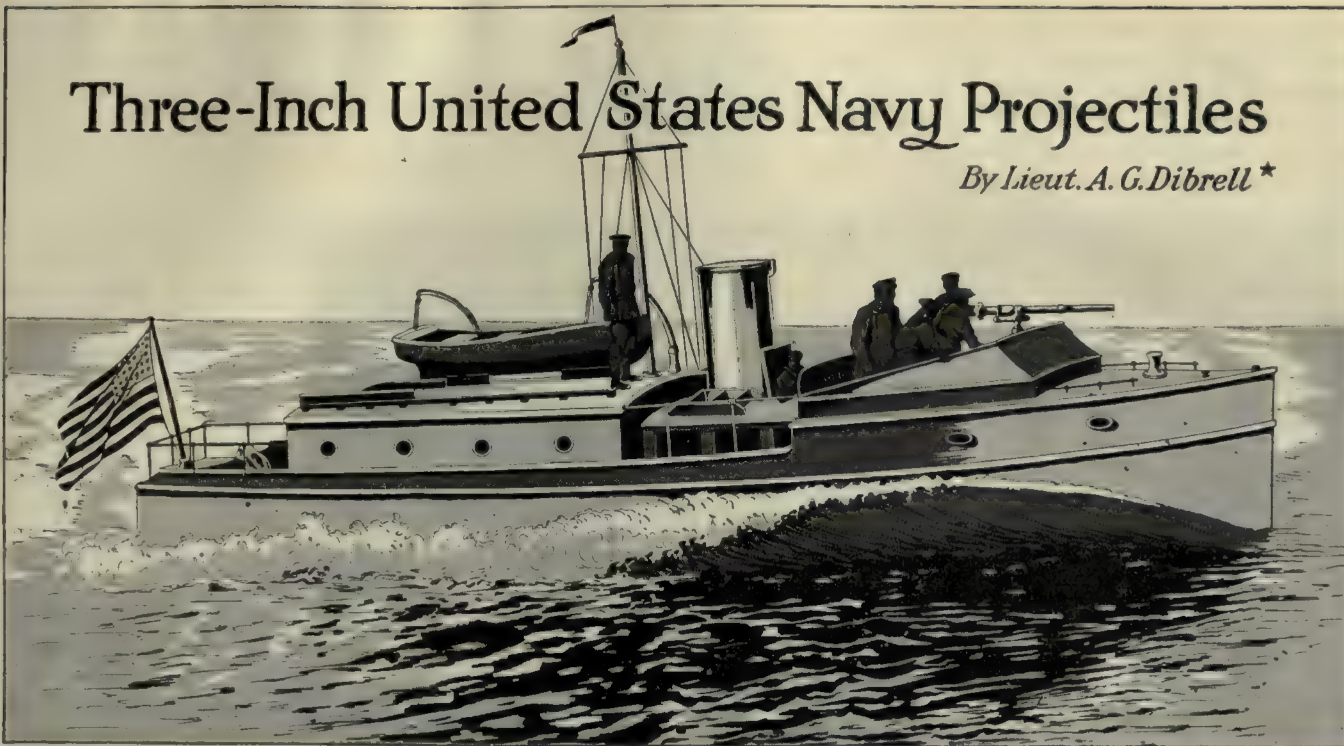
	In Casks		Broken Lots	
	May 25, 1917	One Year Ago	May 25, 1917	One Year Ago
New York	22.00	26.00	23.00	26 50
Cleveland	23.00	26.50	23.25	27.00
Chicago	22.50	26.50	23.50	27 00

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	May 25, 1917	One Year Ago
New York	29.00	28.00
Cleveland	28.00	52 50
Chicago	29.50	46.00

Three-Inch United States Navy Projectiles

By Lieut. A. G. Dibrell *



SYNOPSIS—Shells of the size described here are required in large numbers for use in guns placed on destroyers or on boats of the type known as submarine chasers. These shells differ considerably from the 3-in. ones used in field guns or coast artillery, which have been previously described. The various machine operations are given with considerable detail.

The manufacture of munitions in navy yards, an experimental enterprise, inaugurated last year, has proved signally successful at Puget Sound. As a general proposition in peace times, the Government unquestionably is wise in giving such contracts to private individuals, thereby releasing its own plants for the more important repair work on ships. But the Government should nevertheless be able to perform any class of work necessary for the proper supply of the fleet in all its essentials and have definite information at hand for the use of individuals, should an emergency arise. In the machining of projectiles there is a great amount of preparatory work necessary—special-tool manufacture, gage manufacture and the equipping of machines—before the projectiles can be properly and economically machined. Evidence of this has been obtained in every munition plant visited. Hundreds of rejected shells were seen, most of which were made during the early stages of the shops' contracts. This was owing to the fact that the manufacturers had only drawings and specifications to guide them in the selection of necessary machines and equipment. The Government should furnish the American manufacturers with concrete actual working examples of all the minute details necessary for the proper and efficient manufacture of munitions.

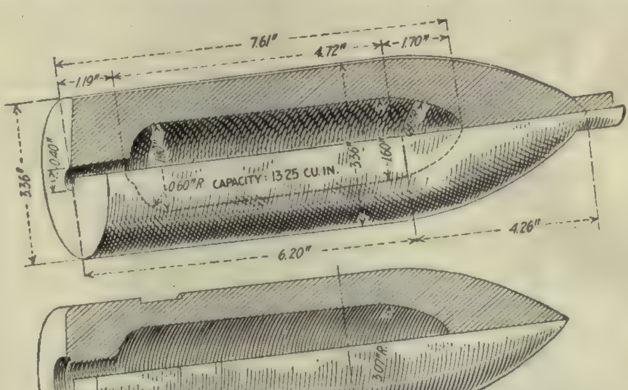


FIG. 1. DETAILS OF UNITED STATES NAVY THREE-INCH COMMON PROJECTILE

Owing to the great number of 3-in. shells that will probably be required to supply the submarine chasers and patrol boats now building, a description of the method adopted at Puget Sound is here given. The machines used are common to all shops, and it is hoped that this description will enable private individuals to equip their plants and be ready to start the work of machining as soon as forgings are received. Fig. 1 gives the dimensions of the 3-in. forgings furnished the navy yard by the American Car and Foundry Company. A radial drill is equipped for the first operation for the 3-in. shells. The chuck shown in Fig. 2 is a universal three-jaw lathe chuck. In the base of the chuck is a center point. The female center shown in the nib on the point of the rough forgings fits over this male point. The jaws of the chuck are then set up to hold the forging, while the small hole in the base is drilled out to $\frac{19}{32}$ in. in diameter. The center in the nib is concentric with the cavity of the forging, and the method of chucking and drilling the fuse hole in the base of the shell brings this hole also concentric with the cavity. The

*United States Navy, Submarine Division.

jaws of the chuck grip the shell about $2\frac{1}{2}$ in. from the base. The surface of the forgings is somewhat distorted by the dies in closing in the base, and the chuck must grip below this part of the forging. The swinging arm carrying a hardened bushing is closed to engage a permanent stop and fastened in place by a wing nut, as shown.

FIG. 5. TURNING BASE AND BAND SCORE

A $\frac{19}{32}$-in. twist drill running at 280 r.p.m. and with a feed of 0.008 in. is used to enlarge the hole. This permits the gage rods, shown at *A* and *C*, Fig. 3, in operation 2 to enter, and also removes rough stock for chasing the threads for the fuse. The lubricant is soap-water compound, which has proved very satisfactory for this work.

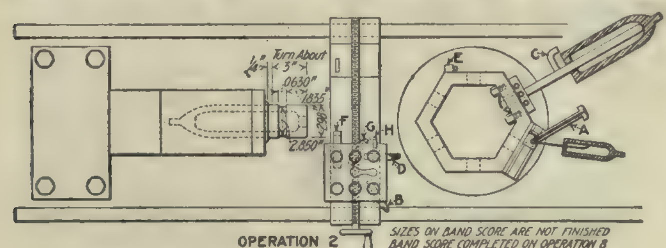


FIG. 3. ARRANGEMENT FOR OPERATION 2

Two machines are equipped for performing the second operation, as this operation requires the greatest amount of time to complete. A 16 x 20 x $1\frac{1}{2}$-in. Warner & Swasey belt-driven turret lathe and an 18 x 24 x 3-in. Jones & Lamson belt-driven turret lathe are used. Fig. 3 shows the Warner & Swasey lathe fitted for performing the operations. The forging is held in a collet chuck of six segments, separated by small springs, and each segment is knurled to give a better grip. The forging is first tested for eccentricity by means of the indicator *A*. The finger travels back and forth on the walls of the cavity and moves the pointer along the graduations shown. If the movement of the pointer exceeds the limits of the graduations, the forging will not clean up and is marked and set aside. The base of the shell is next faced off by the tool *B* on the turret head attached to the crossfeed to suit the gage *C* on the lathe turret. This establishes the dimension 7.42 in. from the nose of the cavity to the face of the base. About 3 in. of the base is next turned to a diameter of 2.995 in. by the tool *D*, finished by the tool *E* to 2.980 in. and the band score cut to a diameter of 2.850 in. and 0.630 in. wide by the tool *F*. The tool *G* rounds the base to the fillet shown on the drawing. The stop *H* is set for the tools *D*, *F* and *G*.

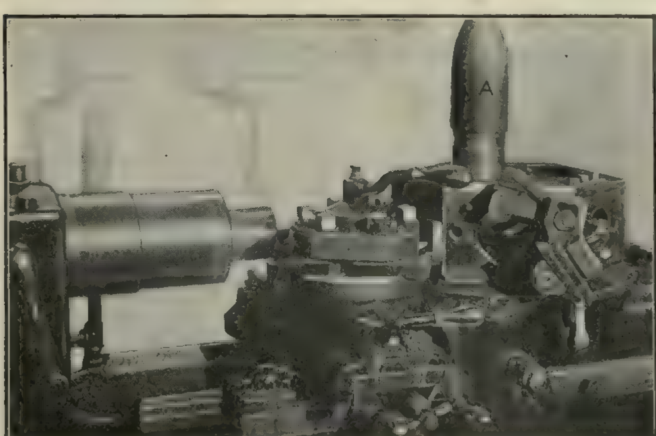


FIG. 4. TURNING BASE AND BAND SCORE

This machine is shown in Fig. 4; the view of the shell *A* on the lathe turret and *B*, Fig. 11, show the machining done. The turret head attached to the cross-slide is an ordinary square turret head holding tools at the corners. The lubricant used in this operation is a compound of soap and water. The cutting tools are all of tungsten tool steel. The Jones & Lamson turret lathe, Fig. 5, works continuously on operation 2, the tool layout being shown in Fig. 6. All selective gear is removed from the spindle drive, and a single back-gear shaft is installed. The forging is gripped in a draw-in collet chuck, operated by hand lever, the female center hole in the nib of the forging fitting over a male center point at the rear of the chuck. The depth of the chuck allows about $3\frac{1}{2}$ in. of the forging at the base clear for machining. The diameter at the base is rough turned by the tool *A* at 45 ft. per min. speed, 0.01-in. feed and $\frac{5}{32}$-in. cut. (Where fins have been left by the closing-in die at the base, the depth of cut is more than $\frac{5}{32}$ in.) The turret is indexed one position, a straight gage rod is inserted in the base hole,

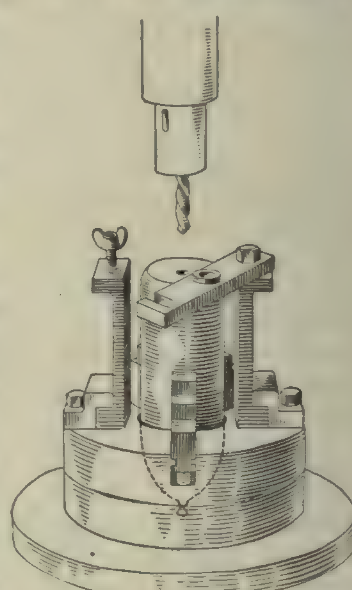


FIG. 2. DRILLING CENTERS

and the forging is faced off at the base by the tool *B* the correct length, which in this case is 7.042 in. from the extreme point of the cavity in the shell.

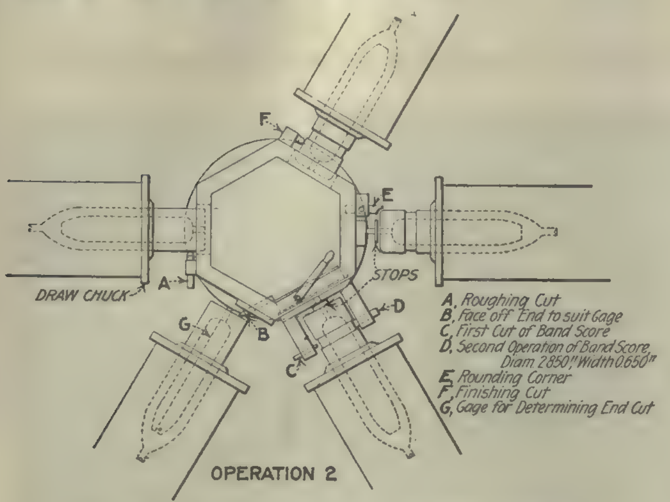


FIG. 6. TOOL LAYOUT FOR OPERATION 2

The work runs at the same speed and feed with $\frac{5}{16}$-in. cut. The turret is again indexed, and the band score is roughed out with the narrow tool *C* and finished with the $\frac{5}{8}$-in. wide-nose tool *D*. The feed and cut are regulated by hand through a cutting-off lever. The turret is again indexed, and the tool *E* rounds off the corner of the base with the machine running at the same speed. The finish cut is taken between the groove and the base of the forging on the next index of the turret, the tool *F* being used. The speed of the work is 120 ft. per min., $\frac{1}{60}$-in. feed, 0.007-in. cut. The lubricant is soap-water compound. Fig. 7 shows the Warner & Swasey lathe fitted for operation 3. The lathe has a special turning carriage fitted to the ways, being pushed forward by a regular turret saddle, which furnishes the power feed. The forging is gripped by a draw-in chuck at the base end, which has been finished in operation 2. The female center in the nib of the forging runs upon the male center supported through the turret hole, suitably arranged for quick disengagement when the work is unchucked. The roughing cut is taken over the body forward of the band score to the bourrelet, as shown in Fig. 8 and at *C*, Fig. 11. Two tools are used in the special carriage mentioned above to shorten the distance of tool travel. A speed of 55 ft. per min., $\frac{1}{64}$-in. feed and $\frac{5}{32}$-in. cut are adopted for this operation. Forgings are run through in lots of 100 on the roughing cut and then run through for a finish cut. In this manner, time is saved, owing to the rapidity with which forgings can be chucked and unchucked and to the fact that the roughing cut does not require accuracy. For the finishing cut the work is rechucked as before; the tools *A* and *B*, Fig. 7, finish cut the body, and the tool *C* on the turret finishes the bourrelet to micrometer sizes. On the finish operation, 175-ft. speed, $\frac{1}{64}$-in. feed and 0.007-in. cut are used. Soap and water compound is employed in both operations.

Operation 4 consists in roughing the radius point, and operation 5 in finishing the point. Both these operations

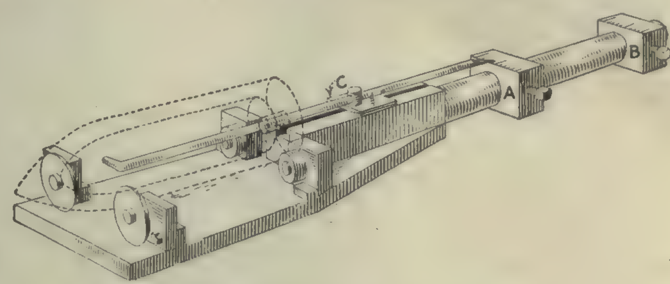


FIG. 13. TESTING FOR ECCENTRICITY

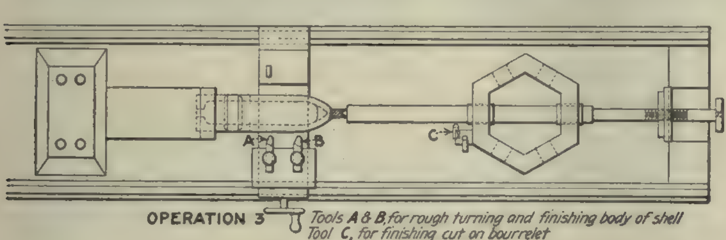
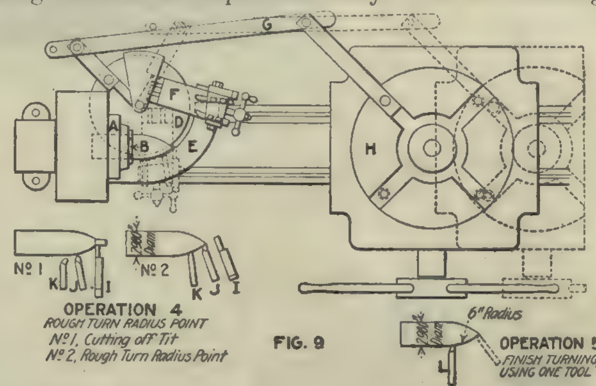


FIG. 7



FIGS. 7 AND 9. TURNING OPERATIONS
Fig. 7—Details for operation 3. Fig. 9—Turning operations on the point

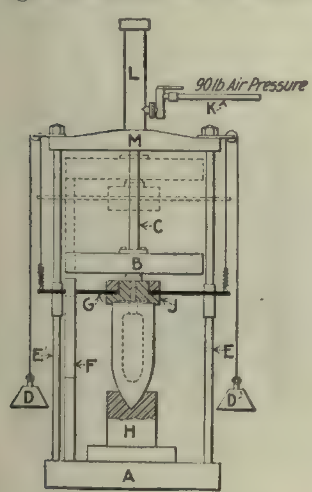


FIG. 14. MARKING THE BASE

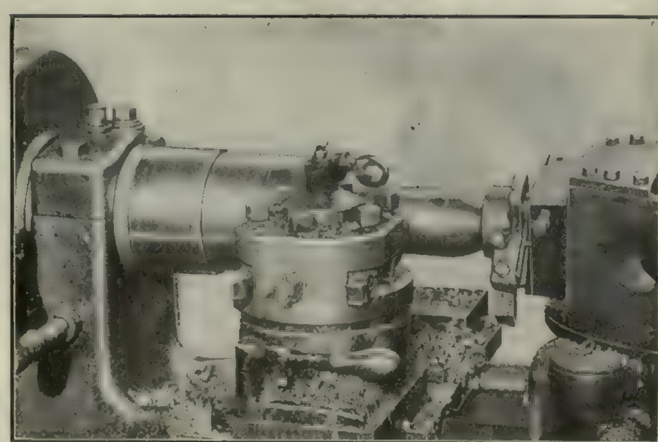


FIG. 8. TURNING FORWARD OF BAND SCORE

are performed in the same machine, a 2 x 24 x 13-in. Jones & Lamson turret lathe, from which the back gearing has been removed and a wide-belt drive connected directly to the spindle. The diameter of the spindle being smaller than the diameter of the projectile, a special outboard bearing *A*, Fig. 9, is fitted to take the overhang from the forward journal. The shell is gripped just back of the bourrelet in a collet chuck *B*. The cross-slide from an engine-lathe carriage is bolted to the swivel base *D* of a planer vise, and this rig is bolted securely to the ways of the turret lathe in correct position for turning the radius point on the fixed center, as shown in Fig. 10. The crescent-shaped casting, which is shown at *E*, is bolted to ways to furnish a bearing surface beneath the tool slide *F*. It has a brass wearing shoe of greater radius than the cutting tool, to prevent springing; a link *G* connects the base to the turret saddle *H*, and the circular movement for radius turning is thus derived from the straight-line travel of the saddle. The ordinary feed mechanism of the turret lathe gives automatic power feed. The tool-holding block carries three tools, as shown. The swivel is moved into position so that the cross-slide engages a stop screw fastened on the face of the outboard-spindle bearing, and the cutting-off tool *I* is then in position to cut off the nib, the feed being made by hand screw.

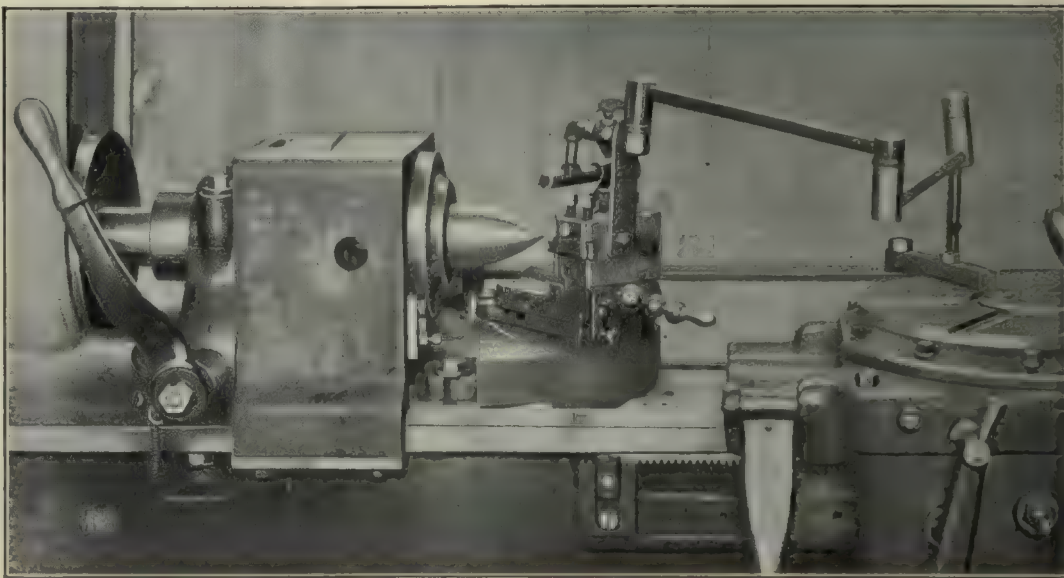


FIG. 10. TURNING RADIUS POINT

distance from the center of the swivel *D*; both tools, therefore, cut in the same plane. By using the two tools the entire surface of the radius point is machined when the tool block moves one-half the distance from the point to the bourrelet. Owing to the great excess of metal on this part of the forgings, it has been found necessary to take two roughing cuts. Furthermore, the radius point is not forged concentric with the straight body. The machine runs at a speed of 200 r.p.m., and the first roughing cut is approximately $\frac{1}{4}$ in. deep and $\frac{1}{120}$-in. feed. For the second roughing cut, the machine runs at the same speed, which gives about 150 ft. per min. at the largest diameter, with a cut $\frac{5}{32}$ in. deep. Lots of about 100 are rough turned, and the machine is shifted for finish-turning operation 5.

For the finishing cut the forging is chucked as before; the feed is reversed so that the finishing tool *L* will travel from the bourrelet to the point of the shell. For finishing, a speed of 240 r.p.m. is used, about 180 ft. per min. at the largest diameter, 0.01-in. feed and 0.015-in. cut. The lubricant for both operations is soap-water

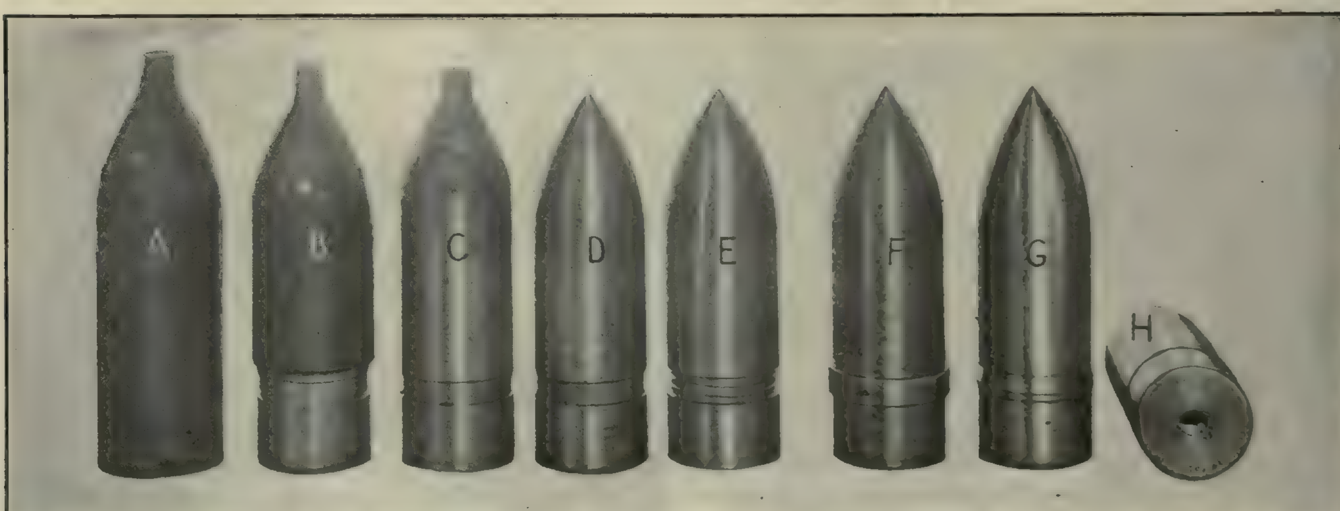


FIG. 11. SHELLS IN DIFFERENT STAGES OF MACHINING

The turret saddle *H* is moved by hand until the tool *J* is at the nose of the forging, the depth of the cut being adjusted by means of the regular crossfeed screw. The tools *K* and *J* are permanently set at the same

compound. A jet for each tool is so regulated that it may be utilized on one or all tools, as desired. The shell at *D*, Fig. 11, shows the condition after leaving this machine.

Operation 6 consists of weighing and gaging to this point (outside of forging finished) and again after the copper band has been finished. The leadingman and the inspector perform this operation. Fig. 12 shows the scale and various gages. Fig. 13 shows the gage for testing the 3-in. projectiles for eccentricity. The shell is laid on the rollers; the finger of the gage is inserted through the fuse hole, as shown, and is held against the walls of the cavity by the small spring on the block *C*, which slides in a slot milled in the casting. The pointer indicates on the blocks *A* and *B* the amount of eccentricity, the graduations being in thousandths of an inch. The shell is revolved on the rollers by hand. The following tests are made here: Gage bourrelet for size; gage body for size; test for eccentricity; gage length; weigh in rough and finished; gage copper band· test capacity of cavity; gage fuse-hole threads.

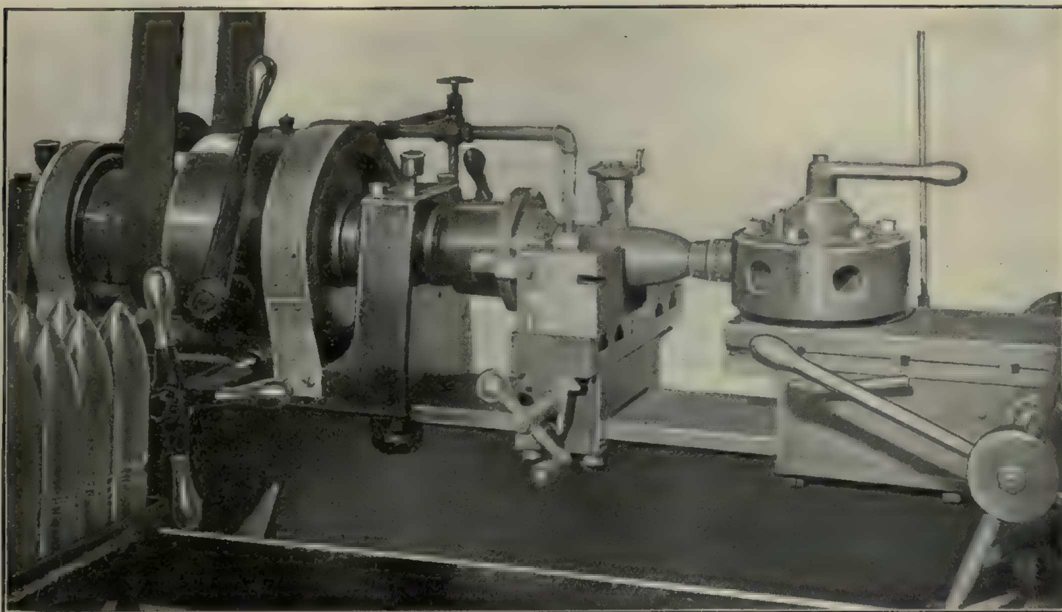


FIG. 15. TURNING SINUSOIDAL WAVES

Fig. 14 shows the device for marking the base, operation 7. It consists of the cast-iron base *A* supporting the two uprights *E*, across the top of which is the yoke *M*. On top of *M* is an air cylinder *L* operated by the lever *K*. The marking die *J* is supported by the plate *G*. The counterweights *D* are attached to the plate *G*, which slides on the two uprights for lifting the plate and die after marking. The conical chuck *H* holds the shell, base up, for marking. The weight being up at the position shown by the dotted lines, the action is as follows: The die is placed over the base of the upturned shell and secured. The air exhaust valve in the cylinder is opened, permitting the weight *B* to fall by gravity from a height of 10 in. There is a small rebound, but this does not affect the marking. The air pressure is turned on, lifting the weight. The die is removed, the counterweights lifting the die and plate. The shell is removed—another one put in the chuck.

Operation 8 is performed in an old-style wire-feed belt-driven Bardons & Oliver $1\frac{1}{2}$ x 14 x 16-in. screw machine, Fig. 15. In order to obtain sufficient diameter to grip the base of the projectile, a special draw-in chuck was made for the spindle. A three-throw cam of tempered steel is secured to the outside of the chuck body, to give the tool the movement necessary for cutting the sinusoidal ribs in the copper-band score. Fig. 16 shows the tool set up for this operation. A comb-shaped tool is held in a block on the cross-slide, as shown at *A*. When the slide is moved forward, this tool shaves the body of the band score to the correct width and diameter, leaving

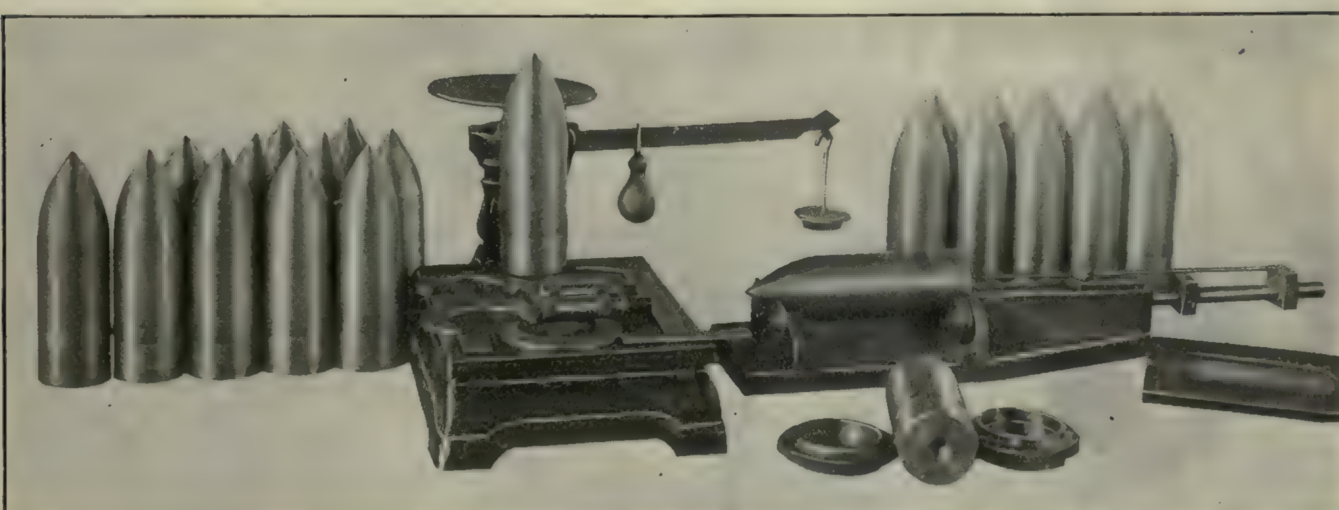
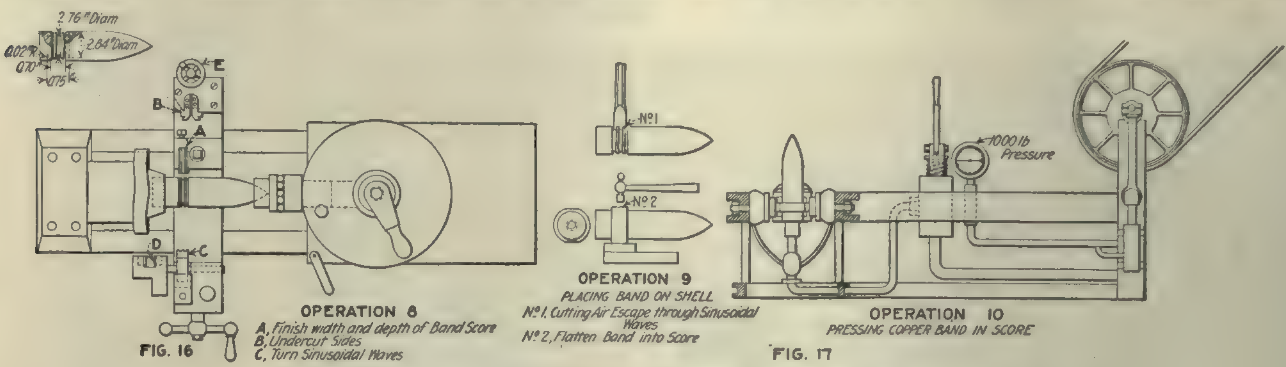


FIG. 12. INSPECTING, WEIGHING AND TESTING

ribs sufficiently wide to permit the tool *C* to finish the sinusoidal waves. The tool *A* travels underneath the forging until the slide engages an adjustable stop, at which time the undercutting tool *B* at the rear of the slide is in position to function. The operator turns the small engage the cam on the chuck previously described. The cam produces lateral motion in the tool *C*, which forms the sinusoidal waves. The cross-slide is fed in until the stop is reached, which is set for the correct diameter of the top and bottom of the waves. The distance of the



FIGS. 16 AND 17. OPERATIONS FOR BANDING
Fig. 16—Set-up for cutting the sinusoidal ribs. Fig. 17—The banding operation

handwheel *E* operating a wedge that forces the undercutting tools to the sides of the groove, the width and depth of undercut being regulated by suitable adjustable stop screws. The operator reverses the direction of the handwheel, and the undercutting tools collapse, permitting their withdrawal from the cutting position.

The cross-slide is next fed in by means of the regular feed screw until the yoke and the rollers *D* connected to the wave-cutting tool *C* in the front tool-holding block

band score from the base of the forging is permanently maintained by a shoulder in the chuck, which engages the base end of the forging. The nose of the forging is supported in a ball-bearing female center held in

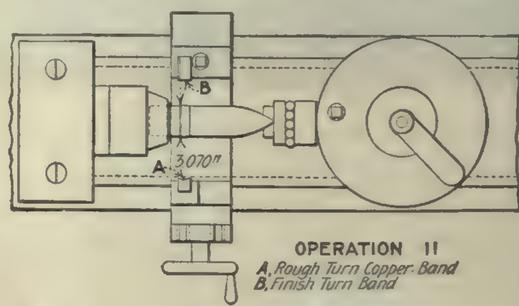


FIG. 18. TURNING THE COPPER BAND

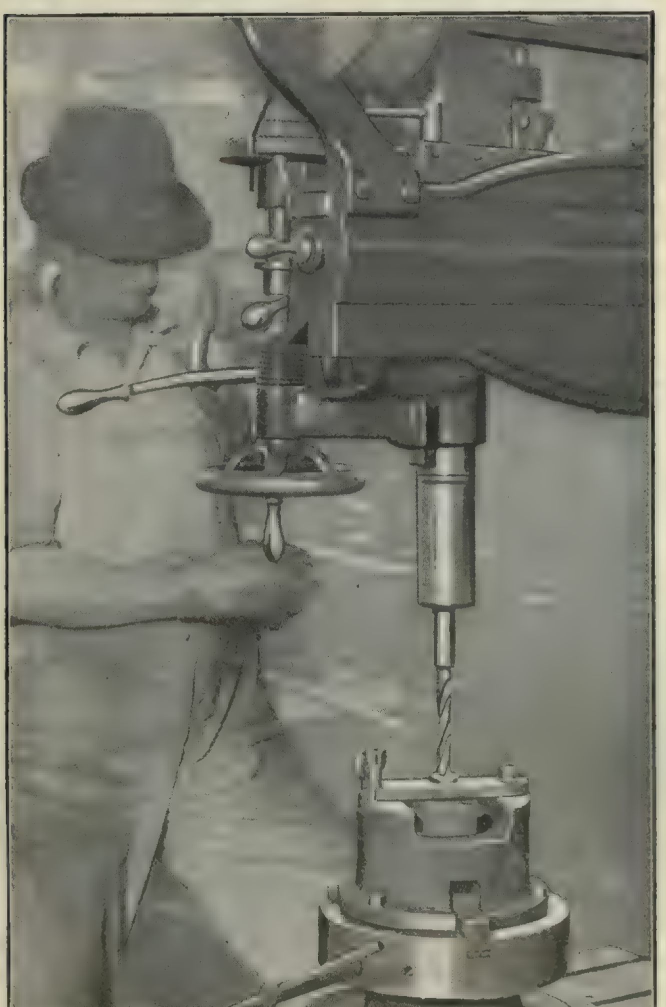


FIG. 20. COUNTERBORING AND TAPPING

the turret hole. The tools are made of tungsten tool steel and may be ground upon their faces without changing their shape. Soap-water lubricant is employed. A speed of 35 ft. per min. is used, all feeds being made by hand.

Operation 9 consists in cutting air vents in the sinusoidal ribs and fitting the copper band ready for the

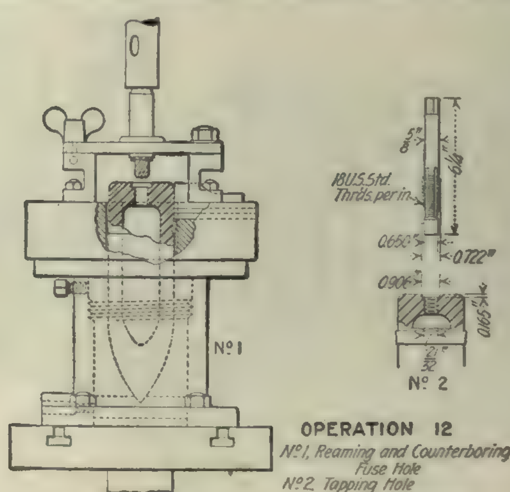


FIG. 21. MACHINING THE FUSE HOLE

banding press. Fig. 17 shows the banding press and the method of performing this operation. In order to shift quickly from the 6-in. banding to the 3-in., special 3-in.

dies were made to bolt to the regular 6-in. dies furnished by the manufacturers of the banding press. A gage pressure of 1000 lb. is used, which gives about 40 tons'

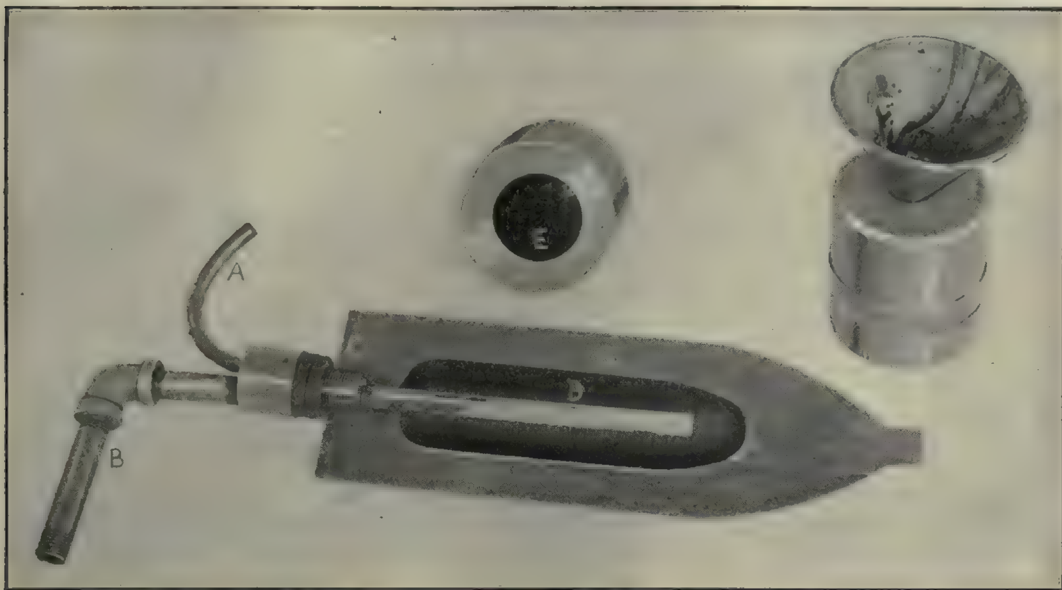


FIG. 23. LACQUERING INSIDE OF SHELL

pressure on the band. Two squeezes of the press are required.

Operation 11 consists in rough turning and finishing the copper band. This is performed in an old-style belt-driven 3 x 16 x 20-in. Pratt & Whitney wire-feed screw machine. A special chuck and a ball-bearing female center, similar to the ones described for the Bardons & Oliver machine, operation 8, were manufactured for this machine. A rigid tool block, holding the formed cutter

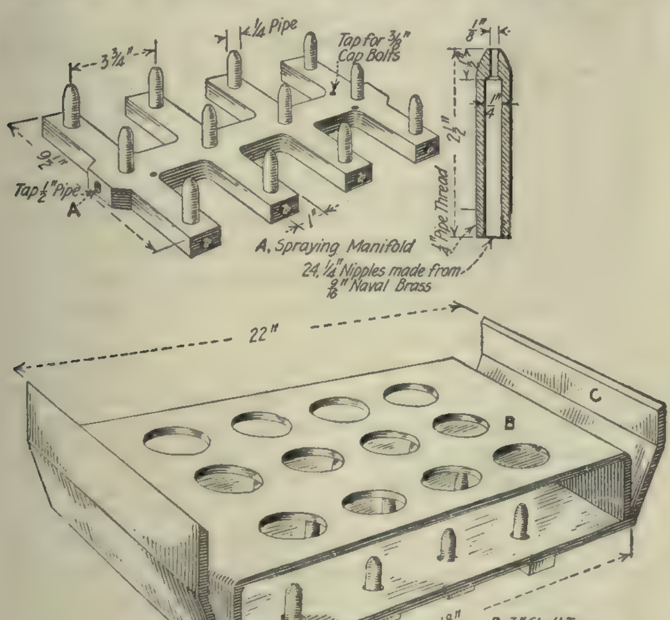


FIG. 22. DETAILS OF SHELL-HOLDING TRAY

A, Fig. 18, is fastened to the front end of the cross-slide. The line of travel of the tool *A* is in line with the center of the forging, the final depth of cut being regulated by a permanent stop to the slide. The roughing out is made with this tool, which cuts full width and the exact contour of the band. A similar tool block is bolted to the tool slide at the rear and holds the tool *B*. The line of cut of this tool is tangent to the perimeter of the band and is set at the correct height for shaving the diameter to exact size. The cutting tools are made of tungsten special steel, are interchangeable and may be ground on their faces without changing their shapes. The speed is 40 ft. per min. The feed is regulated by hand. The lubricant is soap-water compound. Fig. 19 shows the machine in operation. The radial drill used for operation 1 is also equipped for performing operation 12. The shell is held in a three-jaw universal lathe chuck mounted in a cast-iron elevating stand that is bolted to the drilling-machine table, as shown in Fig. 20 and in detail in Fig. 21. The bottom of the stand has a female center hole in which the point of the shell rests. The jaws of the chuck grip the shell between the copper band and the base. A swing leaf that carries a hardened bushing is moved to a permanent stop and locked in place by a fly nut. A counterbore, the body of which fits the hardened bushing, is fed down to the work by means of the hand lever.

The pilot end reams the fuse hole to the correct tapping size, and the recess is counterbored to the correct diameter and depth for the flange on the fuse. The shank of the counterbore fits in the drill spindle and is easily removed. The speed for counterboring is 100 r.p.m. Soap and water compound lubricant is used. The counterbore tool is removed, and the tap and socket are inserted in the drill spindle. The swing leaf is moved to one side, and the pilot at the end of the tap is entered in the reamed fuse hole, thus assuring that the threads will be cut concentric with the base. The tap is run at 30 r.p.m., with pure lard oil as a cutting lubricant.

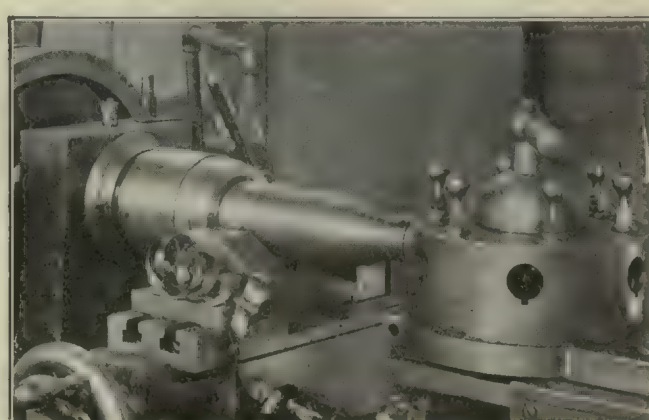


FIG. 19. TURNING BAND

The washing and lacquering are done in operation 13. The tanks, tables and benches made for the 6-in. projectiles are used for the 3-in. shell. Fig. 22 shows the tray made to hold twelve 3-in. shells, each shell fitting over a nozzle that thoroughly washes the inside of the shell. By means of the air-hoist cylinder the tray is suspended in the tank containing the washing solution; then it goes to the fresh water for rinsing, and afterward to the drain board. The cavity is dried by compressed air.

Lacquering the Cavity

When the cavity is thoroughly dry, the lacquering is done, as shown in Fig. 23. The funnel in the base of the cut shell has a long spout that extends below the fuse threads. A small amount of lacquer is poured into the cavity through the funnel, and the pipe rig, shown in longitudinal cross-section of the forging, is screwed into the fuse hole. When the plug is screwed home, the end of the pipe *D* is immersed in the lacquer previously poured in, just clear of the cavity point. The compressed-air pipe is connected to *B*, which throws the lacquer out against the inner walls of the shell, the excess escaping by the discharge pipe *A*. At *E* may be seen a shell that was cut to determine how well the surface was covered; no bare spots could be found.

The fuse hole is closed by waste or a fuse plug, and the projectile is painted on a turntable. The shells are then sent to the magazine for loading and stowing, ready for issue to the service as acquired.

Internal-Grinding Problem

By O. D. Carter

For some time we have been grinding automobile cylinders on a 16-in. lathe with a grinding attachment built by another concern. With this attachment we are able to grind a cylinder within 0.0005 in. both round and straight. Using a wheel $\frac{3}{16}$ in. smaller than the bore, cylinders 4 in. in diameter and under can, in about twice the time, be ground with a finish equal to that secured on a commercial grinder.

However, if the wheel is set more than $\frac{3}{16}$ in. eccentric, the small drive rod through the lathe spindle sets up considerable vibration, which causes slight wheel chatter. A larger rod seems to increase this chatter, while a rod turned small about midway between its ends lessens it to some extent. On account of this failing, for grinding cylinders above 4 in. in diameter a large wheel must be used. This again makes trouble, since the greater arc of contact causes the wheel to spring from its work, while the torsion of the long driving rod seems to produce a varying wheel motion that leaves a slightly rough finish, although no excessive wheel wear takes place.

Since the amount of large work was increasing and a commercial grinder seemed out of the question on account of both cost and long delivery, the management decided to build an attachment that would not have the defects of the other.

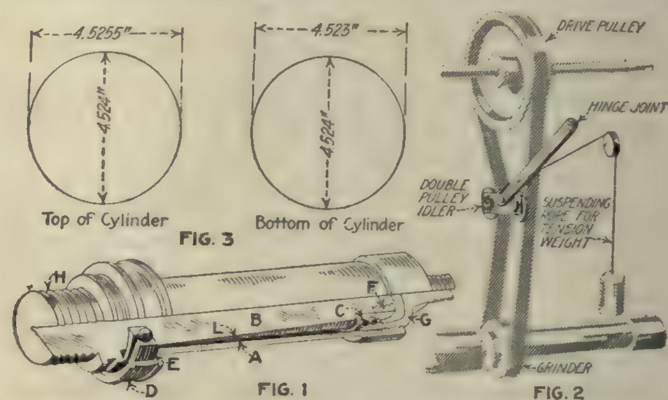
The result was a head as in Fig. 1, driven as shown in Fig. 2. A gibbed slide several times heavier than that on the old attachment was made to give the head its throw. This was threaded to fit the spindle, and the journal *B*, Fig. 1, was threaded at *H* to fit the other slide member. The shell *A* was mounted on this journal by means of the ball bearings *C* and *E*. The front was a double-row bearing held against the journal shoulder by the nut *F* and tightened in the shell *A* by the cap *G*, on which the wheel was mounted at *G*, each wheel being first mounted on a sleeve tapered and threaded to fit *G*.

The bearing *E* was a light press fit in the shell *A* and a snug sliding fit on the shaft *B*, to allow for expansion. At *D*, immediately over the rear bearing, *A* was formed for a driving pulley. The space *L* was partly filled with oil.

The grinder was attached to a 19-in. lathe. An angle plate was bolted on the carriage, and the cylinders were strapped to the plate. A 3-in. wheel run at 3400 revolutions was used. This was about 200 revolutions faster than the other attachment. The result, as shown in Fig. 3, was far from pleasing.

At the bottom the measurements read: Vertical, 4.524 in.; horizontal, 4.523 in.; near the head the vertical corresponded with that at the bottom, or 4.524 in., while the horizontal showed 4.5255 in., making a variation in the cylinder of 0.0025 inch.

Although the lathe was new, we at first doubted its truth and examined the bearings. They showed close limits and a fair fit in the boxings. The whole was carefully assembled, taking care that there was no lost motion



FIGS. 1 TO 3. INTERNAL-GRINDING ATTACHMENT

or binding in the bearings. The grinding was not improved. In their order a spring was substituted for the rope and weights, the angle plate was changed for another, and the gib in the slide was set up absolutely tight. After trials the speed was reduced to 3000 revolutions, but no relief was experienced.

The bar was then tapered more and the cap *G* lightened with no effect. Under heavy cuts the wheel broke down rapidly, and the work was rough; but after truing the wheel a light cut produced a good finish. Several cylinders produced like results, regardless of feeds or speeds.

Later, I bored a gas-engine cylinder with a bar held in the chuck and the tail center, the cylinder cradled on the carriage, and brought it within 0.001 in.; and I have ground wristpins within close limits, so the lathe is not to blame.

I believe that the shell with its revolving parts is too heavy for a bar of less diameter and that the wheel sets up a vibration much as does filing steel tubing some distance from the steadyrest, while in the other grinder the wheel shaft is supported by a large housing that absorbs the vibration and allows the overhang from the front bearing to be much less.

Selling United States Machine Tools in Latin America

By Alfred Thomas Marks

SYNOPSIS—Suggestions as to getting acquainted, the use of credentials, licenses and traveling expenses in South America. The growth of the machine trade with South American countries and the way in which it can be increased.

The itinerary of the traveler who plans to cover South America in the shortest possible time and without unnecessary expense should be a matter of careful study. At best, the trip is one that should not be undertaken without careful preparation and an intelligent comprehension of just what it involves. Many failures to get the best results in South America may be traced directly to inadequate preparation—taking too much for granted and depending upon methods that have been found to operate satisfactorily at home.

It is essential in going about a selling trip in Latin America that we understand several all-important phases of the enterprise, the chief of which is that we are to deal with peoples whose viewpoint on trade, as well as on many other subjects, is almost diametrically opposite to ours. We are dealing with a people who are naturally suspicious of us and who hold to the theory that a man must prove himself their friend before they cease to consider him their enemy. Stated differently—that a salesman is guilty of harboring some intention of "doing" them, if he can, until he proves to their satisfaction that he has no such intention. In a word, he is guilty until he proves himself innocent. The other side of the picture is that, once you have gained the friendship of the Latin American, it is a permanent and valuable asset—he sticks to you through thick and thin.

While the ability to speak Spanish will be found to facilitate business intercourse greatly and save the expense and annoyance of an interpreter, it is nevertheless not essential; besides, Portuguese is the national language of Brazil, one of the greatest of the Latin American markets. The inability to speak either of these languages need not operate against undertaking the Latin American selling trip. More than half the foreign traveling salesmen visiting Latin America—not only from the United States, but from Europe as well—do not speak the languages of the country, but depend upon native interpreters, who are also utilized to assist in carrying samples

It would seem to be especially timely that we get a close-up view of the details of selling our machine tools and related lines to the Latin Americans—that is, just what the conditions are that surround the salesman from this country—in view of the fact that in the year 1916 our sales in these lines to Latin American countries were not only large, but much more than double those of 1915 and rapidly increasing.

While in Montevideo, Uruguay, a few months ago, the writer happened into the establishment of a "distributor" and met there a salesman representing a European machinery-manufacturing concern. He spoke Spanish well and immediately got in touch with one of the proprietors. To my surprise he was not encouraged to exhibit his samples and catalogs and finally slipped them back into the cases impatiently. A short time later a traveler for a New York exporter in practically the same lines came in with his interpreter and catalogs. This man was under the handicap of not being able to speak Spanish, so had to have a native assistant. He was greeted effusively; the aforesaid distributor carefully inspected the catalogs, a good bill was sold, and the incident was concluded with dinner for the three of us at a good hotel, the merchant underwriting the bill.

How One Salesman Succeeded

Later I asked the salesman how he managed to stand so well with the customer. He replied that this was the third bill he had sold the house, but that when his initial visit was made he almost decided to quit the Latin American field. He had been turned down right and left. Finally, a German friend engaged in another line suggested that he adopt different tactics. He "called back" on the big distributor, but without catalogs or samples, and did not mention business in the remotest way. He insisted upon the merchant having dinner with him and talked (through his interpreter) of everything except his own line—that subject he carefully steered clear of. When he sought his humble hotel, he found that his expense account had taken a decided jump, thanks to his hospitality. When he arose the next morning, he found the store proprietor awaiting him in the hotel lobby. That day he sold the distributor a bill of over $2000.

The point here is that you cannot rush Latin American trade. Friendship comes first; your buyer must know you. It is simply impossible to sell a house "between trains," as is frequently done in this country. But the Spanish American is, above all things else, loyal to his friends, and trade once established on this basis is as nearly permanent as any trade can be. This trait is what gave the Germans such a wonderful grip on the Latin American markets—they studied the people and shrewdly cultivated the traders before they said a word about trade.

Leaving New York, the traveler usually makes Rio de Janeiro, Brazil, as a first stop. This voyage requires 16 days; 6 days more bring him to Montevideo, Uruguay,

and another day lands him in Buenos Aires, Argentina, one of the handsomest and most modern cities in the world. From here he crosses by the Trans-Andean Ry. to Santiago, Chile, on the west coast, and thence he travels north to Valparaiso, Lima, La Paz, Guayaquil, Bogota and Central American points, passing through the Canal on his return to the Atlantic and covering Cuba on the home trip. The trip can be made in 10 or 20 weeks, depending upon the number of points touched and the time that it is found desirable to spend in each place visited.

Credentials and Licenses

The salesman traveling in Latin America should have some documents certifying to his identity and connection with the firm he claims to represent. A power of attorney is also essential in case the traveler expects to have an occasion to enter into any legal contract for his firm or to appear in court. Such a power of attorney should be legalized by the consular representative of the country in which it is to be used. Passports are necessary in only a few of the countries.

Licenses to do business are required in most Latin American countries by the various provinces or municipalities. While in most of these countries the license fees are small, in some of them—notably in Argentina, Bolivia and Uruguay—they are sufficiently high to make it desirable to find some legitimate means of avoiding their payment. This result is usually accomplished by having the traveler affiliate himself with some local importing house or agency of the firm represented by him, so as to enable him to do business as an agent of the local firm without payment of a license fee. In Argentina there are license fees for each separate province or territory. In Bolivia the collection of the license fees is usually farmed out to private companies, and travelers are generally able to obtain material reductions from the prescribed schedule of fees. That the Latin American countries are cognizant of the detrimental effect of the present laws affecting license fees may be inferred from the report on the subject adopted by the International High Commission at Buenos Aires, last April, which provides for a single license for all the countries.

The customs treatment of samples is essentially uniform throughout Latin America. Samples without commercial value are admitted free of duty without any special formalities, while samples having a commercial value are admitted under bond or upon deposit of an amount sufficient to pay the duty in case of failure to reëxport them within a certain time limit. While as a general rule refund is granted upon the reëxportation of samples, in Cuba only 75 per cent. of the amount deposited is refunded, and this refund privilege is extended only in case of samples not exceeding $500 in value. On samples valued at more than $500 the full amount of duty is collected without any refund. In Colombia the refund is limited to 75 per cent. of the duty, without restriction as to value of samples. In most countries a definite time limit is specified for the reëxportation of samples, but extensions are usually granted. In some of the Latin American countries reëxportation must take place through the port of original entry, while in others samples may be reëxported through any port. The sale of a part of the samples does not affect the refund privilege, but duty is collected on the sold articles.

The commercial traveler visiting South America should take with him a "To whom it may concern" letter of introduction from the firm he represents, so that the merchants on whom he may call will know that he is the bona fide representative of the firm. An even better method of introducing a company's representative to a Latin American buyer, which is more courteous than an open letter, is to write to the foreign buyers informing them that the representative has sailed for that country and will in the near future call on them. This form of introduction is much appreciated by Latin American merchants and will more readily assure the traveler an interview than the mere presentation of a business card.

These questions are frequently asked by United States machine-tool and machinery exporters: What can we sell

THE LATIN-AMERICAN IS KEEN ON MERIT

the Latin Americans? Can we find a profitable market there in view of the fact that practically all the principal mechanics and operatives are Europeans and naturally prejudiced in favor of German, English or French products in the way of machinery and machine tools? Can we compete with Great Britain and Germany in South American markets, considering that these countries have been for years supplying practically all the machinery Latin America used? The best and most conclusive answers to these questions are furnished by Otto Wilson, in charge of the Latin American division of the Bureau of Foreign and Domestic Commerce, who talked with the writer recently. Says Mr. Wilson:

"When any of our exporters ask the questions, 'What can we do? Can we do it?'—and such queries are constantly being put up to the Department of Commerce—I do not feel that I am ultra-patriotic or overconfident when I say that our manufacturers and exporters can do

anything the manufacturers and exporters of any other country can do, and not only do it as well, but do it better. I am willing to go farther and say we can make better machine tools than does any other country. The fact that in Latin America we are rapidly building up sales in this line right now is evidence that we can meet the competition. The answers to the can-we-do-it question is that we are doing it.

"One very important fact should not be overlooked: While Germany and Great Britain have had the start of us because they went after the business and we did not, nevertheless the Latin American is keen on merit; and when he gets a tool that is better than the one he has been accustomed to using, he knows it and will adopt the better product. Another point that might be emphasized is that many writers on Latin American trade insist that we must sell the Latin Americans what they have been accustomed to and that to try to bring them to our point of view is simply waste time. This is true only to a limited degree.

"In going into a market we must needs give the people what they know, at first; but it is easily possible, if our products are superior to those formerly in vogue, to show them that fact. We did it with United States shoes—and now American footwear is the standard for all South America. And in the matter of tools, as in everything else, the South Americans are not so hidebound that they will not recognize the better tools and the better ways of handling them."

Expenses of Travelers

Lastly, may be mentioned the matter of traveling expenses in Latin America—and this is a subject not clearly appreciated by most American exporters. There is constant complaint by American commercial travelers that their houses raise objections to the size of their expense accounts, and the necessary items entering into them seem to be much better understood by German, English and French exporters. Transportation difficulties, customs charges of all kinds, taxes on commercial travelers, and different usages in the Latin American business world pile up expenses that are quite unknown in the United States. Especially is this true of a salesman traveling with samples. The details of looking after the shipping of trunks, getting them through the customs, etc., often take so much attention and time that in cases where a number of trunks are carried many European firms employ an extra man to accompany the salesman and look after the samples. Charges are also much higher for an inexperienced man, as prices asked for porterage, unloading, lighterage, etc., are often regulated only by what the employee thinks he can obtain.

Hotel and sample-room rates are high in Brazil, Argentina and Uruguay, and decent accommodations, with one sample room and meals, will average $12 to $15 a day in those countries. In the west-coast countries the rates are somewhat more reasonable. Including everything, however, a salesman can hardly get along on less than $10 a day, and that means extremely careful expenditure and very little entertaining of buyers at high-class hotels. From $12 to $15 a day is a fairer average; and if many trunks are carried, expenses may easily run up to $20 a day. In some of the countries railway fares are as high as 6c. and 8c. a mile, the average for the continent being about 5 cents.

Lapping Hardened-Steel Surfaces

By C. A. Macready

The article on page 59 must have been an eye opener for the old-timers who have been in the habit of using a coarse-grained abrasive and cast-iron rubbing block, although what they accomplished in the way of embedding abrasive in the cast-iron lap is not duplicated by charging a lap in the manner described by Mr. Cline.

To crush the coarse abrasive the old-timer had to employ a pressure that crushed the grain of the abrasive. This grain will not be crushed as fine at the first charging as by the following charges, as eventually the surface of the lap is completely covered with abrasive. This, of course, means that the old is dislodged to replace the new; therefore, for a sharp lap, I prefer the brittle (fine washed grade) rather than the tough abrasive. The brittle abrasive crushes easily with a light pressure and settles in among the lodged abrasive more evenly and as permanently as is possible with any charged surface.

Abrasive grains allowed to rub against one another in their container—can, bag or lap—will lose their sharp cutting edges. These edges will be renewed if the grain is crushed.

A lap surface that is completely embedded with abrasive will not retain new abrasive in the cast iron except by the displacement of abrasive already embedded.

To recharge a lap means simply to lodge the fresh abrasive among the already embedded abrasive grains. This disturbs, or crushes, the embedded grains and causes new, sharp edges to form.

A grain of abrasive, if crushed, becomes smaller than the original grain, and being irregular in shape, the chances of the newly crushed brittle grains occupying spaces of more nearly uniform size is greater than when the tough grain is merely displaced or rolled over and reembedded.

The Ideal Finisher

The ideal finisher is the oilstone. It has no grains to become loose and therefore will cut without scratching; and it may be sharpened by the crushing effect of rolling abrasive grains on its surface.

The foregoing are conclusions based upon the old-timers' manner of charging a lap. If they are right in principle, then a way had to be found that would give the sharp edges and not tear the lap surface abnormally.

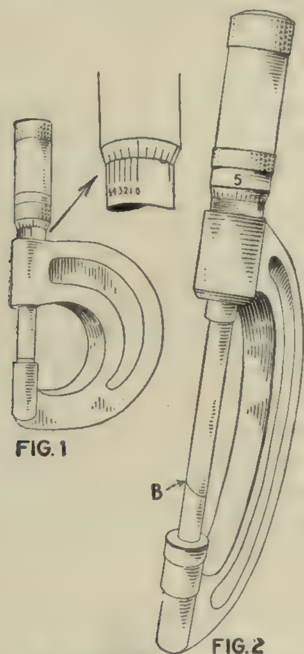
It is good practice to employ a hardened-steel rubbing block. There should be just enough kerosene to cover the surface with a thin film and not enough to cover the lap surface. If the kerosene covers the lap surface it causes the edges of the work to lap below the plane wanted; that is to say, the edges are rounded—the same condition that in hole lapping is called "bell-mouthing." For this reason, enough gasoline is squirted on the lap to mix with the kerosene and carry it over the lap surface. When the gasoline evaporates it leaves a thin film of kerosene that will not wear the edge of the work on the average gage. My experience has been that a perfectly dry lap will gather glazed spots, or "birds'-eyes," as some call them. These are liable to retain a grain at the peak of the glazed spot that will scratch.

The wear on the lap caused by the crushing of the fine washed carborundum is so small that I have no difficulty in retruing my laps with a lead lap charged with

the 5-min. grade of carborundum. I have two laps (cast-iron) that have not been planed for 10 years. These laps are 9 x 9 x 2 in. They are required to be true enough to make a knife-edge straight-edge 7 in. long.

The seasoning of the laps beyond the annealing as described in Mr. Cline's article is unnecessary, because when the abrasive is forced into the surface of the lap it sets up stresses that would destroy the seasoning effects described. There is quite a change in the surface tension of a lap that has had abrasive forced into it, after being scraped to fit a surface plate. The curling of a heavy cross-sectioned piece while being lapped is a good illustration of this compression of the surface.

A lap that has been scraped to fit a surface plate is not a continuous plane. If it is 90 per cent. a plane, it is a good surface plate; but the valleys, I find, raise the



FIGS. 1 AND 2. A SOURCE OF ERROR IN MICROMETERS

dickens with the work edges. There is not much to choose between a "narrow gutter" lap and a scraped lap.

I have obtained the best results by taking two laps just as the broad-nose planer tool left them and lapping them together, using, if they are very bad, 120 carborundum to start with and finishing with 5-min. carborundum. If both laps are concave at the start—most planers plane concave—one of the laps will become flat before the other. To observe the progress of the lapping, the laps should be tested often by making a knife-edge straight-edge upon them. The hardest iron will work down to isolated spots that will have to be discovered and rectified with a small cast-iron plate that is used the same as the large one. This process will bring a good surface. The final correction of the other lap will be done with a true lead lap. It is not generally known that a concave lap will lap a plane surface if given a sweeping (not rotary) motion; the surface around the depression, however, must be kept in contact with the surface to be trued.

I have made many glass test bars on these laps and have obtained a finish that when held at an angle reflected objects like a mirror. The lead lap strips or loosens the coarse abrasive from the cast iron so that the lap surface can be cleaned with the hand. I have also obtained a finish on hardened-steel surfaces similar to that of a first-class mirror by using oilstones. These mirrors would reflect objects without distortion. The oilstone was flooded with kerosene as a lubricant. In this class of work a heavy pressure is not necessary; speed and a light pressure fulfill all the requirements.

In this same article by Mr. Cline there is a statement about measuring that I think he will revise if he tries the following: Using a ten-thousandth micrometer, adjust the anvil as shown in Fig. 1—that is, so that the graduations do not quite match. Depend upon the sense of touch in making contact of the anvil with the spindle. This contact should be made without looking at the micrometer. After having educated the sense of touch so that the lines on the sleeve can be located equally between the lines on the thimble, without looking at the micrometer, the touch will be sensitive enough to set the spindle on work to be measured. Give this micrometer to the men, and by their answers you can judge whether they have a heavier or a lighter touch than you.

Unless one alters the turning effort, measurements will often be made where the graduations do not line up. For practical purposes, when this occurs, why not call it a measurement to the fifth decimal? It may not compare accurately with "bronze No. 11 or low iron No. 57," but it could be used as a comparison if the measurement were taken from an accurate standard.

The use of the anvil of the micrometer for this test throws out all the variables that can enter when a micrometer is relied on to test the touch of different men. Just to mention a few variables that can be verified, I will take the possible mechanical defects of the micrometer.

The faces of the spindle and anvil are not in a plane at right angles to the axis of the spindle. This is shown exaggerated at *B*, in Fig. 2. Consequently, there will be a difference in readings if the anvil is moved. The spindle end is likely to be more crowning than the anvil. This will make a difference if all the surfaces measured are not free from the perspiration of the hand, as some perspiration is acid and some neutral. For this reason a little vaseline rubbed on the work will often facilitate measuring.

A Habit To Be Avoided

Avoid the habit of reading the micrometer at the same time the work is measured. I know the average toolmaker can accustom his touch to read to the fifth decimal. One thing usually noticeable when using a strange micrometer is the difference in the friction of the spindle. It will throw a man off his touch while making a measurement.

The following test was adopted in one shop department where there were six ordinary workmen. When they first came to work at type-mold making and were required to duplicate measurements, a piece of unknown size was passed around to each man, and the readings given were compared. Each man used his own micrometer, with which he was familiar, and the readings were within the fifth decimal.

There have been descriptions of such a micrometer as Mr. Cline considers desirable, but it did not read to the fifth decimal. It would take some compounding to make such a dial or indicator easy to read.

Making Vehicle-Wheel Boxes Without the Use of Molding Machines

By Ethan Viall

SYNOPSIS—This is one of the cases where highly specialized handwork beats a machine. The methods shown have been in successful competition for several years with the best molding-machine practice. A huge number of vehicle-wheel boxes of all sizes are turned out annually at an exceedingly low labor cost.

When first-class mechanics, with ample training, specialize along certain lines, they are apt to produce results that are hard to beat. While the Keagy & Lear Machine Co., Coshocton, Ohio, does not confine itself entirely to the making of buggy- and wagon-wheel boxes, that part of its business has been pushed more than any other, and the results of specializing in this direction are plainly apparent. The method of handling the box-casting work has been a revelation to many molding-machine salesmen. The first cost of installing molding machines has never been a deciding factor with this firm. An effort has simply been made to obtain the best method of producing vehicle-wheel boxes quickly, in large quantities, at the lowest possible cost.

All the wheel boxes are cast in a vertical position, the number of patterns to a plate varying according to the sizes cast, as shown in Fig. 1. The sizes known as ¾ to 1¼ in. have six to a plate; the 3 to 3½ in. run four or five to a plate, according to length; larger sizes have two, and so on, the patterns in no case being made too heavy for convenient and quick handling. Flask boxes, as shown at *A* and *B*, are made both round and square, of heavy sheet iron. The ordinary run of flask boxes will average 9½ in. in diameter by 10½ in. long for the round, and 11½ in. by 16½ in. long for the square.

FIG. 1. EXAMPLES OF BOX PATTERNS

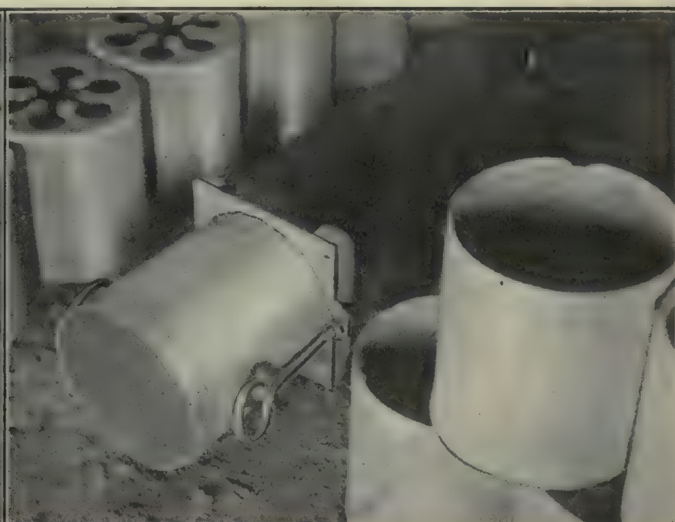


FIG. 2. MOLD PARTLY TURNED OVER

FIG. 3. READY TO DRAW OUT PATTERN

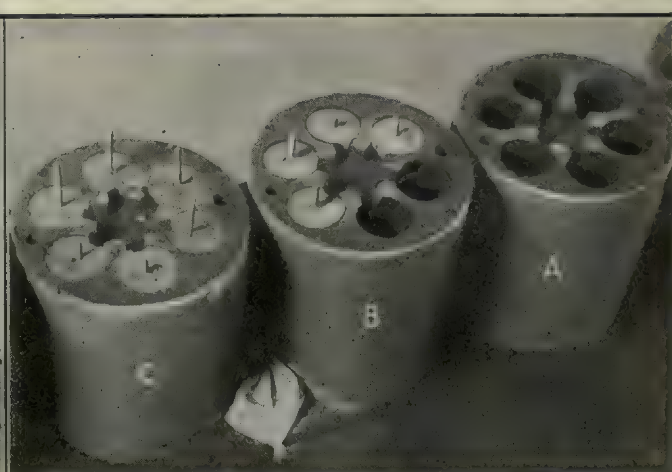


FIG. 4. SAND MOLDS WITH AND WITHOUT CORES

In getting ready to make the mold, the molder sets a plate on the floor in the position shown, and puts a flask box over it. He then shovels in the sand, rams it down, levels it off with his shovel and next gently tips it over on its side, as shown in Fig. 2. His next movement

brings it on end, as shown in Fig. 3. Now taking hold of the handle on the bottom of the plate with one hand, he gently raps and removes the pattern, leaving the mold

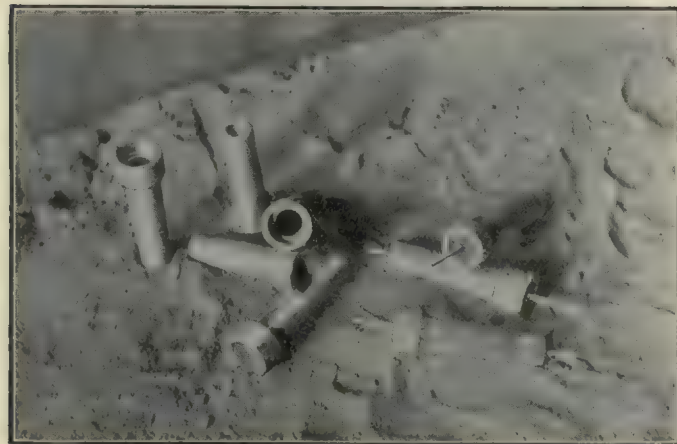


FIG. 5. ROUGH AND TUMBLED BOXES

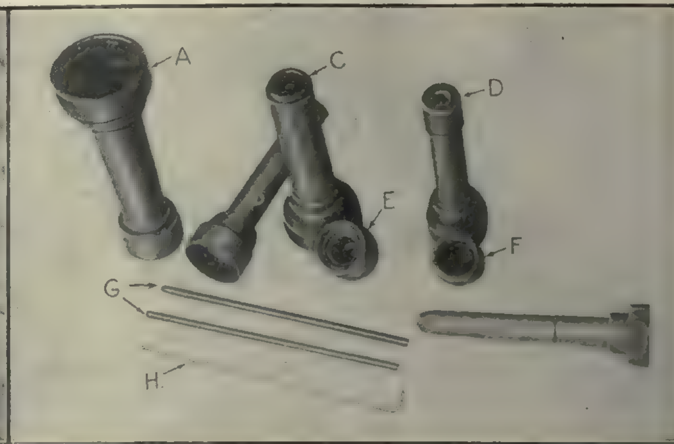


FIG. 6. CORE BOXES, RODS AND CORE

as shown at *A*, Fig. 4. The illustration of this mold, together with the views of the patterns, will give a better idea of the exact shape of the patterns than any amount

FIG. 7. FILLING A CORE BOX

of other explanation could. The mold is next dusted as usual, and then the cores are placed, as shown at *B* and *C*. Pouring the melted metal into the center leaves a

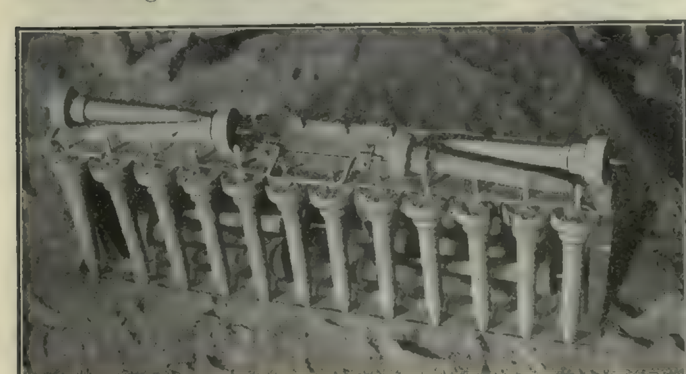


FIG. 8. CORES IN HANDLING RACK

FIG. 9. GENERAL VIEW OF PART OF FOUNDRY

sort of spider from which the box castings are easily removed.

Actual timing on a molder at work filling the flasks shown, without his knowing it gave 40 sec. flask to flask.

The average day's work of each molder is 165 flasks complete. It will be noticed that in doing this work the flask is just high enough for the convenient shoveling of the sand, and at no time is it necessary to do any heavy lifting to handle the mold. After being removed from the mold the boxes are tumbled and are then ready to be sent to the machine shop. Fig. 5 shows a few boxes just as they come from the mold, and at the left are some after tumbling.

Cores for the wheel boxes are made in the type of core boxes shown in Fig. 6. At *A* and *B* are complete boxes; *C* and *D* have the bottoms removed and placed at *E* and *F*, to show the inside; *G* are centering rods; *H*, a vent wire; and *I*, a completed core.

Making the Cores for Wheel Boxes

It will be observed that the cap used on the bottom of the core box tapers slightly toward the center in order to locate the centering rod and core. In filling the core box the workman holds it as shown in Fig. 7, with a center rod and vent wire together, and presses the core mixture around them. The rod is centered at the bottom by the cap just referred to, and at the top by the eye. The mixture is hammered in around the rod, the wire removed, and then the core is lifted out and placed on a baking and handling rack close at hand. One of these racks filled with cores is shown in Fig. 8. After baking, a lot of cores can be easily carried to the molders without removal from the racks until wanted for use. The core mixture consists of about four shovels of sea coal to a wheelbarrow of sand, no binder being used.

A view of part of the foundry is given in Fig. 9 and shows a lot of the molds ready for pouring. The melted

metal is carried to the molds in an 850-lb. truck ladle, like the one shown in Fig. 10. The truck is moved as needed along a track that runs down the middle of the foundry.

The inside of the boxes is machined out first. This is done on a station-type machine, Fig. 11. There are four tool and ten work stations, the tools revolving only and the work being fed up to them by means of a hydraulic vertical table feed. This machine was made by the Spears & Riddle Co., Wheeling, W. Va. A closer view of the tools and table is given in Fig. 12. Two reamers—a roughing and a finishing—are used for the taper part of the bore, and two others for the shoulder. As arranged, a box is finished at each indexing of the table. The indexing is done by means of a pin inserted in the rim of the table, as shown. The boxes are held on the table in a floating holder, into which they are dropped by the operator.

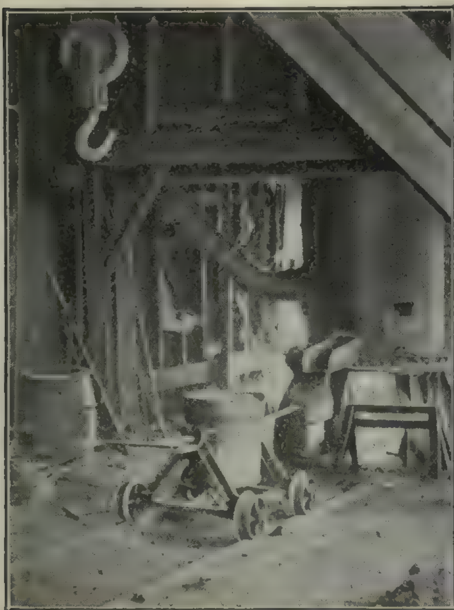


FIG. 10. CUPOLA AND TRUCK LADLE

FIG. 11. STATION-TYPE BOX-BORING MACHINE

FIG. 12. CLOSE-UP VIEW OF TABLE AND TOOLS

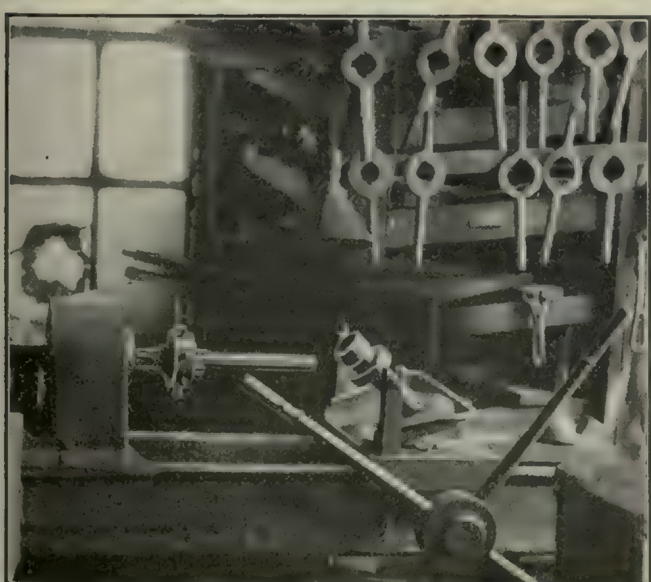


FIG. 13. METHOD OF FINISHING IN A LATHE

Where more accurate work is required, the boxes are again finish-reamed in a lathe, as shown in Fig. 13. The boxes are held in a floating yoke carried on supports of the carriage and are fed to the combination tool by means of the capstan. Work holders for various sizes are shown hanging on the wall back of the lathe. The outside is not machined all over, as only enough is turned to make the box center and bed properly in the wheel hub. This is done by placing the boxes on mandrels and turning them in lathes. About $^3/_{64}$ in. of metal is allowed for the machining work in casting.

Design of Cut-Steel Bushed Roller-Chain Drives

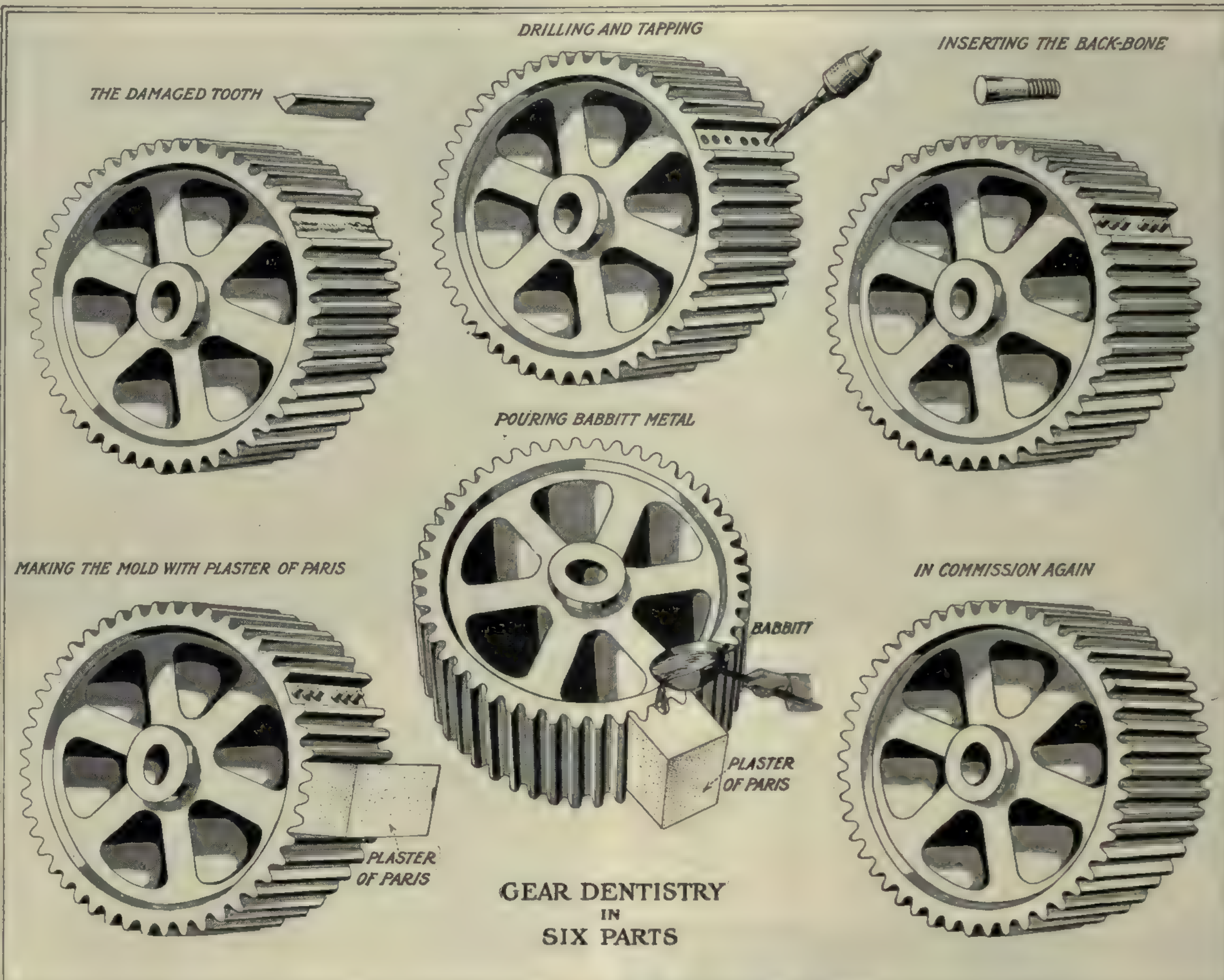
In the article by Mr. Connor, on pages 589 to 592, an omission was made in Table 2, page 590, under the heading of "Principal Dimensions and Comparative Chain Designating Numbers." A number of sizes made by the Whitney Manufacturing Co. should have been included. These are given below with their principal dimensions and the corresponding Diamond chain numbers:

Diamond	Whitney	Pitch, In.	Roll Width, In.	Roll Diameter, In.
149	...	5/8	3/8	0.4
153	101	3/4	5/16	15/32
153	202	3/4	3/8	15/32
155	105	1	3/8	9/16
155	106	1	1/2	9/16
155	469	1	5/8	9/16
156	206	1	1/2	5/8
156	207	1	5/8	5/8
154	208	1	3/4	5/8
151	470	1 1/4	1/2	5/8
151	471	1 1/4	5/8	5/8
151	...	1 1/4	3/4	5/8
152	211	1 1/4	5/8	3/4
152	212	1 1/4	3/4	3/4
157	75	1 1/2	5/8	3/4
157	76	1 1/2	3/4	3/4
157	...	1 1/2	1	3/4
158	216	1 1/2	3/4	7/8
158	217	1 1/2	1	7/8
159	220	1 3/4	1	1
167	230	2	1 1/4	1 1/8

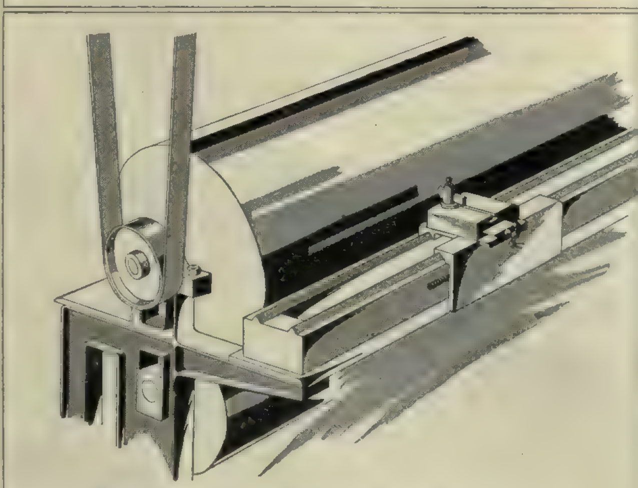
On page 589, it was stated that the maximum speed reduction should not exceed 3 to 1. This should have read 5 to 1. The lettering on the chart on page 590, reading "Oil Wheels below 250 Mark of Steel," should have read "All wheels below 25 teeth made of steel."

From a Small-Shop Notebook

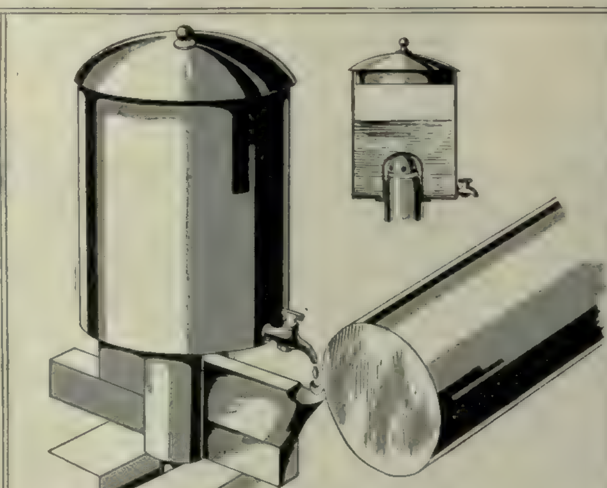
By J. A. Lucas



GEAR DENTISTRY IN SIX PARTS

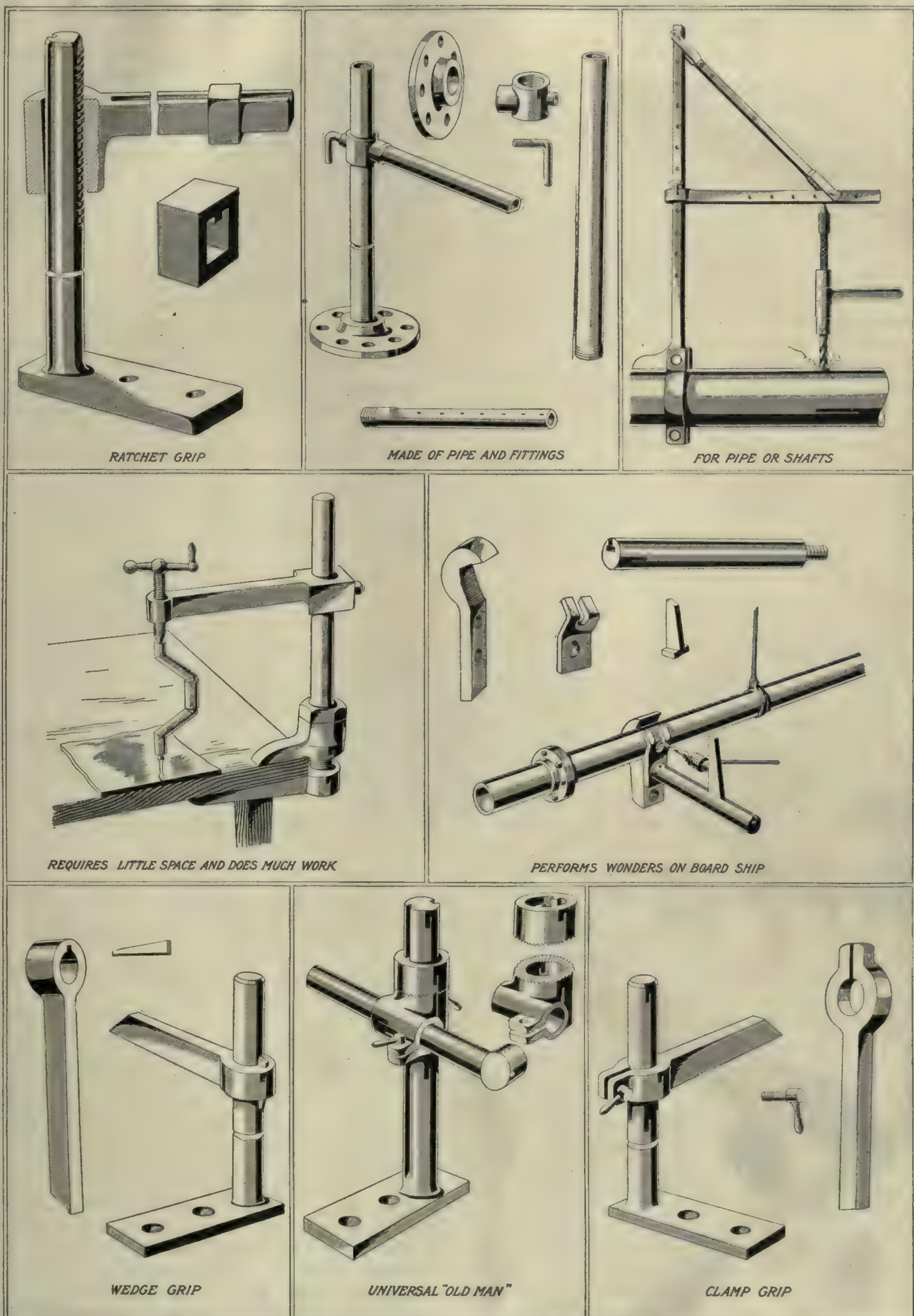


TAKING THE LATHE TO THE WORK IS SOMETIMES NECESSARY



THE LUBRICANT FOLLOWS THE TOOL

TAKEN FROM ACTUAL PRACTICE



SEVEN APPLICATIONS OF "OLD MEN"

Wages and the Cost of Training New Men

By Entropy

To say that the whole wage question is shot to pieces is trite. One man's guess seems to be as good as another's when the question is of how much should be paid for a given kind of work. Men arrive at their rate by precisely the same method that their employers use to find out what price to put on their product. They shop around until they find the shop that will pay them the most, which is usually the shop that needs men worst. Their employer has this advantage, that he does not have to turn down one customer after another until he finds the best buyer, for he can bid and reject orders, while the workman must usually work, for a short time at least, in each new shop to establish the fact that he was paid so much at Blank & Company's.

Employers are finding that in this bidding for help there are more things than money to consider. In spite of the tremendous increase in the rate with which men move from shop to shop, this increased rate does not apply very much to men who have been on the last job more than a few months or to those who have matured. Almost any shop that keeps employment statistics knows that its turnover of labor due to men going to better jobs is very small among those who have been in their employ more than a few months, ranging from three to six. It also knows that the larger part of the roaming is among young men, unmarried and without strong family ties. Among the older men, if the increase in pay follows the increased cost of living, which is really a mark of depreciation of the currency with which they are paid, there is little trouble from this source.

A man who stays steadily on the job is worth more than an equally capable man who leaves his job once a year, by just the amount that it costs to break in a new man and bring him up to an equal state of efficiency. If the man is a laborer, it may be that the total cost of bringing him up to the average value of the gang is merely the cost of the clerical work incident to getting him on the payroll. If he is a skilled mechanic, there is always the chance that a new man may come along any minute who is so much more capable than the man now on the job that we can make money from the start by making the change. If, on the other hand, machinists are so scarce that they can only be trained by apprenticeship, then it is an expensive matter, as it seems to be impossible to give them adequate training and make a profit from them at the same time.

The man who costs the most to train and whom it is most profitable to keep for a considerable length of time is the operative who is made from the greenest of raw material and trained to do one thing only. The cost of breaking in such a man may be almost anything, probably seldom under \$25 for simple jobs, up into the hundreds for men whose work is truly mechanical. The latter cost high because they must have drilled into them most of the things that require time in the making of a machinist. Usually they must learn to measure, to set and possibly grind a cutting tool and to place work in jigs. The first two of these things are the time-consuming factors in teaching the full trade; and those who can readily grasp the principles will in most cases develop, if allowed to, into all-round men. Men of this class who stay are worth considerably more to the firm that hires them than the variety that stays less than a year on the job.

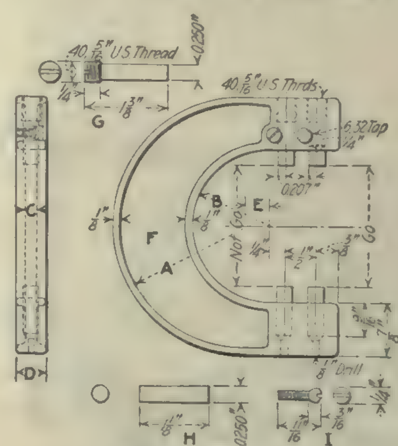
The young unmarried man is the most serious problem. Our sympathy goes out to him in his travels, because most of us realize that it is better for him to have worked in a good variety of shops and to have learned to get along with a variety of people. His wanderings are really a part of his educational career and should bear fruit many times over both for himself and for everyone for whom he works. There is certainly no more exasperating man to employ than the one who has worked all his life in the shop where he learned his trade and whose only reply to every suggestion is, "They never did it that way in the shop where I came from."

Limit Snap Gages

By Leslie A. Wells

The gages described herewith were developed by the writer for a factory using several hundred gages of this type yearly.

Each gage consists of seven parts as shown—one main casting *F*, two each of the parts *G*, *H* and *I*. The illustration shows the method of assembly and the general appearance of the completed gage.



Size of Gage	A	B	C	D	E
2	2 1/8	1 1/4	3/16	1/2	7/16
2 1/2	2 3/8	1 1/2	3/16	1/2	1/2
3	2 5/8	1 3/4	3/16	1/2	9/16
3 1/2	2 7/8	2	3/16	7/16	5/8
4	3 1/8	2 1/4	1/4	7/16	11/16
4 1/2	3 3/8	2 1/2	1/4	5/8	3/4
5	3 5/8	2 3/4	1/4	5/8	7/8

DETAILS OF LIMIT SNAP GAGES

All the parts are made up in quantity and assembled as needed, *G* being screwed about $\frac{1}{16}$ in. under the body of the casting, *H* being pressed into place as far as possible, it being the practice to cut off the surplus stock with a thin emery wheel, allowing about $^1/_{64}$ in. for finishing. When a proper adjustment is obtained the binding screw *I* is tightened and sealing wax is poured on top of the adjusting screw *G*.

Why would not glass make a good frame for this type of gage? Being somewhat acquainted with the glass business, I believe it is not so improbable as it may appear. It would make a cheap gage, and one less liable to distortion from changes in temperature; also, if dropped, it would not be sprung, but would break beyond repair, which would be a blessing as anyone knows who has had to keep gages checked up for a battery of 800 automatic screw machines.

Arrangements of Geared-Head Lathes

By Reginald Trautschold

SYNOPSIS—The demand for geared-head lathes and their field are discussed. Geared heads are classified according to procurable spindle speeds. Six typical layouts are shown and their arrangement commented on.

The advent of the geared-head lathe was coincident with the introduction of individual motor drives for lathes, not that geared-head lathes are not also well adapted to the familiar overhead belted drive, but that the abolition of comparatively long center driving belts necessitated some substitute for the standard cone pulley with its series of spindle speeds. Inability to shift the short, tight belts customarily employed for individually motor-driven lathes required that the changes in spindle speeds needed for securing the economic cutting speed for work of varying diameter be obtained through a system of selective gearing.

The ease, rapidity and convenience in changing spindle speeds realized through the selective geared-head transmission—manipulation of conveniently located control levers on the headstock instantly producing the desired changes in speed—give to the geared-head lathe decided advantages in speed changes from lineshaft transmission over the more common cone-pulley arrangement with its simple but crude and annoying belt shifting. The efficiency of geared-head lathes is obviously independent of whether the drive shaft is driven from an overhead lineshaft or from an individual motor. This elasticity of the geared-head lathe promises to lead to its adoption for work requiring frequent changes in spindle speed, leaving the field of "single-purpose" operations to the simpler machines.

The peculiarities of geared-head lathes commence with the transmission of the power delivered by the drive shaft, and though the problem presented is the same in all cases—the arrangement of a gear train that will furnish the desired spindle speeds—it has been successfully solved in various ways by different manufacturers.

The drive shaft of geared-head lathes carries the driving pulley, connected universally to its shaft through some kind of clutch. The operation of the gear trains may therefore be immediately arrested by releasing the clutch, and the lathe may be started from an active driving pulley. Reverse speeds may be secured by a suitable arrangement of bevel miters on the drive shaft, by overhead countershafts or by reversing devices in connection with the driving motor, and present no unusual or difficult problem in the way of design or construction.

Geared-head lathes do not necessarily offer any greater variety of spindle speeds than can be secured by the cone-pulley arrangement, but they do simplify the changing of spindle speeds, so that the classification of geared-head lathes naturally resolves itself according to the number of spindle speeds procurable: An eight-spindle speed geared-head lathe being equivalent to a four-step cone-pulley lathe with ordinary back gears, a twelve-spindle speed geared-head lathe to a six-step cone-pulley lathe with the customary back gears or to a four-step cone-pulley lathe of the triple-geared type; the speed changes varying according to geometric progression.

Typical of geared-head lathe design with eight spindle speeds is the arrangement of gears of the Reed-Prentice Co., shown diagrammatically in Fig. 1.

A double friction clutch on the drive shaft engages either of two gears loosely mounted on the same shaft. These gears deliver four speeds to the two gears mounted

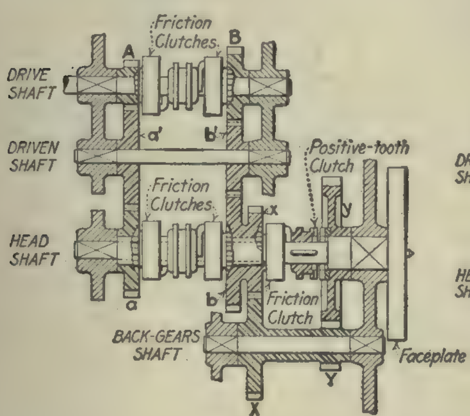


Fig. 1

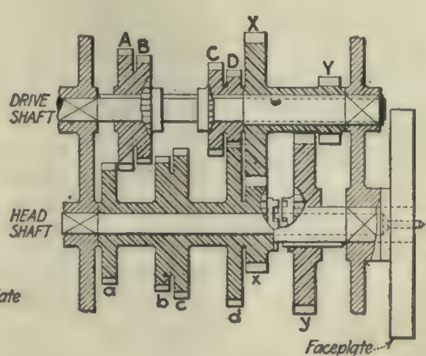


Fig. 2

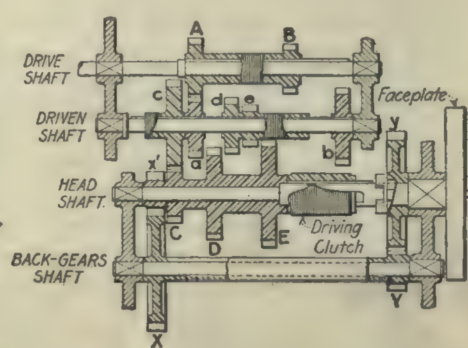


Fig. 3

Fig. 1:

Back gears out / Positive tooth clutch in	A-a', a'-a; A-a', b'-b; B-b', a'-a; B-b', b'-b
Back gears in / Positive tooth clutch out	A-a', a'-a, x-X, Y-4; A-a', b'-b, x-X, Y-4; B-b', a'-a, x-X, Y-4; B-b', b'-b, x-X, Y-4

Fig. 2:

Direct	A-a; B-b; C-c; D-d
Back gears in	A-a, x-X, Y-4; B-b, x-X, Y-4; C-c, x-X, Y-4; D-d, x-X, Y-4

Fig. 3:

Back gears out	A-a, c-C; A-a, d-D; A-a, e-E; B-b, c-C; B-b, d-D; B-b, e-E
Back gears in	A-a, c-C, x-X, Y-4; A-a, d-D, x-X, Y-4; A-a, e-E, x-X, Y-4; B-b, c-C, x-X, Y-4; B-b, d-D, x-X, Y-4; B-b, e-E, x-X, Y-4

FIGS. 1 TO 3. LAYOUTS FOR VARIOUS 8- AND 12-SPINDLE-SPEED HEADS

Fig. 1—Layout of 8-spindle speed head—speeds controlled by double clutches. Fig. 2—Layout of 8-spindle speed head—speeds controlled by sliding gears. Fig. 3—Layout of 12-spindle speed head—gears shifted with pinion and serrated hubs

on a free-running sleeve on the head shaft through the two gears on the driven shaft. These four speeds may be transmitted direct to the spindle by engaging the friction clutch firmly mounted on the head shaft or may be further reduced through the interposition of the back gears. The back gears are brought into operation by releasing the friction clutch controlling the direct drive and engaging the positve tooth clutch engaging the face gear that is fast to the head shaft.

The twelve gears constituting the transmission of the geared head thus give eight distinct spindle speeds, controlled by but three operating levers. Four shafts are used in this head and the engagement of all gears, with the exception of the face gear on low speeds, is through friction clutches, to minimize the shock incident to sudden gear engagement in speed changes.

Another arrangement of gearing that also gives eight spindle speeds has been adopted by the Worcester Lathe Co., in which but two shafts, the drive shaft and the head shaft, are employed. This arrangement is made possible by the mounting of the back gears on a sleeve supported by the drive shaft and the elimination of the driven shaft by mounting on the sleeve of the head shaft four gears of varying size. This design is shown in Fig. 2.

Mounted on the drive shaft are two sets of double gears, sliding on a key, or spline, which may be shifted so as to engage any one of the four direct driving gears on the sleeve of the head shaft, thus securing four different speeds of rotation for this sleeve. The face gear, which slides on a key, or spline, on the head shaft, may be shifted to engage the revolving head-shaft sleeve through a positive clutch so as to transmit the four speeds directly to the spindle. By shifting the face gear in the other direction, it engages the pinion of the back gear that is loosely mounted on the drive shaft and rotates the spindle at the four lower speeds, the gear of the back gears being in constant mesh with a pinion connected to the driving sleeve of the head shaft.

Twelve Gears Minimum for Eight Speeds

Twelve gears are again employed for the eight spindle speeds and this number would appear to be the minimum for such range. Two shafts less than in the previous arrangement are used, however, resulting in a different arrangement of gears. Friction clutches are not employed but could be used with a slightly different arrangement of driving gears on the drive shaft.

An ingenious design for securing twelve spindle speeds with the aid of but fourteen gears on four shafts is the arrangement adopted by the Springfield Machine Tool Co. The arrangement of the gears is typical of geared heads developing such number of spindle speeds, but the method used in shifting the gears is unusual. This head is illustrated in Fig. 3.

The drive shaft carries a sliding sleeve supporting two driving gears that mesh with one or the other of two fixed gears on the driven shaft, the sliding driving sleeve being moved on a key, or spline, in the drive shaft. The driven shaft also carries three sliding gears of varying size, one individual and the other two in the form of a double gear, which are also mounted on a key, or spline, and engage three gears carried by the head-shaft sleeve. The two driving-gear speeds are thus increased to six on the head shaft and, through the back gears and head gear, six more spindle speeds are obtained. When the drive is direct—that is, with the back gears out—the driving clutch on the head shaft engages the head-shaft sleeve; and when through the back gears, the driving clutch engages the face gear, the transmission being through the back-gear pinion connected to the head-shaft sleeve.

The shifting of the gears is through the medium of a pinion fast to the control lever shafts and the serrated hubs, or sleeves, of the gears—an adaptation of the rack-and-pinion principle. The driving clutch on the head shaft is moved between the head-shaft sleeve and the face gear in a similar manner. The body of the clutch is serrated, the serrations engaging the operating pinion on the control lever shaft.

Twelve Speeds with Fourteen Gears

Another interesting arrangement of fourteen gears by which twelve spindle speeds are secured, one in which but two shafts are employed, is shown in Fig. 4. Here, as in the two-shaft arrangement for eight spindle speeds, the back gears are mounted on a sleeve carried by the drive shaft and the driven shaft with its intermediate gears eliminated.

In this arrangement, the construction of the Hamilton Tool Co., the drive shaft supports two main driving gears *A* and *B* loosely mounted as far as the driving shaft itself is concerned, but straddling an attached shifting friction on the drive shaft by which either of the two main driving gears may be engaged. The driving gears mesh with a free-running double gear on the head shaft, so that the active driving gear transmits motion to the other through the double gear on the head shaft—the double gear acting in a manner similar to a set of ordinary back gears. One of the main driving gears forms an intricate part of the driving sleeve on the drive shaft—the sleeve also carrying three other gears. These latter gears transmit motion to the triple shifting gears mounted on a key, or spline, in the head-shaft sleeve, giving to this member six different speeds—three from either of the main driving gears.

In addition to the three driven gears, the head-shaft sleeve carries attached a back-gear pinion and a flange plate that abuts against the face gear of the head. The rotation of the head-shaft sleeve may be transmitted directly to the face gear by the insertion of a "spring plunger," giving the six direct spindle speeds, or else the back gears may be brought into mesh, giving the six lower spindle speeds—the "spring plunger" being taken out when the back gears are thrown in.

The back gears are mounted loosely on an eccentric sleeve supported by the drive shaft and are thrown in or out of action with the back-gear pinion on the head-shaft sleeve through the medium of a conveniently located control handle, much as the back gears of an ordinary cone-pulley lathe are brought into use.

The only gears in this type of head that are moved any considerable distance are those constituting the triple shifting gear mounted on the relatively slow-moving head-shaft sleeve.

Twelve spindle speeds are secured in the geared head of the lathe built by the Lodge & Shipley Machine Tool Co., with the use of only thirteen gears, by making two of the gears of double width and in constant mesh with their respective mating gears, whether actively engaged

in transmitting power to the spindle or simply running freely. This arrangement of gearing is shown in Fig. 5.

Four shafts are used in this head and the construction is typical of twelve-spindle speed geared-head lathes in which four separate shafts are used.

The drive shaft carries two sets of double gears, one pair of which is free to travel in either direction on a key, or spline, in the drive shaft and the other is held stationary on the drive shaft as far as its location is concerned but is mounted so that it can revolve freely. These two sets of gears may be connected into what is virtually one member by the jaw-clutch construction of their adjacent ends. The larger gear, *C*, of the free-running double gear is in constant mesh with the smallest of the three gears constituting the free-running sleeve on the driven shaft.

The driven shaft also carries a fourth gear, *d*, which may be shifted so as to form an intimate part of the triple gear sleeve by the engagement of their respective clutch hubs or else may be run in mesh with the smaller gear of the free-running double gear on the drive shaft.

back gears. The twelve spindle speeds are thus obtained through the agency of three shift levers, one controlling the movement of gears on the drive shaft, one the gear on the driven shaft and the third controlling the shifting of the back gears.

These five illustrations of typical geared heads are all more or less similar, differing principally in the methods employed for shifting or engaging the gears and upon whether independent-driven and back-gear shafts are employed or not. A radical departure from the general gear-shifting method and construction has been developed by the Bridgeford Machine Tool Works, however, which embodies certain features of the customary gear-shifting method and the utilization of a swinging gear cone arrangement for intermediary transmission between the drive and driven shafts. This arrangement of geared head is shown in Fig. 6.

The drive shaft of the Bridgeford geared head carries but one driving pulley, firmly attached to the drive shaft. This engages the largest gear of the gear cone, which is free to swing in an arc about the drive shaft, the driving

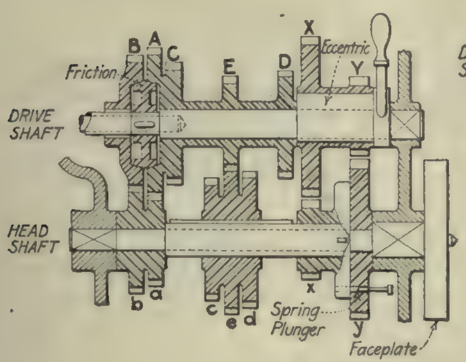


Fig. 4

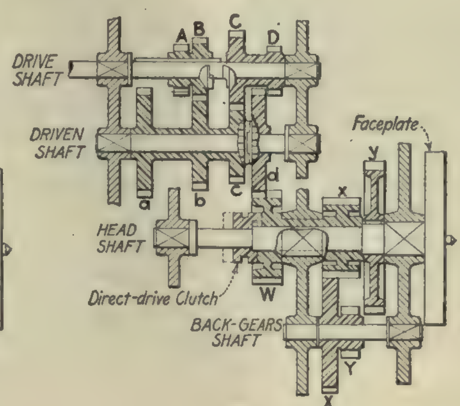


Fig. 5

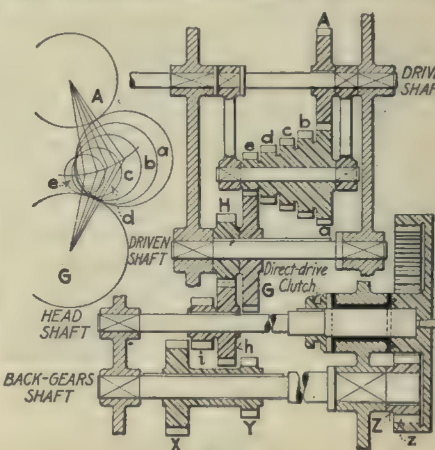


Fig. 6

Back gears out. Spring plunger in	A and C-c
	A and D-d
	A and E-e
	B-b, a-A, C-c
	B-b, a-A, D-d
	B-b, a-A, E-e
Back gears in. Spring plunger out	A and C-c, x-X, Y-4
	A and D-d, x-X, Y-4
	A and E-e, x-X, Y-4
	B-b, a-A, C-c, x-X, Y-4
	B-b, a-A, D-d, x-X, Y-4
	B-b, a-A, E-e, x-X, Y-4

Direct-drive clutch in. Back gears out	A-a, d-W
	B-b, d-W
	C-c, d-W
	D-d, d-W
	A-a, c-C, d-W
	B-b, c-C, d-W
Direct-drive clutch out. Back gears in	A-a, d-W, x-X, Y-4
	B-b, d-W, x-X, Y-4
	C-c, d-W, x-X, Y-4
	D-d, d-W, x-X, Y-4
	A-a, c-C, d-W, X-x, Y-4
	B-b, c-C, d-W, X-x, Y-4

Direct	A-a, e-G, H-h
	A-b, e-G, H-h
	A-c, e-G, H-h
	A-d, e-G, H-h
	A-e, e-G, H-h
First back gears in	A-a, e-G, H-h, i-X, Z-3
	A-b, e-G, H-h, i-X, Z-3
	A-c, e-G, H-h, i-X, Z-3
	A-d, e-G, H-h, i-X, Z-3
	A-e, e-G, H-h, i-X, Z-3
Second back gears in	A-a, e-G, H-h, h-Y, Z-3
	A-b, e-G, H-h, h-Y, Z-3
	A-c, e-G, H-h, h-Y, Z-3
	A-d, e-G, H-h, h-Y, Z-3
	A-e, e-G, H-h, h-Y, Z-3

FIGS. 4 TO 6. LAYOUTS FOR VARIOUS 12- AND 15-SPINDLE-SPEED HEADS

Fig. 4—Layout of 12-spindle speed head—speeds controlled by sliding gears. Fig. 5—Layout of 12-spindle speed head—using 13 gears to obtain the changes. Fig. 6—Layout of 15-spindle speed head—using a swinging gear cone to obtain changes

In either position, gear *d* is in mesh with the wide end gear on the head-shaft sleeve, so six different speeds are transmitted to the head-shaft sleeve from the three drive-shaft speeds, as indicated on Fig. 5.

Mounted at the other end of the head-shaft sleeve is another wide face gear that is in constant mesh with the gear of the back gears, which latter may be shifted so as to engage the face gear on the head shaft in one position or to revolve freely in the other. The face gear is firmly attached to the head shaft.

The six head-shaft sleeve speeds are transmitted directly to the spindle through the engagement of a positive drive clutch on the head shaft or may be transmitted to the spindle through the back gears by disengaging the direct drive clutch and engaging the face gear with the

gear *A* and the largest cone gear *a* remaining in constant engagement. On the driven shaft there are two gears, one firmly attached to the shaft for the transmission to the head shaft and the other free to shift on a key, or spline. This latter gear, *G*, may be moved along the driven shaft so as to engage any one of the gears composing the swinging gear cone, the gear cone being swung at the same time into the position required for the correct engagement of the particular cone gear with the sliding gear *G*.

The stationary gear on the driven shaft, gear *H*, transmits motion to the head shaft through the gear *h* with which it is also in constant engagement. The gear cone illustrated is composed of five gears of varying size, so that five speeds are given the head shaft. These speeds

are transmitted directly to the spindle through the direct-drive clutch attached to the head shaft. Through simple back gears these five speeds are increased in number by five more and through the triple-geared arrangement by another five, giving a range of fifteen spindle speeds with the use of fourteen gears.

The first and second sets of back-geared speeds, constituting the triple-geared arrangement, are controlled by the shifting back-gear sleeve carrying the gears X and Y. The sleeve slides on a key, or spline, in the back-gear shaft and X engages gear i, mounted on the head shaft and attached to the gear h. Gear Y engages the head-shaft gear h and either X or Y transmits motion to the back-gear pinion Z, gears X, Y and Z all being firmly attached to the back-gear shaft. Pinion Z drives the internal face gear z with the direct-drive clutch out and either set of back gears in.

The triple-geared arrangement could be adopted for any of the previously described geared heads by the interposition of two additional gears, one on the head shaft and the other on the back-gear shaft, necessitating but little alteration in the general design of the heads. This would convert the ordinary eight-spindle speed geared head with simple back gears into a twelve-spindle speed mechanism and the usual twelve-spindle speed geared head into a transmission giving eighteen spindle speeds.

Geared-head lathes with eighteen distinct spindle speeds are usually limited, however, to those of large swing in which considerable difference in spindle speeds due to a large variety of diameters of work may be required. For lathes of lesser swing, a fewer number of spindle speeds is usually sufficient, the demands and requirements for spindle speeds being no different for geared-head lathes than for the older type of cone-pulley lathes.

A Few General Comments

To secure eight spindle speeds, a driven shaft being interposed between the drive and head shafts and simple back gears employed, two drive-shaft speeds—that is, two driving gears of different size—have to be employed, or a gear cone with two steps placed between a single driving gear on the drive shaft and the gears of the driven shaft. Such an arrangement of geared head may be modified to give twelve spindle speeds by the addition of two more gears to form a triple-geared arrangement.

The elimination of the driven shaft in an eight-spindle speed geared head necessitates four drive-shaft sleeve speeds, or the interposition of a gear cone with four steps between a single-gear drive shaft and the head shaft. The triple-geared arrangement of back gears may likewise be used with this construction, necessitating the use of two more gears but increasing the spindle speeds to twelve.

In the case of the twelve-spindle speed geared head with simple back gears and a driven shaft, the drive shaft need only have two sizes of driving gears, the driven-shaft gears multiplying the number of speeds delivered to the head shaft by three, through the equivalent of a three-step gear cone. The triple-geared arrangement of back gears increases the number of spindle speeds to eighteen.

The omission of the driven shaft necessitates six drive-shaft sleeve speeds, while the interposition of a swinging gear cone between the drive shaft with a single driving gear and the driven shaft requires a gear cone of six steps.

The number of spindle speeds obtainable without the interposition of a swinging gear cone is always an even number, but with the swinging gear cone arrangement any number of spindle speeds may be practically secured as but one driving gear is employed on the drive shaft. In this latter construction of geared head, the number of spindle speeds is equal to the product of the number of steps to the gear cone and two, for simple back-geared construction, or to the number of gear cone steps and three, for the triple-geared type of geared head.

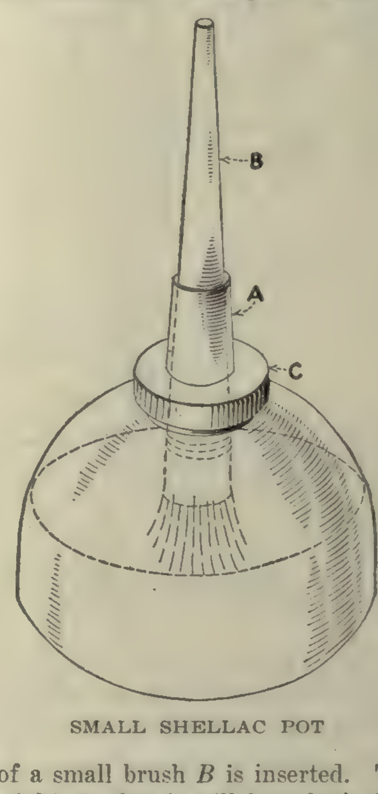
Friction clutches, if employed, are always advisably placed on the higher speed shafts and positive clutches on the head or back gear shafts, the shock of sudden tooth contact being less destructive on the slower gears.

The geared heads described in the foregoing do not, of course, include all types of such mechanism, but those referred to are sufficiently typical and indicate in themselves certain types of designs that have proved successful.

Small-Quantity Shellac Pot

By F. L. Thornton

In small shops where shellac is often used in but small quantities, I have found a common oil can, shown, very convenient as a container. The spout is cut off at A, and



SMALL SHELLAC POT

the handle of a small brush B is inserted. Thus the can is made air-tight, so that it will keep both the brush and the shellac in good condition. The collar C keeps one's fingers out of the shellac.

Graduated Vise Jaws

By A. E. Holaday

I have several vises with the front jaw graduated in ½-in. graduations and find them useful for cutting off short pieces of stock, as they save the time of measuring

Manufacturing Operations on Wire Wheels

Special Correspondence

SYNOPSIS—Some of the operations and tools in the manufacture of wire wheels are shown, including an interesting type of taper boring tool having inserted cutters. The operations for assembling the wires in the wheels are fully illustrated, also the enameling and baking.

Wire wheels for automobiles do not appear to be used so much in this country as in Europe. There are many advantages claimed for them, such as equal expansion of the entire wheel, as all parts are made of metal, thus preventing distortion; they are not affected by excessive moisture or the lack of it; they possess greater elasticity and are light in weight.

One of the latest developments in wire wheels, illustrated in Fig. 1, is being manufactured by the Phelps Manufacturing Co., Columbus, Ohio.

The finishing operation on the inside of the rear inner hub, which has been finish machined on the outside in a previous operation, is shown in Fig. 2. The piece is held in the chuck as shown, fitting in the outside finished surfaces. The hole is then rough bored, finish bored, outside faced and taper reamed. The production is four hubs per hour. The interesting feature of the tooling for this part of the work is the rough boring tool shown in position for operating. This bar is made with inserted tools of square section high-speed steel and is held in the bar because the holes into which they fit have a slight taper. After the tools have been drawn down the correct angle to suit the taper hole to be machined the tools are ground on the cutting edges.

In Fig. 3 is shown the jig for drilling the spoke holes in the outer hubs. The piece *A* is located on an arbor that fits into a previously bored hole. The nut *B* holds the hub in position. The various positions for the holes to be drilled are obtained by fitting the pawl *C* into the notches of the index wheel. For the second row of holes to be drilled, the jig is slid over until the pawl is in contact with the second indexing wheel *D*. The positions for the second row of holes are determined in a similar manner, with the pawl and the notches on the periphery of the wheel *D*. The hub being drilled is revolved in the jig by means of the handle *E*.

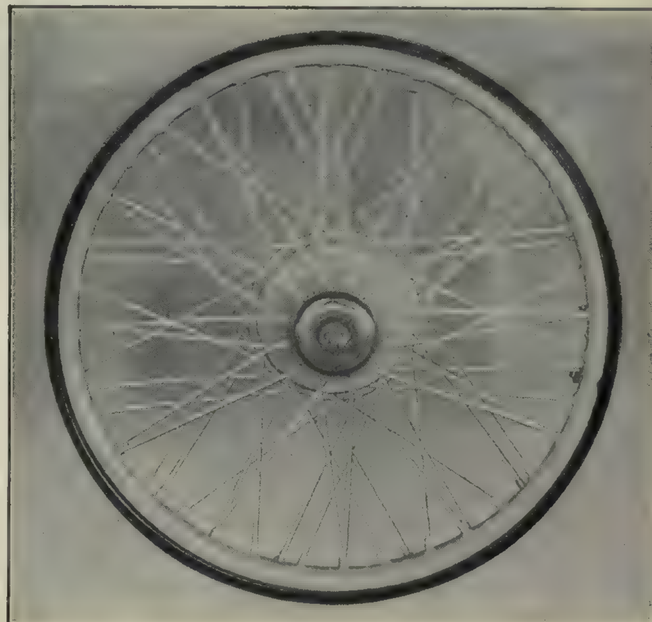


FIG. 1. A COMPLETE WIRE WHEEL

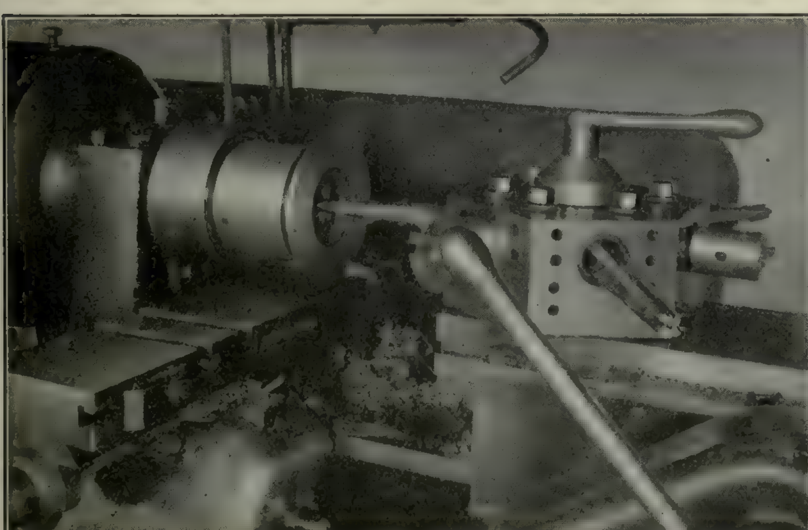


FIG. 2. FINISH MACHINING THE HUB

FIG. 3. DRILLING THE OUTER HUBS

It will be observed that the jig is tilted at an angle by means of the pin *F*, which fits in a hole machined in the sub-base of the jig. When drilling the holes at the other end of the hub, the drill is guided through the jig plate *G*. During this operation the pin *F* is placed in the hole *H*, thus tilting the hub back into a different plane than the one now occupied. These different angles for the two drilling operations are necessary, so that the spokes when placed in the wheel will be at the correct angle with the center line of the wheel. In the

hub shown sixty-two $^{15}/_{64}$-in. holes are drilled. The production is 15 pieces per hour.

In Fig. 4 is shown how the spokes are put in the wheels. The wires are slid into the holes of the hub—a button head prevents them being drawn through too far—and then placed through the holes in the rim. A nipple is afterward screwed onto the threaded end, which is the part reaching through the rim. The nipples are then tightened with a screw-driver. An average of six of these wheels may be spoked in an hour.

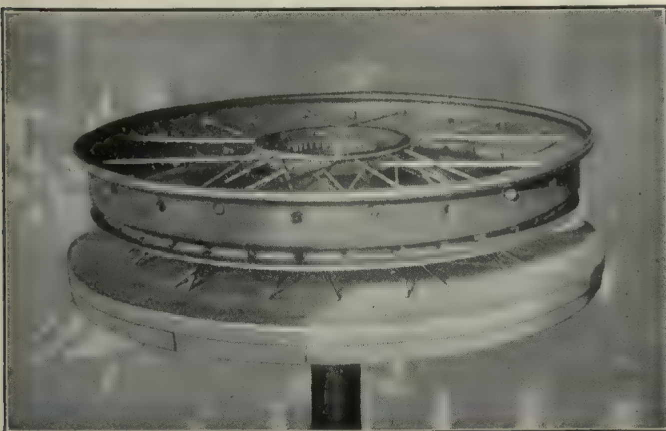


FIG. 4. PUTTING IN THE SPOKES


FIG. 5. TIGHTENING IN THE SPOKES

The wheel is then placed on the fixture shown in Fig. 5 and the spoke nipples tightened until the wires are tight and the wheel runs true. In Fig. 6 is shown the fixture with the wheel removed. It will be seen that the rim of the fixture is provided with openings. The lower wires of the wheel fit into these openings, the hub locating on the turned arbor *A*. When the nut is tightened on the arbor threaded end the wheel is held firmly in position, so that the tightening operation may be performed conveniently. An average of four wheels may be put through this operation in an hour.

The wheels are then trued in the fixture shown in Fig. 7. The wheel is placed on an arbor that fits into the bored hole and the spokes tightened until the wheel runs true. The straight-edge *A* is placed against the edge of the wheel rim, the wheel spun round and the spokes adjusted until the straight-edge touches at all points on the edge of the rim.

After the wheels have passed inspection to cover all the machining operations, they are enameled. This operation is performed as shown in Fig. 8. The wheel is held by the man and dipped into the tank *A*. After every part has been immersed, the wheel is placed on the pipe as shown. The superfluous enamel drops into the trough underneath and thence back into the tank. When one of the pipes has been filled, it is transferred to a truck that holds two pipes and the truck wheeled onto tracks that run into the oven where the enamel is baked.


FIG. 6. FIXTURE WITH WHEEL REMOVED

FIG. 7. TRUING THE WHEEL

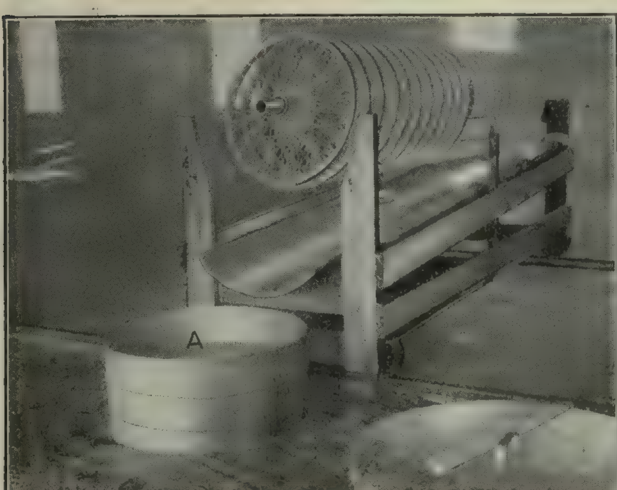


FIG. 8. DIPPING THE WHEEL

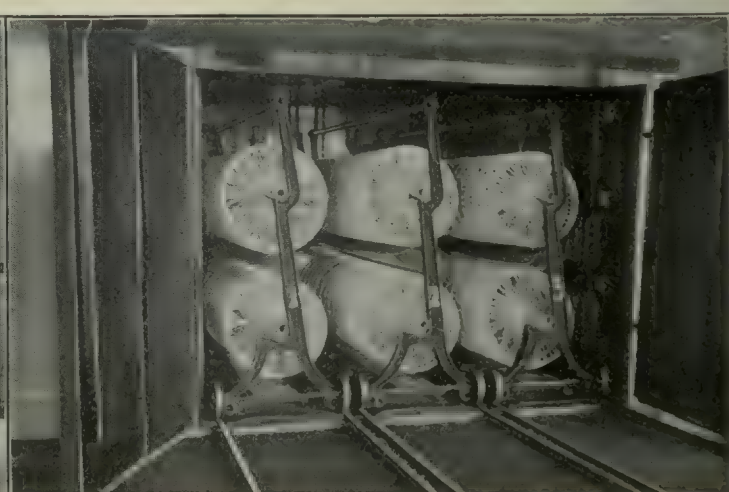


FIG. 9. BAKING THE ENAMEL

In Fig. 9 is shown the oven, in which are three trucks holding 120 wheels. For the most part enamel of two colors is being used to cover the wheels. For the white the oven is kept at 150 deg. F. and for the priming coat

the wheels are left in the oven 1 to 1½ hours. For the finishing coat the wheels are left in the oven 2½ hours.

When the wheels are covered with black enamel the oven is kept at a temperature of 350 to 400 deg. F., and the wheels are left in the oven 1½ hours for the priming coat and 2 hours for the finishing coat. The hub is then

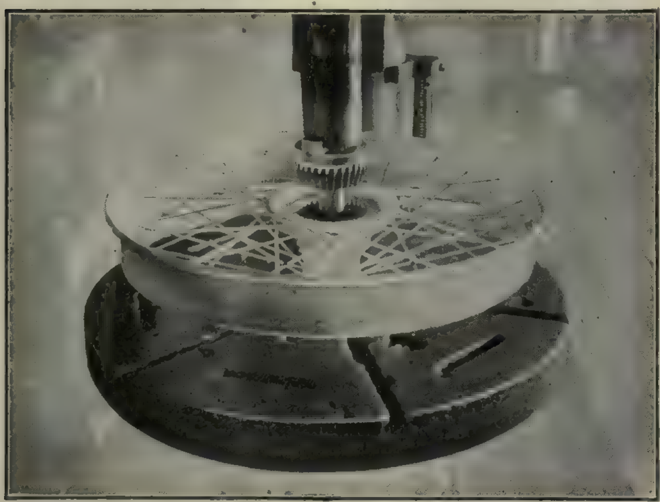


FIG. 10. FINISH REAMING THE HUB

reamed, to remove any enamel that may have gathered in the hole. This operation is shown in Fig. 10. The tool is fed down until the hole is the correct size, a gage being used to test the operation. The wheels are now conveyed to the shipping room and are ready for use on the automobile.

Gages for Transmission Sliding Shafts and Gears

By A. E. Burrell

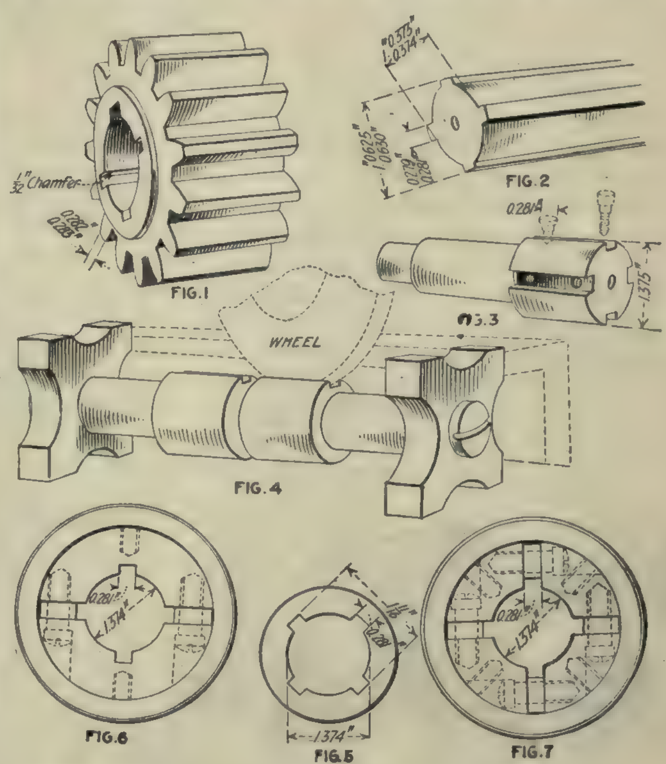
In Fig. 1 is shown a gear with four equally spaced broached keyways. Careful work is required throughout, as even with an accurate broach there are three chances for error in the spacing of the keyways, and these errors may either accumulate or correct themselves in the subsequent operations.

There seems to be only one "best" type of gage for the inspection of the keyways in the finished gear. This is shown in Fig. 3. The body is ground, and the keyways are also ground for inserted keys. If desired, this gage can be made in limit form by making the keys to "go" size for a little more than the width of the gear to be gaged, the rest of the key being a "not go" dimension. The body of the gage should be made of one diameter throughout and not in limit form.

Dividing heads for the surface grinder are not usually part of the equipment of a small toolroom. How to grind accurately by other means both the sides and the bottom of the keyways is shown in Fig. 4. For convenience, two gages are made in one piece with grinding stock left on body, end bearings and in the keyways, which should have clearance grooves machined in the corners, and holes tapped for the fastening screws. After hardening, the gages should be carefully straightened, the body ground to size, or plus 0.0002 in. for lapping, and the ends ground to some convenient standard size, at the same time facing the shoulder.

The two square blocks shown must be made as accurately as possible, with the sides square with each other and parallel with the bore, which should be central and a good fit on the ground ends of the gages. With the aid of a surface plate and indicator for setting them the gages should be clamped on the blocks by the end binding screws with the keyways central, as shown in Fig. 4. The wheel of the surface grinder should be thinned down till it will pass freely in the milled keyways, and the cutting side relieved to within 1/16 in. of the edge. With the back plate of the surface grinder set up to the required height, a cut is taken over its edge, to insure its being true with the ways of the grinder.

The blocks and gages, as one piece, are placed on the magnetic chuck, with the blocks against the back plate and the cross-slide adjusted until the wheel just touches the back face of the keyway. Without moving the cross-slide the gages are turned end for end, and a trial cut is



FIGS. 1 TO 7. EXTERNAL AND INTERNAL GAGES

taken over the other side of the same keyway, then over both sides of the other three keyways in succession. By repeating this procedure for each adjustment of the cross-slide the keyways are eventually ground out to required width and will be parallel and central with the body of the gage. The spacing can be checked up by measuring with micrometers across corners, but with accurate blocks and careful work this method can be relied on for correct results.

The making of gages for inspecting shafts having a section like Fig. 2 offers some interesting problems, also a wide range of design. In Figs. 5, 6 and 7 are shown three different types of gage, which will suffice for this article. In Fig. 5 is shown a solid gage similar to a ring gage. This is not a durable gage as very little usage ends its value for reference purposes, owing to the fact that while the hole can be finished to size after hardening, the slots must be machined to size, previous to hard-

ening, making the accurate spacing of the slots more or less a matter of doubt. It is not to be recommended for either quantity or quality gaging. However, as it is the simplest and cheapest to make—a recommendation in many shops—it must not be overlooked.

The only difficulty experienced in making these solid gages is in the spacing of the slots. A slotting attachment on the miller handles this work nicely, with the gage held in the dividing-head chuck. The shaper can also be utilized, if nothing better is available, by clamping the dividing head to an extension plate on the knee. The machine best suited for the work, however, and one rarely used outside of its regular production work, is the Fellows gear shaper, as with a few simple attachments it can be turned into an ideal indexing slotter.

The gage to be slotted can be set dead true on the work spindle of the machine or on a suitable faceplate, and a toolholder to take a slotting tool may be used in place of the regular cutter. A stud, squared on the end to fit a crank, is screwed, instead of the usual nut, against any suitable change gear on the lower wormshaft for hand indexing, and a pointer is fitted to coincide with a zero line scribed on the side of the change gear. The rotary feed is of course disengaged and the machine used simply as a slotter, although the radial feed can be used for feeding in to depth. The 36-in. index wheel of this machine must necessarily give more accurate results than the 6- or 8-in. wormwheel of a dividing head. After hardening, the gage must be carefully trued up for grinding the hole, or the spacing of the slots will be inaccurate in the finished gage.

In Fig. 6 is shown a built-up gage that needs little explanation. It has the advantage of the slots being ground after hardening and allows for a slight adjustment when worn. The outer knurled ring acts merely as a retainer for the gage proper, consisting of two main segments and two flat plates ground to the finished size of the slot separating them. The gage is first made in ring form, Fig. 8, grinding stock being left in the hole and outside diameter; the holes are drilled and tapped for the fastening screws, and the two opposite slots are roughed out. The other two slots are machined as in Fig. 8, to facilitate separating the segments. After hardening, the hole is ground to size or minus 0.0002 in. for lapping, and the outside diameter is ground to fit the bore of the holding fixture as shown in Fig. 9.

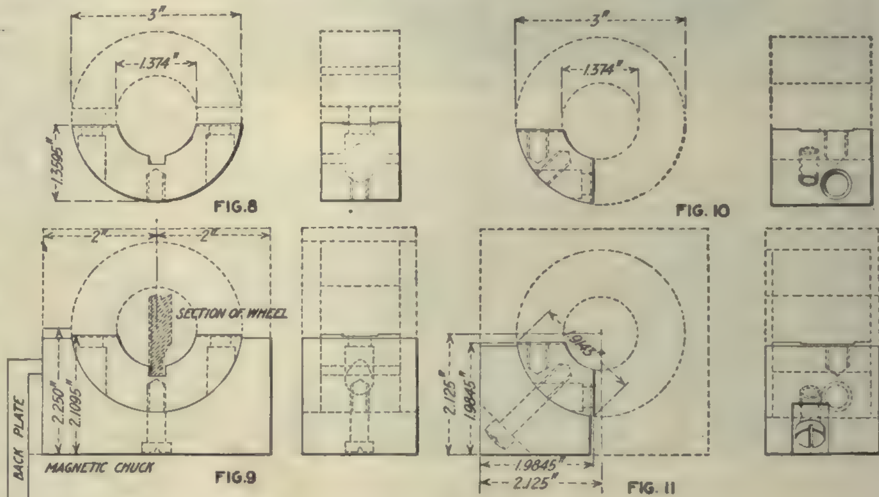
This fixture should be made as accurately as possible, as the errors in it will be multiplied in the finished gage. The two working edges must be equidistant from and together with the base, parallel with the bore. The distance from the base to the center of the bore is measured and recorded, so that the faces of the gage segments can be ground and measured from the base. The slots are ground in the same manner as the keyways in Fig. 4, by placing one edge of the fixture against the back plate of the magnetic chuck for one side of the slot and reversing the fixture for the other side. The spacing blocks between the main portions of the gage need no comment, being ground to the required width of slot or, better still, about 0.0002 in. left on all the ground surfaces for lapping to finished size.

In Fig. 7 is illustrated a gage composed of four segments and four spacing blocks, finished to the required width of slot and held together by screws. They may be pressed into a knurled retainer, or the retainer may be heated sufficiently to allow it to be slipped over the assembled gage, which it will hold firmly when it is cold. Although this gage is a little more complicated than the one shown in Fig. 6 the added cost is more than compensated for by provision for adjustment when worn, both in the hole and the slots. The gage is roughed out, with an allowance for grinding in the hole and on the outside diameter.

After the holes for the fastening screws are drilled and tapped, four slots, 1/32 in. less than finished size in width, are milled at 90 deg. to each other, from the outside to about ¼ in. from the hole. After hardening, the hole is ground, leaving an allowance for lapping. The outside diameter is ground to fit the holding fixture, shown in Fig. 11, and is then cut into segments, as shown in Fig. 10, by grinding.

The method of grinding the flat surfaces of the segments on a surface grinder needs little explanation, but the fixture calls for accurate work. The square block shown should be made with two sides dead square with each other, equidistant from the center and parallel with the bore. Then the portion not needed should be cut away. The segments can be ground to size with very little trouble by working from both bases of the fixture, for each cut taken. The final measurements can either be taken from these bases, or the dimension across corners figured, which, being a direct measurement for the two surfaces, will give very close results. For the final finishing, however, the gage will have to be assembled, the size of the hole measured and the flat surfaces of the segments lapped until the hole is closed in sufficiently to allow for a lapping operation in the hole, insuring its being to size and round.

A gage finished in this manner, provided the work throughout has been accurate, will well repay the extra cost of making, giving something that can be sworn by, with no chance for argument.



FIGS. 8 TO 11. METHOD OF MAKING THE GAGES

The Sine Bar in Machine Work

By Hugo Pusep

SYNOPSIS—A few years ago the sine bar was practically unknown to the majority of mechanics. It was a new tool whose possibilities could be appreciated only after it had been used on accurate work, for setting up, laying out or measuring angles. At the present time, notwithstanding its popularity, the use of the sine bar is restricted almost entirely to angular work on the surface plate.

There is an unlimited field for the sine bar in all classes of machine work, but more especially in machine work of the toolroom. Various objections have been raised against its use in machine work. The contention that it was impracticable to clamp a jig or a fixture to so frail a tool as the sine bar stands out as one of the chief objections against it in certain classes of work.

I have collated examples showing how the sine bar has been employed successfully in a variety of machine work. In many instances it has simplified the setting up for machining operations and incidentally saved considerable time. In setting up a job on the machine, it does not by any means follow that the part to be machined should be in actual contact or rest on the sine bar. In few instances, with the possible exception of such work as light gages, angle forming tools and so forth, does the sine bar contact with the work. Where the sine bar comes in contact with heavier work, it is then used as a kind of precision protractor and serves the purpose of providing means for setting the job to any desired angle by the aid of an indicator.

Using the Sine Bar Direct

The most common use to which the sine bar is put and the one most familiar to mechanics is that of setting it up on an angle plate and then clamping the part to be finished in direct contact with the sine bar. (See Fig. 1.)

At *A* is shown a flat gage, one end of which is square to its parallel sides, while the other end has two obtuse angles of the same degree. In this instance, if the job is done on the surface grinder, one of the angles is ground first; the gage is then turned over and the remaining angle ground. The different methods of using a sine bar in conjunction with the angle plate and surface grinder are assumed to be generally known, and this one example will be sufficient.

Under this heading are included all jobs where angular surfaces are to be machined accurately with the aid of the sine bar; or holes bored a certain angle to any given plane. It also includes the setting up of machine tools in order to produce an angle, such as setting the shaper head to any degree which the tool is supposed to travel when using the up-and-down feed, or setting the centers in a universal grinder when it is necessary to grind an accurate cylindrical taper. An indispensable auxiliary for the sine bar in connection with machine work, especially the miller, is the clamping plate, shown in Fig. 2, which is made of cast iron of any convenient size. With a sine bar 5 in. long the plate could be made to the dimensions given; it would then meet most requirements in small and medium toolwork. In larger work, where 10 in. or longer sine bars are used, the plate, of course, has to be correspondingly larger.

After it has been planed, this clamping plate is made parallel and accurately squared on all sides by scraping or grinding. It has a number of holes tapped with a $\frac{5}{16}$ standard tap to receive capscrews, by which the sine bar is secured and held to the plate while in use. A sufficient number of holes should be provided to allow the sine bar to be clamped in any position on the plate. A form of clamp that will be found handy in this connection is shown at *A*, Fig. 2. It is assumed, of course, that the thickness of the sine bar is $\frac{1}{2}$ in. Two such clamps, as shown, are sufficient to hold a sine bar to the clamping plate while setting it on the surface plate, and also when in use on the machine. In other words, the clamps are only the means for holding the sine bar securely to the clamping plate, while the former is being set with an indicator, because absolutely nothing else comes in contact with it. To make the meaning of this quite clear, the following example is given:

A box jig *A*, Fig. 3, of a simple design, has to have a hole bored through the flat end *D* and through the lug *E;* the center line of these holes to be exactly 30½ deg. to the machined face *F*. The sine bar is now set in relation to the clamping plate as shown at *B*, Fig. 3. This is accomplished in the usual way, the end *G* of the clamping plate resting on the surface plate while it is held square with clamps against an angle iron. After the sine bar has been set to the proper angle, the clamping plate is set up on the miller table, as shown diagrammatically at *C*, Fig. 3. It will be seen that as the sine bar was set 30½ deg. from the end of the clamping plate, all that is necessary is to indicate the sine bar—with the indicator held in the drill chuck of the miller spindle—true with the table travel of the miller and then clamp the side *F* of the jig against the side of the clamping plate. The whole is securely held with four U-clamps, as is clearly shown. The indicator is now removed and the center of the miller spindle brought in line with the center line *HH* of the jig, and the holes finished.

The Clamping Plate a Necessity

From the foregoing example the necessity for the clamping plate has been made quite clear; without it the sine bar could not be utilized for a job of this kind. In working out blanking and forming dies, having angles in their make-up, the sine bar can easily be set to the angle required and together with the clamping plate secured to the table of the profiler. Then there is no need to watch if the cutter follows the lay-out lines, thus resulting in less eye strain and producing better results both as regards the quality of work and the time taken. In Fig. 4 is shown how the shaper head can be set.

One advantage of setting the shaper head in this manner is the fact that when the base of the jig or fixture to be machined is clamped directly to the shaper table, it does not make any difference if the surface of the table is not true in relation to the travel, because the

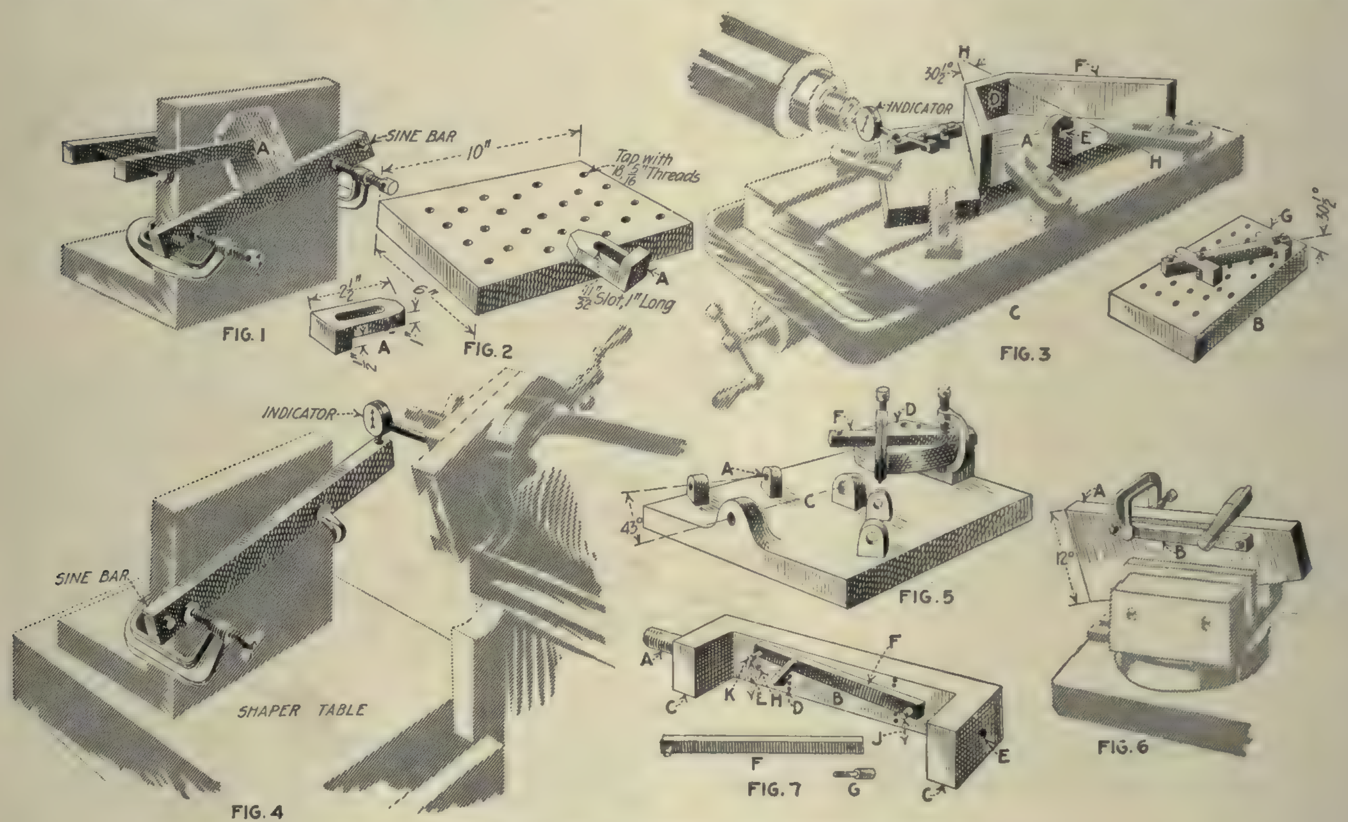
tool slide will follow the course to which the head was set by the sine bar, which bears the same relation to the shaper table as the fixture—a rather encouraging fact to know, especially if every shaper in the shop is out of true.

Securing the Sine Bar to the Job

In Fig. 5 is given an instance where the sine bar is clamped direct to the work. It is one of the easiest ways of setting up a job on the machine for all accurate angle work, and should be resorted to whenever it is possible to hold the sine bar to the job. The line reaming fixture shown demonstrates how a job of this kind can be bored with absolute certainty that the holes *A* are 43 deg. from the center line *C* of the fixture. The sine bar in this case can be conveniently clamped to the bushing plate *D*. Two settings of the sine bar are necessary to complete this job. As the clamps holding the sine bar to the bushing plate are toward the miller spindle, the sine bar has to be indicated at the back edge *F*. In Fig. 6 is shown an angular job set up in the shaper vise preparatory to finish shaping the top edge *A*. The sine bar in this instance is secured to the work and is set 12 deg. on the surface plate from the finished bottom edge. The work, along with the sine bar, is then clamped in the shaper vise as shown, and with an indicator in the tool post of the shaper the sine bar is trued up in line with the ram travel of the shaper. It is understood, of course, that in this particular case the under side *B* of the sine bar is used for indicating, the clamps interfering at the top.

In a certain jobbing toolshop a large number of short cylindrical pieces were to be ground; but as the pieces ran in small lots whose taper per foot was different in each individual lot, it was deemed advisable to design some sort of gage for setting the swivel table of the grinder to the proper taper without the long and tedious cut-and-try method. A Brown & Sharpe cylindrical grinder was used for the job, and although the graduations on the table scale are accurate, there are always adjustments to be made either way in order to make the job come within the specified limits, as all good grinder hands know.

This process of resetting the grinder for different tapers was very much in evidence when the product of two days' grinding was compared. The output on a job where the tapers were alike was just about two-thirds larger per day than on days when the grinder had to be set several times for pieces of different tapers, although of the same length. So the heads of the department were looking for a method whereby the time for resetting the grinder could be cut down to a minimum. From a suggestion of one of the tool makers, who was known throughout the shop as the "sine-bar crank," the simple fixture shown in Fig. 7 was made.



FIGS. 1 TO 7. VARIOUS APPLICATIONS OF THE SINE BAR

The body of the fixture is made of machine steel with centers *E* in each end and with one end turned down to accommodate a grinder dog, as at *A*. The flat part *B* is machined half the thickness of the sine bar below the centers and about $1\frac{1}{2}$ in. longer than the total length of the sine bar, the side *C* being square with the flat *B* and also parallel to the centers *E*. Two rows of holes *D* are drilled and tapped with a $\frac{5}{16}$ tap, for the sine-bar clamp screws. The sine bar *F*, Fig. 7, used in conjunction with the fixture, had a fixed stud in one end, 1 in. in diameter, while the other end had a 0.500-in. hole, lapped a good fit for the plug *G*.

To set this sine-bar fixture for any required taper the procedure was as follows: The fixture was laid on a

surface plate, resting on its side, as will be seen clearly in Fig. 7. The sine bar is free to pivot on the plug *G*, which is inserted through the ½-in. hole of the sine bar and into one of the holes *H* of the fixture. The distances of the holes *H* from the side *C* are carefully measured and stamped on the fixture for future reference. The reason for having two ½-in. holes in the fixture is for convenience in clamping, because either hole can be used as occasion requires, thereby making the fixture universal in its scope.

For the sake of example let us assume that a $\frac{1}{3}\frac{2}{2}$-in. taper per foot is under consideration. From the table for tapers and corresponding angles we find that the angle with the center line of this taper is 1 deg. 25 min. 1 sec.; turning now to the table of sines and multiplying the sine of this degree by 5—which is the distance the measuring studs of the sine bar are apart—we get 0.12372 in. as the sine of 1 deg. 25 min. 1 sec. on the length of a hypotenuse of 5 in. In the case of the fixture here shown, the hole *H* is 2 in. from the side *C*; in other words, the distance *J* from the surface plate to the under side of the pivoting plug *G* is just 1.5000 in. Now adding the sine of the angle gives us 1.62372 in. for the height *L*. We used Johansson gages for setting the stud *K* a correct height from the surface plate, this being the quickest way of getting any height in shops having a set of these gages. Of course, the regular height gage or size blocks can be used advantageously.

With the sine bar thus set, the fixture is placed between the grinder centers and the sides *C* squared with the grinder table. By means of an indicator held conveniently to the wheel stand, the swivel table is adjusted till the reading on the indicator is absolutely identical at all points along the sine bar. Although this description has been rather lengthy, the actual setting of the fixture and the grinder takes but a few minutes. In the above mentioned shop it was the custom to have a tool maker set the fixture for the next job while the job in hand was not yet completed. The grinder hand was also instructed how to use the fixture when setting his grinder for the next job; and it might be said that the production increased considerably and very accurate taper work was the result. In a short time most of the tool makers were borrowing the sine-bar fixture for setting the compound rests on the bench lathes and taper-turning attachments of the engine lathes.

Possibilities of the Sine Bar

The few instances here given of different applications of the sine bar in connection with machine work do not cover a fraction of its possibilities. It has been my experience that wherever I could use the sine bar successfully on a machine the result has been angles of unquestionable accuracy. It will be clearly seen that, in order to extend the field of usefulness for the sine bar certain accessories will become necessary. In the toolroom where accuracy is the watchword, the first cost of these accessories should not be considered, because once made they will be used over and over again. The sine bar has only made its initiatory entrance into the toolroom and, like all other new methods, is looked upon rather as a luxury than a necessity.

In a majority of toolrooms, I can safely say, the production of angles is left to chance. By this I mean that in most cases the degree graduations of machine tools are depended on to a large extent; and after the job has been removed from the machine and found to be just a little off, it is generally passed as "good enough." As no two bevel protractors will read alike, it is really a problem to check up an angle and determine with any degree of certainty whether the angle is correct or not. So in closing I would suggest that in order to eliminate this uncertainty when machining work comprised of one or more angles the mechanic, before starting, should ask himself, "How can I apply the sine bar to this job?"

Sammy's Shop—One Reason Why Shafts Are Varied Instead of Holes

By W. Osborne

"Mr. Brown, some time ago I read some things about how much better it would be if we made all of our shafts of one size. You know what I mean is, if we made all of the same size shafts of one size. You know, like this, if we made all of the two-inch shafts two inches, and all of the three-inch shafts three inches and all of the rest of them the same way." Sammy had an idea in his head, but seemed to be having some trouble extracting it.

Mr. Brown seemed puzzled and a little bit alarmed. "Don't we make our two-inch shafts two inches now? I always thought that we did and cannot see any reason for doing anything else. A two-inch shaft should certainly be two inches and nothing else. If you have not been having it done that way, I am very much surprised," and from the look that he gave Sammy he might have added that he was very much disappointed.

Perhaps it was this look that made Sammy ask, "Mr. Brown, what size should a two-inch hole be made?"

Sammy tried to look neutral, as Mr. Brown looked him over carefully as he replied, "Any right-witted man would be likely to make it two inches."

"Maybe," said Sammy, "but you could hardly make the same sized hole and shaft do for running, neat and shrink fits, could you? We have the three kinds on the cornsheller."

"Oh," was all that Mr. Brown said. He waited.

"We have been keeping our holes as near to the standard sizes as we could and then have been making the differences in the size of the shafts. If we wanted a shrink or a driving fit, we left the shaft large; and if we wanted it a running fit, we made it small. If we wanted a neat fit, we made it wring in by hand. If we made the shaft to a standard gage, we could make the holes different sizes for the different kinds of fits. To do that, we would need to get our reamers oversize enough for the running fit. When it wore down, it would get to be the size for the other fits. When a reamer got dull and had to be ground, we could grind it to the next kind of a size."

The High Cost of Oversize Reamers

After some talking, Mr. Brown ordered the reamers necessary to try the plan on one size of cornshellers. They were ordered through the usual channels and were to be of the make that was in regular use. After a long wait they came and were put to work.

Several days later, Mr. Brown came rushing out of the office with wrath in his eyes and a bill in his hand. "Look here, will you? These people have charged 50 per cent. more for those new reamers than they do for

the standard-sized ones, and all because they were left three-thousandths large. Here is a nice little size that costs $6.90 regular. Now they bill it as a special and charge us $10.35."

"There surely must be some mistake, Mr. Brown, for if they left it in the rough, it wouldn't cost us more than 50c. to grind it ourselves, and we are not in the business at all. Write and see if there is not some mistake somewhere."

Mr. Brown did write, and he found that there was not any mistake. To get a reamer left oversize cost the extra price and took a lot of extra time besides. He could not understand why there should be this difference in price. It had been found that, when a twist drill was wanted longer than the standard, the increase in price was large, but some reasons could be seen for that. The drill would be special from the forging on through every process, but it would not be so with the reamer. It would be regular up to the last operation of grinding to finished size. Without being familiar with the methods of the reamer manufacturers, Mr. Brown and Sammy believed that the grinding to size was an individual operation that could not be trusted to an automatic machine, but must be done by an intelligent operator with means at hand to know, at the various stages of the grinding, the size of the reamer being ground. Why stopping two to three thousandths larger than usual should add greatly to the cost they could not understand. If the added cost was not there, then it must be in the system somewhere. If it were there, it would seem as though some day a scientific manager should be put to work on it.

They began to wonder if it would not be to the interest of some drill and reamer maker to establish a department by itself, out of the way of the regular work, and run it to take care of such work at a price that would not be a loss, but that would be less oppressive to the user. It could easily be that in time there would be a standard oversize just as there used to be oversize V-thread taps before the days of U.S.S. taps. The advertisement that the first firm starting such a thing would get out of it should help to keep down the costs.

Using Adjustable Reamers

This way of keeping all the shafts to a standard size proved very attractive to Sammy, and he did not want to discontinue it. The added cost was disturbing. One day a man from a small shop that makes adjustable reamers came in with samples of his wares and found a very willing and appreciative audience. His reamers have a range and some refinements that are not needed to do the work on cornshellers, but they are cheaper to use than the others at the special price, and now they are becoming the regular reamer for the work.

There is one other point that should not be lost sight of. All this trouble about the special reamers took place before the war. Sammy has reason to think that he could not get oversize reamers now at any price and get them in time to use before he became so old that he would not be interested in their arrival.

Shops that have to use reamers always have some way of grinding them. If they could get reamers that were not ground to size, but were stopped without the last operation being done on them, the finished grinding could be done with very little trouble and with very little loss of time. It would not make any additional expense to the manufacturer to leave them that way. It would mean that the jobber, if he stocked them, would have to carry that much additional stock.

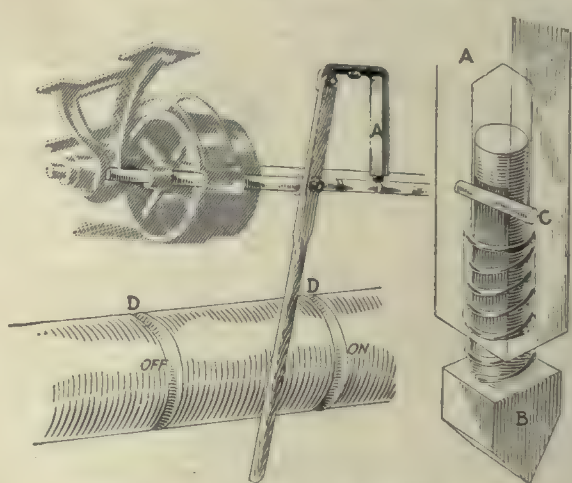
It may be that there are manufacturers of reamers who are willing to coöperate in this matter as soon as the need is pointed out to them. While at first they might not do a very large business in that line, yet it would doubtless grow.

It took a long time for the U. S. Standard of bolt threads to come into use, and one of the hold-backs was that the dealers treated taps, dies, setscrews, capscrews and bolts with these threads as extras, thus putting a premium on lack of progress. This matter of the sizes of reamers does not rank with that system in importance, but it is of enough moment as a step in advance in shop practice to deserve some measure of recognition and encouragement from the reamer manufacturers. The prices that are now charged seem unreasonably high even in consideration of everything, unless the point is that the manufacturers do not want to be bothered and are doing all that they can do to keep from being bothered.

Positive Stop for Shifter Rod

By E. N. Gillis

To prevent the shifter rod moving endwise by itself and starting the machine the device shown in the accompanying illustration was made. It consists of a piece of iron *A* bent at right angles and attached to the stringer with wood screws, the other end being drilled to receive a pin *B* and a coiled spring. The shank of the pin is filed flat on one side and a pin *C* driven into the holder to keep it from turning, but allowing it to move in and out of the hole. Two small grooves *D* are turned in the



POSITIVE STOP FOR SHIFTER ROD

shifting rod, one in the "on" and the other in the "off" position.

Now when the machine is stopped it is stopped for good, and no vibration can start it, the same, of course, being true when it is going. The device has given us so much satisfaction that we are fitting it on all our machines that have a shifting belt drive.

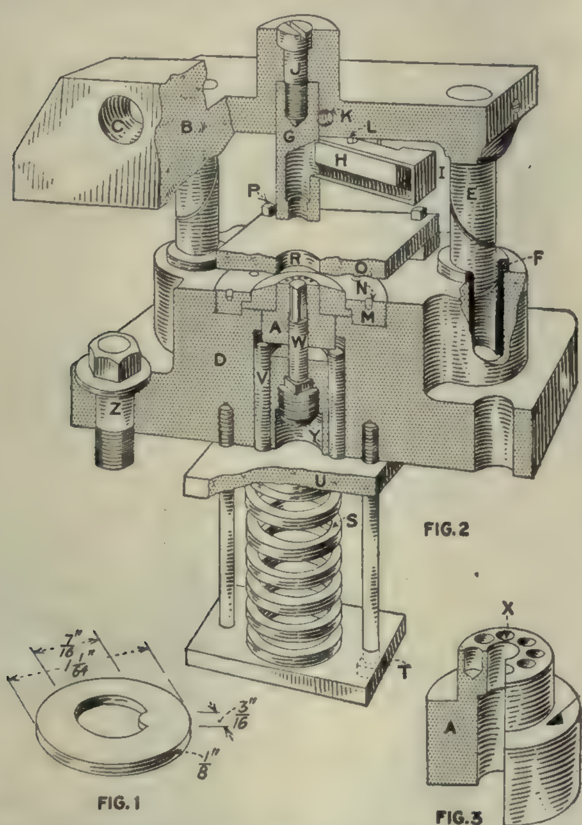
The safety features secured by the use of this device are well worth the cost of its installation, to say nothing of the convenience secured through its operation.

IDEAS FROM PRACTICAL MEN

Compound Die and Punch for Lock Washers

By Ernest A. Walters

In Fig. 1 is shown a lock washer blanked from $\frac{1}{8}$-in. steel scrap. In Fig. 2 is shown the die on which the lock washer is blanked. One of the features of this die is the



FIGS. 1 TO 3. THE WORK, THE DIE AND THE KNOCKOUT

knockout bushing *A*, shown in detail in Fig. 3. This bushing is so arranged that it is impossible to plug it up as long as the operator gives the necessary attention to his work.

The knockout bushing *A* has the holes *X* drilled in its face. These holes are called "signal holes" and will always show whether the last blank has been discharged or not. Should the washer stick in the die and cover the signal holes *X*, the difference between the plain face of the washer and the drilled face of the die *A* at once becomes apparent to the operator, who can then remove it before tripping the press.

The punch shoe *B*, Fig. 2, is of cast iron and fits the press ram, to which it is bolted. The die *D*, made of cast iron, is aligned to the punch by the heavy steel guide pins *E* and the bushings *F*.

The blanking punch *G* is made of hardened tool steel. The punch is counterbored for slug clearance and has an opening at *H* through which the slugs are discharged into the chute *I*, which is fastened to the punch shoe by the screw *L* and so arranged that the slugs will fall clear of the die. The punch is held by the screw *J* and kept from turning by a tapered pin at *K*.

The blanking die is a bushing held in place by the threaded bushing *M*, which is seated and secured by a spanner wrench fitted to the holes *N*.

The stripper *O*, held by the capscrews *P*, is open in front to allow the operator greater freedom and a better vision while operating the die.

The opening under the stripper at *R* is necessary in order to let the washer slide off the die when blanked, the press being inclined at an angle of 45 deg.

The bushing *A*, Fig. 3, is made of tool steel hardened and ground to size and serves as a knockout for the blanking die. Special care must be taken at the time of setting up the die to get the proper pressure on the pad *A* by the correct adjustment and tension of the spring *S* and the nuts *T*, Fig. 2.

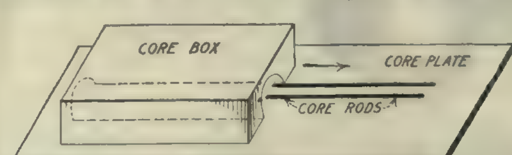
The pressure is transmitted to the knockout bushing by the plate *U* underneath the die, and the hardened pins *V*.

The perforating punch *W* has a square head to prevent it from turning in the die and is securely seated by the setscrews *Y*. The die is fastened to the bed of the press by the capscrews *Z*.

Making a Long Core with a Short Core Box

By M. E. Duggan

A casting is wanted today. The pattern and the core boxes are ready for the foundry. The $2\frac{7}{8}$ x 24-in. core box cannot be located. The foundry has neither core box



HOW THE LONG CORE IS MADE

nor stock core the required size on hand. The only core box available measures $2\frac{7}{8}$ x 14 in.

If such a core is wanted in a hurry, and the 14-in. box is made with end boards, knock them off; cut core

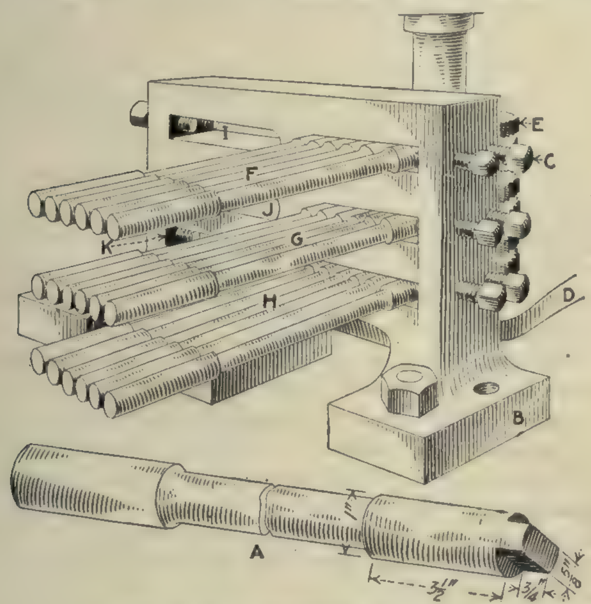
rods to the required length; fill in the core sand and place the core rods in the usual manner.

When the box is filled and rolled over on the core plate, the box is driven (not lifted) ahead about 2 in. in the direction of the arrow, core sand is filled in the end of the box, and the shifting process is repeated until the core is finished. The drying or baking is proceeded with in the regular way.

Almost Continuous Milling

By William Fyfe

In reading over the pages of the *American Machinist*, one finds wonderful records of output illustrated in connection with continuous cutting on the miller. We have a very simple operation cutting two flats to fit a wrench



MULTIPLE MILLING FIXTURE

on the end of a turned piece that is threaded later. For this purpose we use a vertical miller and circular attachment and a pair of side-milling cutters set to size. When the cutters are in action, the operator is kept busy removing and replacing the work after it has passed the cutters. This method is far superior to the old and tedious process of machining one at a time in a small slotting machine, where 50 per cent. of the time is lost on the upstroke of the tool.

The illustration herewith shows an outfit designed with a view to faster production of the same class of work. Although it is not exactly continuous in operation, it is nearly so, as there are three sets of cutters in action and no spaces between the pieces. The work is milling the ends of crown stay-bolts *A* for locomotive boilers. These bolts are about 20 in. long, with ends 1 in. in diameter by 3½ in. long. Six are placed in each slot in the fixture *B*. Three-sixteenths of an inch is milled off each side at the end for a distance of ¾ in., leaving a wrench grip ⅝ in. thick. Each set of stay-bolts in the fixture is independently clamped by a pair of ⅜-in. setscrews. When the fixture is full, the table is run forward to the cut and the feed thrown in.

The cutters *E* are 4 x ⅝ in., located on an arbor supported below by the bracket *D*. When the cutters have passed the work in the first three slots *F*, *G* and *H*, the setscrews *C* are loosened and the work is removed. While the cutters are operating on the work in the slots *I*, *J*, *K*, the slots *F*, *G* and *H* are being filled. On the completion of the work in the slots *I*, *J* and *K*, the crossfeed is run over so that the work in *F*, *G* and *H* will clear the cutters. The table is run back to starting position and the cut repeated. While the cutters are busy on the stays in *F*, *G* and *H*, the ones in *I*, *J* and *K* are removed and replaced.

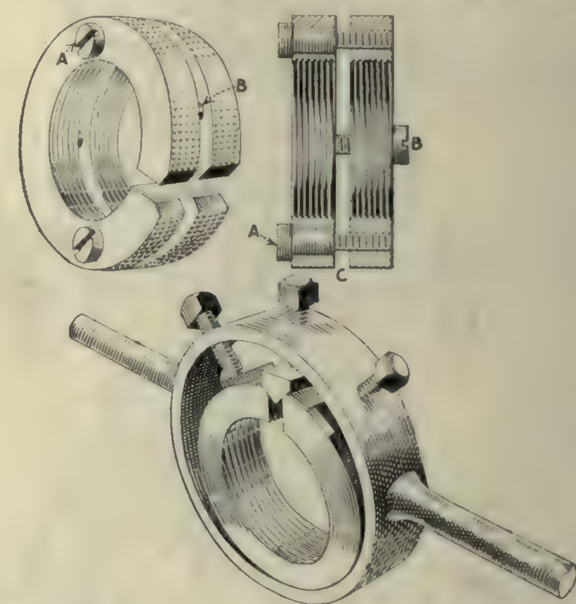
From 3000 to 4000 pieces a day can be milled in this way, depending on the dexterity of the operator. The cutters are flooded with lubricant. The fixture is made of cast iron and is intended for use on a vertical miller.

Lap for Correcting Thread Gages

By John P. Marion

One of the many troubles that a gagemaker encounters is correcting the lead on thread gages. I have been working at this for some time and have had many suggestions on how to overcome it. If, in hardening, the lead changes ever so little, it is very difficult to correct.

The illustration shows a lap that can be adjusted to overcome either long or short errors in lead. It is simple and inexpensive. As an example, we will take the lap for a thread gage 1 in. long. Take a cast-iron lap that



LAP FOR CORRECTING ERRORS IN LEAD

is 1 in. long and drill and tap two holes halfway through at *B*. Chuck the lap in the lathe and split it at *C*, so there are two laps of the same length, say about $\frac{7}{16}$ in. long. When put together, the screws *A* will draw the two halves in, correcting long lead, while the screws *B* will correct short lead. A strip of steel under the adjusting screws in the lap holder will give an even tension on both sides of the lap. I have been using this lap, and it gives the very best result.

Thread-Cutting Suggestion

By Daniel W. Rogers

When cutting threads with the compound rest set over, better results can be had by setting it over 29½ deg. instead of 30 deg.

Measuring and Gaging Screw Threads

The gages here described briefly have been suggested for measuring or testing taps and screws. Some are for both pitch diameter and lead, others for either of these functions. The subcommittee of the American Society of Mechanical Engineers, which is studying the question of screw-thread tolerances, would be glad to receive further suggestions from all who are interested in this important problem. Gages for both the shop and for final inspection and measurement should be included.

The gage, Fig. 1, measures the variation from standard of both the pitch diameter and lead of screws and taps. It is constructed with the fixed V point, a micrometer-adjusted grooved roll and a floating point. The grooved roll fits over the thread and is free sideways to allow for variation in lead. This roll is set to the standard pitch diameter of the work to be tested by the micrometer thimble.

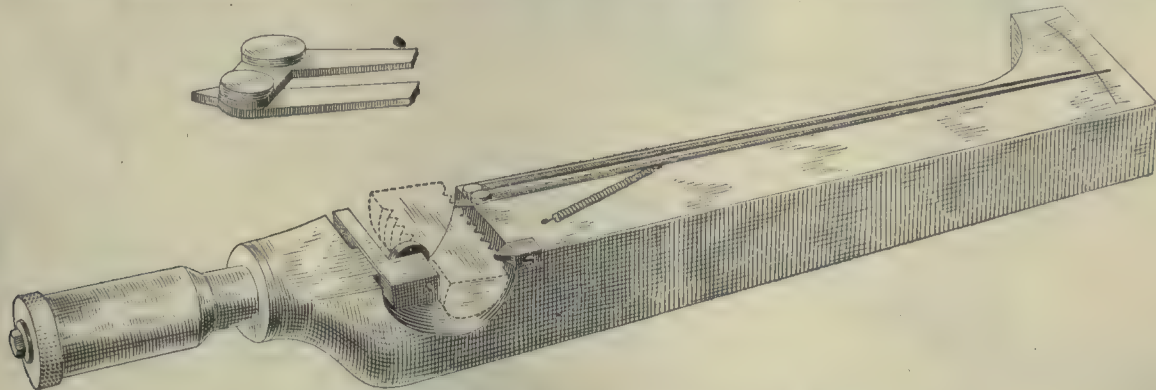


FIG. 1. GAGE FOR PITCH DIAMETER AND LEAD

The floating point is so connected that the longer lever shows variation in lead and the shorter lever variations in pitch diameters, each pivoting about its own center. Work is placed between the points, as shown by the dotted sections, and the variations from standard of pitch diameter and lead are read directly in thousandths.

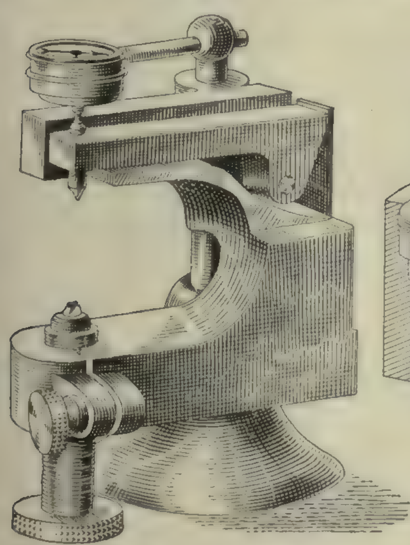


FIG. 2A

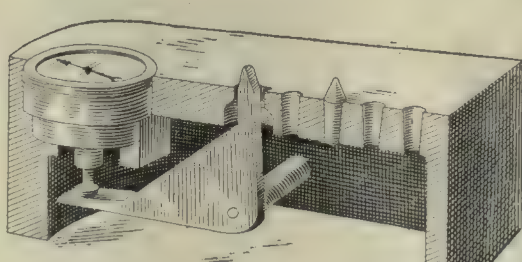


FIG. 2B

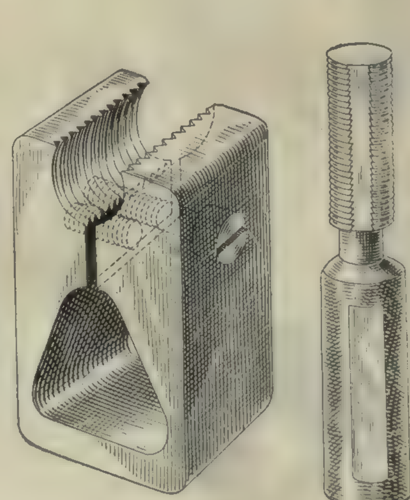


FIG. 3

FIGS. 2A TO 3. VARIOUS GAGES FOR PITCH DIAMETER AND LEAD
Fig. 2A—Gage for variations in pitch diameter. Fig. 2B—Gage for testing lead. Fig. 3—Gage for pitch diameter

The gages shown in Figs. 2A and 2B are to be used together, the gage 2A measuring variations in pitch diameter only. The V-shaped anvil is adjusted through a wide range of diameters and can be locked in position by a clamping screw. A gaging arm is pivoted and the gaging point is held in contact with the work at a constant pressure, by a spring at the rear. A regular dial indicator is in contact with the arm. The gage is set to a standard, and as work is passed between the points variations in diameter are transmitted through the arm to the dial indicator, where the amount of variation may be read directly in thousandths.

The gage shown in Fig. 2B is for lead only. The positive point may be used in any of the four positions, to allow for different lengths of thread. The floating point is part of the bell crank lever, which is mounted to act on the dial indicator, as the distance between the measuring points varies. The indicator is set to a standard. Then work is positioned on the two points. Any variation from standard in the lead will be read directly in thousandths on the dial.

A gage for pitch diameters only is shown in Fig. 3. This gage is made slightly tapering and is split and furnished with screws for adjusting and locking. It is ad-

justed so that the setting standard illustrated will screw into gage until a line on standard matches a line on gage. The other line on gage indicates 0.001 variation from the standard in pitch diameter.

Fig. 4 is a combination gage for pitch diameter and lead. In this gage there are a fixed point and two adjustable points, one for variations in pitch diameter and the other for variations in lead, these variations being in both cases read in thousandths on dial indicators. Indicators must be set to a standard before testing work. There is an adjustable block which may be set by a vernier so that work resting on it will have its center line in line with the gaging points.

The gage illustrated in Fig. 5 has three fixed points, located correctly for lead and having a set relation to a flat pin between which and the screw being tested a pin gage is used. This pin gage is of such a diameter that it "will not go" when the work passes inspection as to combined errors of diameter and lead. A dotted section of work being tested is shown in the illustration.

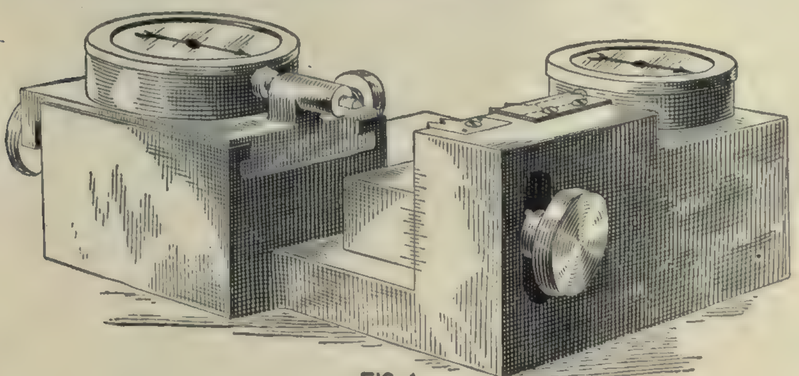


FIG. 4

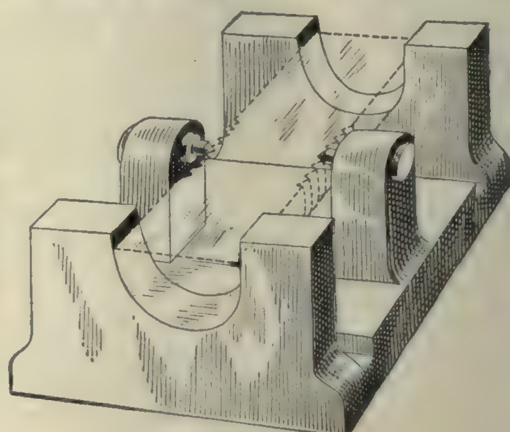


FIG. 6

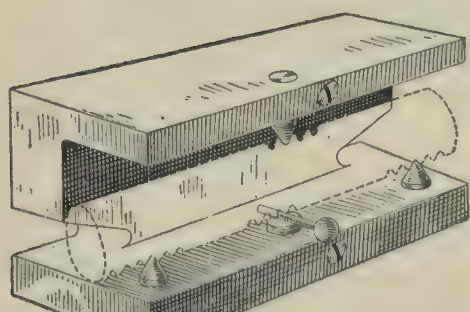


FIG. 5

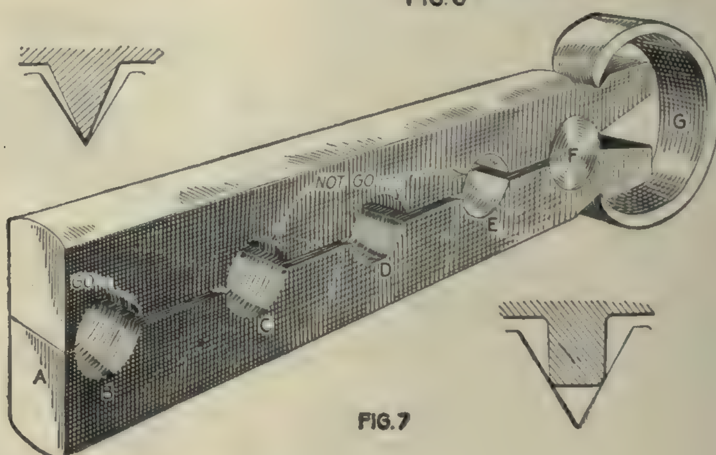


FIG. 7

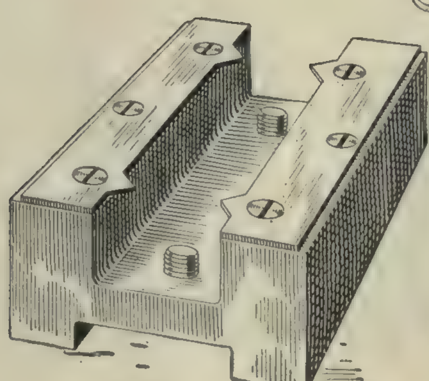


FIG. 8

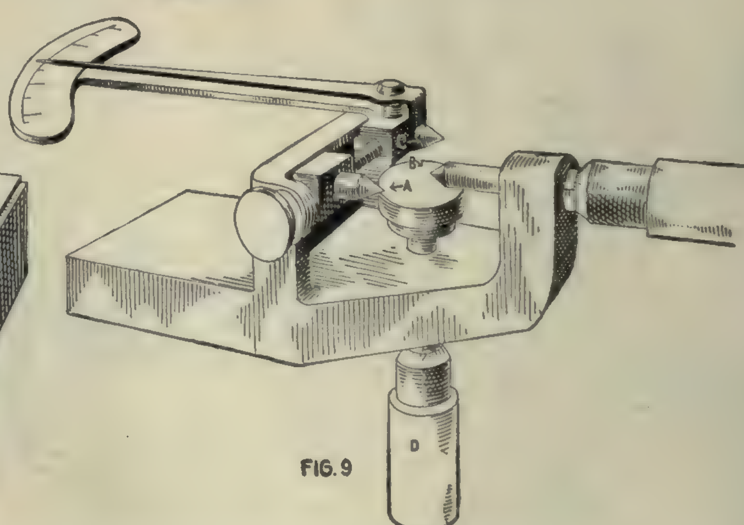


FIG. 9

FIGS. 4 TO 9. VARIOUS GAGES FOR TESTING SCREW THREADS

Fig. 4—Combination gage for pitch diameter and lead. Fig. 5—Gage for testing lead. Fig. 6—Gage for lead. Fig. 7—Gage for root, pitch and outside diameter. Fig. 8—Gage for lead and pitch diameter. Fig. 9—Combination gage for lead and diameter

In Fig. 6, the gage has two fixed points, located correctly. Guiding grooves serve to align the work, which is placed in the gage as shown by the dotted section; the amount of variation from standard cannot be accurately measured, as estimate being the only thing possible where this type of gage is used.

The gage shown in Fig. 7 is fitted with a hinge *F* and a spring *G* like that on a spring caliper. The jaws open to admit the insertion of the screws to be measured, and the two halves are then brought together by the fingers. The hole *B* is the "go gage." It is threaded standard, and when the flat surfaces between this and the end are in contact, represents the maximum size of hole. Any screw that goes in here will go in the tapped hole, regardless of the lead error. The other three holes *C, D* and *E* are "not go" gages and test the root diameter, the pitch diameter and the outside diameter respectively. In order to eliminate the question of lead, in both *C* and *D*, only a single turn of thread is used, and this is of special form, as shown by the small diagrams. The last hole *E* is plain, to gage the minimum outside diameter. Special attention is directed to the fact that the "not go" gage *D*, in combination with the "go gage" *B*, limits errors of pitch diameters and lead also.

The gage illustrated in Fig. 8 is similar in principle to the gage shown in Fig. 6. It has the four fixed points located in the correct relation to one another. Screws locate work so that its center line is on the line of gage points. Work is placed in position, and variations in lead and pitch diameter may be estimated.

A combination gage for diameter and lead is shown in Fig. 9. The point *A* is adjustable longitudinally by means of a micrometer screw, so that it can be positioned in proper relation to *B*, which is adjustable for different diameters, the pitch diameter of work being read directly by means of its micrometer. The point *C* is connected to the indicator, variations in lead being read directly in thousandths on the scale. A block supports the work in the proper relation to the gage points, and is set by means of the micrometer *D*.

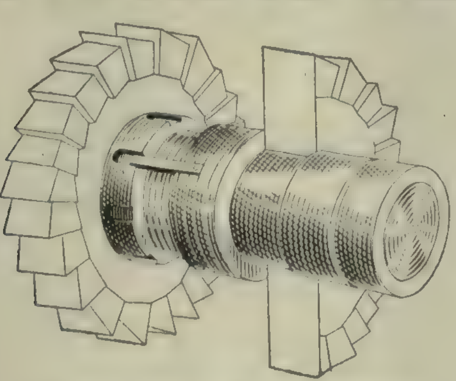
Gages 1, 2, 4 and 9 are suited to a wide range of diameters and pitches. Gages 3, 5, 6, 7 and 8 are limited to one size only.

Adjustable Spacing Collar

By H. E. McCray

On our gang mills we use quite a number of adjustable spacing collars similar to the one shown in the illustration.

One bushing is turned down and threaded, the other fitting over it with a female thread. The thread is a



ADJUSTABLE SPACING COLLAR

comparatively fine pitch—20 per inch—for two reasons. The fine pitch, of course, has a small angle and does not readily loosen under vibration; and a fine adjustment is possible. A small flat spring is fastened to the male collar and bears in notches milled in the opposite one. Notches are milled 30 deg. apart in this collar, so that each one gives an adjustment of a little over 0.004 in. We find this accurate enough for manufacturing purposes, using a thin sheet-metal stamping to fill out if necessary.

By using an adjustment of this sort with a wide range, side milling cutters can be ground on sides as well as periphery, and it is unnecessary to go through a tedious cut-and-try process whenever a gang of cutters is ground and reset. Its cheapness also has much to recommend it.

Productive Shop School

By Joseph Ahlers

With all the toolmakers busy on special tools, a firm confronted with the necessity of increasing the toolroom supply of mandrels, arbors, boring bars, reamers, plugs, taps and other such simple yet important tools, tried out a novel plan.

A school was organized for the purpose of instructing those employees who desired to become students in the art of tool design and production. The ordinary machinist or apprentice is only too eager of the opportunity to gather any information regarding toolmaking, so a full class was soon enrolled. The number of students was limited by the toolroom equipment, as the classes are held in the toolroom. Each student works on a machine or vise. Sessions are held on certain nights each week or during certain noon hours. The tuition is free.

The faculty is composed of two instructors—the chief draftsman, who lectures on mechanical drawing and mathematics; and the tool foreman, who lectures on tool design, hardening, tempering, annealing and general toolmaking operations. The instruction in mathematics and drawing includes shop arithmetic, mensuration and the primary principles of mechanical drawing, such as projections, sections, scale, dimensions. The instruction in toolmaking is most practical. Each student is given an assignment, according to his ability, with full and careful directions. One works on the tool grinder, sharpening cutters; another grinds drills; and more work on lathes, turning mandrels, reamers and taps. Others mill reamer flutes and cutter teeth on the miller. As each student finishes each piece or operation, he is required to have it inspected by the instructor, who approves or scraps it. Every student is given a chance on every kind of work from the cutoff saw to the oil-hardening furnace.

It can be readily seen that this course of instruction, even though the subjects are elementary, covers quite a volume of information and would certainly be valuable to anyone who cares to avail himself of the opportunity to acquire it. Both the student and the firm benefit. A man can learn to do anything, if given the proper instructions and directions, and nearly always without waste. Thus, the student's first arbor is a success, likewise the tap and the reamer. Among the men who enroll in this class are many first-class machinists in their particular field, and their work is invariably in Class A. Their finished tools are consigned to the tool shelves.

In this manner the firm is obtaining about 100 productive hours per week without cost except for power, and this expense is by far exceeded by the value of the tools. The instructors ask no remuneration, but the results would more than justify their being compensated.

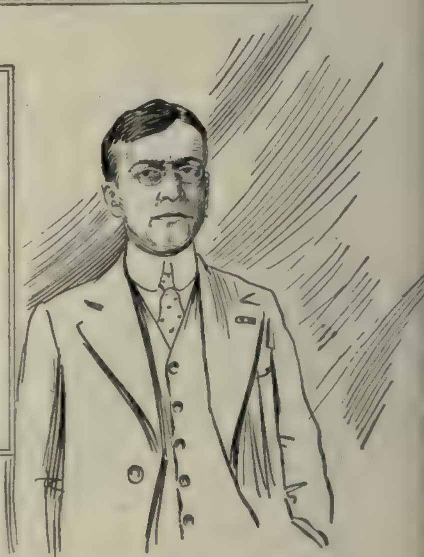
Cabinet and Council
American

Industry and business, science and invention, are warfare's most powerful weapons. That our Government clearly realizes the importance of American industries as factors in the world war is evidenced by the conference held at Washington, May 25, at which those directing our war activities personally addressed the technical, trade and business editors of America. The sketches below are from life.

Francis S. Peabody,
CHAIRMAN FUEL BOARD

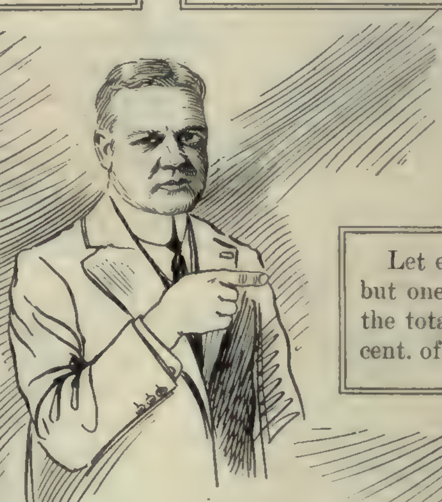
I came here with a feeling of scorn for Government efficiency. I found a tremendous efficiency and no red tape. The Government does not hamper—it *does* help.

War has become a thing of industry and commerce. It is a conflict of smoke-stacks—the combat of the driving wheel and the engine. Organizing an army without destroying industry is a serious proposition.



Newton D. Baker,
SECRETARY OF WAR

This will be a war of attrition. It will be a long war lasting from two to five years. Europe has been a laboratory of food experiment.



Herbert C. Hoover,
FOOD ADMINISTRATOR

Let each American family waste but one slice of bread per day and the total loss is equivalent to 2 per cent. of our annual flour consumed.

Franklin K. Lane,
SECRETARY OF INTERIOR

Germany is the combination of the feudalism of the thirteenth century and the science and invention and genius of the nineteenth century. A government by the soldiers is not consistent with the government by the people.

I have felt that we will find the means of dealing with the submarines, such as enabled Farragut to say, "Damn the torpedoes, full steam ahead!" Thirty-six thousand engineers have enlisted in the navy.

Josephus Daniels,
SECRETARY OF NAVY

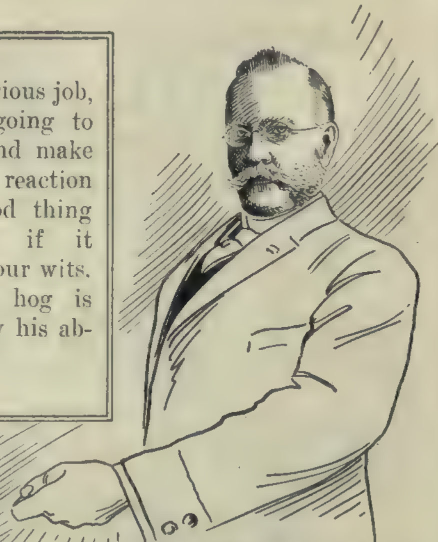
# of Defense Address Industry

In addition to those of the speakers sketched on these pages the following men addressed the editors: George Creel, chairman Committee on Public Information; V. H. Manning, director Bureau of Mines; F. H. Martin, in charge of Red Cross work; Howard Elliott, of the Railroad Executive Committee; and G. O. Smith, director United States Geological Survey.

Frank A. Vanderlip,
PRES. NATIONAL CITY BANK

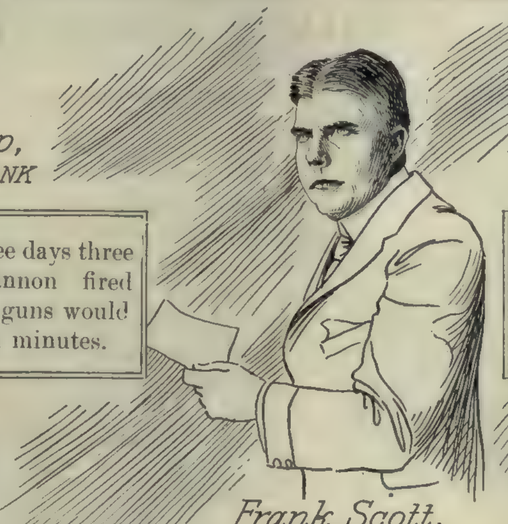
Our success is to be measured by the completeness of our national organization. This war must be fought on the savings of the future. We have got to have the power of successful business if we are to raise the finances to fight Germany.

This is a serious job, but we are going to clean it up and make it safe—the reaction will be a good thing for America if it makes us use our wits. The business hog is conspicuous by his absence.



Wm. C. Redfield,
SECRETARY OF COMMERCE

At Gettysburg in three days three hundred and ten cannon fired 32,000 rounds. Today, guns would fire that much in seven minutes.



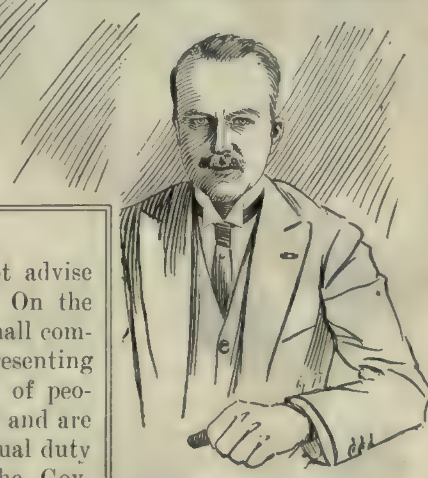
Frank Scott,
CHAIRMAN MUNITIONS BOARD

The war consumption of everything except food and clothing has been multiplied. Cannon must be replenished like ammunition.

Wm. B. Wilson,
SECRETARY OF LABOR

If manufacturers will plan their annual inventory, overhauling and repair of plants to come at harvest time, they will release a great body of workers for the peak load of harvest and thus help to solve the food problem.

Mobs cannot advise on anything. On the other hand, small committees, representing large numbers of people, can advise and are now in the actual duty of advising the Government.

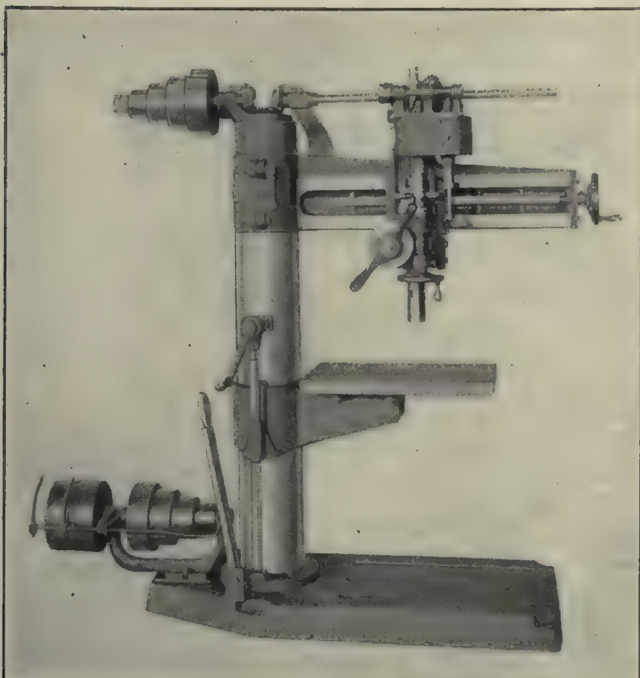


Walter Gifford,
DIRECTOR COUNCIL OF NATIONAL DEFENSE

Shop Equipment News

Radial Drilling Machine

The radial drilling machine shown is made by the Canedy-Otto Manufacturing Co., Chicago Heights, Ill. Two models are manufactured, one having power feed and the other lever feed, both models being made with



RADIAL DRILLING MACHINE

either $2\frac{1}{2}$- or $3\frac{1}{2}$-ft. arm. A set of four step cones gives four changes of speed.

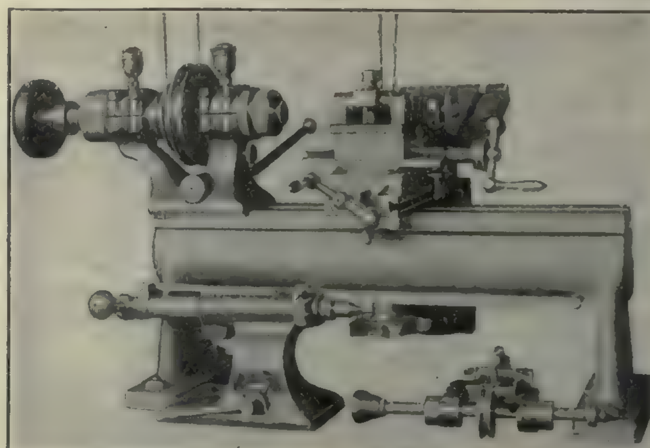
The spindle and feed drives are operated through bevel gears on top of the column, which make it possible to swing the radial arm through about half a circle. The table is elevated by a crank-operated screw and may be swung out of the way in order to use the baseplate when desired.

Combination Precision Lathe and Grinder

The Ideal Machine and Tool Co., 128 Opera Place, Cincinnati, Ohio, is now manufacturing a combination precision lathe and grinder of rather novel design. The machine has a swing of 7 in. and is made with different lengths of bed, the shortest giving a distance of 12 in. between centers. A compound slide rest with a stop is used, which will give a longitudinal feed of 3 in. at one setting. The crossfeed also has a maximum movement of 3 in. Both feed screws and the tailstock are fitted with micrometer dials.

The spindle is ground and lapped, threaded for chuck or faceplate and fitted for draw-in collets to accommodate work up to $\frac{1}{2}$ in. in diameter. The three-step cone pulley has 12 holes, equally spaced in a circle, for dividing work or for holding the spindle while tightening collets. A brass collar covers the threads on the spindle nose, when not in use, to protect them from injury. Provision is made for taking up wear and end play.

A 4 x 6-in. table, provided with T-slots and adjustable to any angle, is mounted on a slidable bracket, at the rear, which has a vertical movement of $4\frac{1}{2}$ in. The bracket is held in position by a T-head bolt that slides



COMBINATION PRECISION LATHE AND GRINDER

in a T-slot extending the full length of the bed. This table is used for holding work while performing various types of surface grinding. Both the headstock and the tailstock can be removed while grinding without loosening bolts or screws.

A toolpost is provided, accommodating tools up to $\frac{5}{16}$ x $\frac{1}{2}$ in. The machine, countershaft and motor are mounted on a wooden base, thus making a portable outfit.

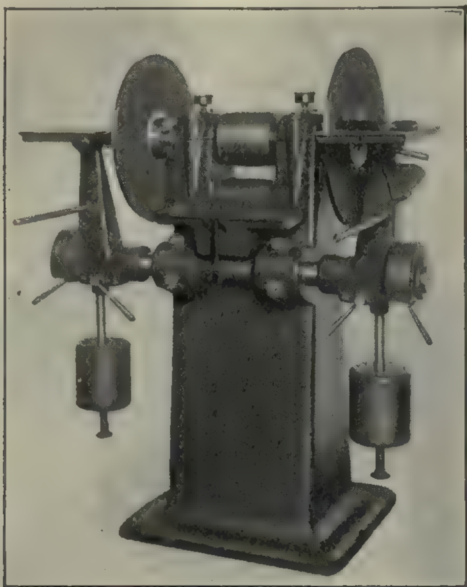
The machine is furnished either with or without internal- and external-grinding attachments, collets, chuck, motor and steadyrest. The weight complete is 180 pounds.

Disk Grinder

The illustration shows an 18-in. disk grinder that has recently been placed on the market by the Charles R. Carpenter Machine Co., Robbinsdale, Minn. The arbor is of hardened steel, ground to size, and runs in split bronze bearings $1\frac{3}{8}$ x $6\frac{1}{4}$ in., which may be adjusted both diametrically and longitudinally to compensate for wear. Grease cups are used for lubrication. The studs for supporting the table arm are also ground to size and lubricated by grease cups.

The angular adjustment of the universal table is controlled by a clamping handle below the table. This feature, together with the graduated table top and protractor blade, allows the table to be quickly placed in position for grinding either plain or compound angles. Clamping handles are provided for the table arms, in case a rigid table is desired. This may be done without

disturbing the adjustments of the table-arm bearings, which are controlled by the fillister-head screws shown. The two-way thrust collar is inclosed in the table arm, allowing adjustments to be made without admitting grit



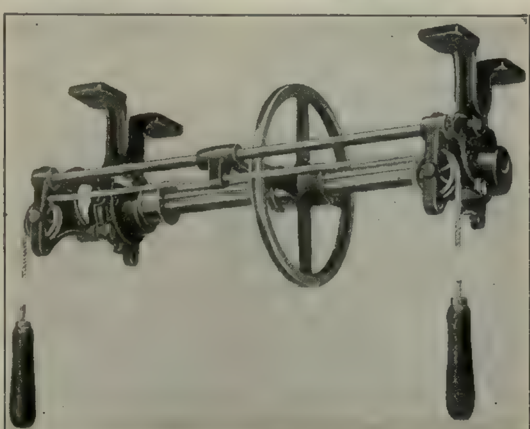
DISK GRINDER

to the bearings. Dust shields are placed on the disk ends of the table arm bearings. All adjustments are controlled by means of clamping handles, making the use of wrenches unnecessary. The weight of the machine is 1700 pounds.

Grinding Countershaft

For the purpose of providing a grinder countershaft, for use with small lathes, which would overcome the usual difficulties experienced in this line of work the Dalton Machine Co., Inc., 1911 Park Ave., New York City, has placed on the market the device shown in the illustration.

In this countershaft the driving pulley travels the entire length of the shaft, so that it may be kept in line with the driven pulley on the grinder attachment.



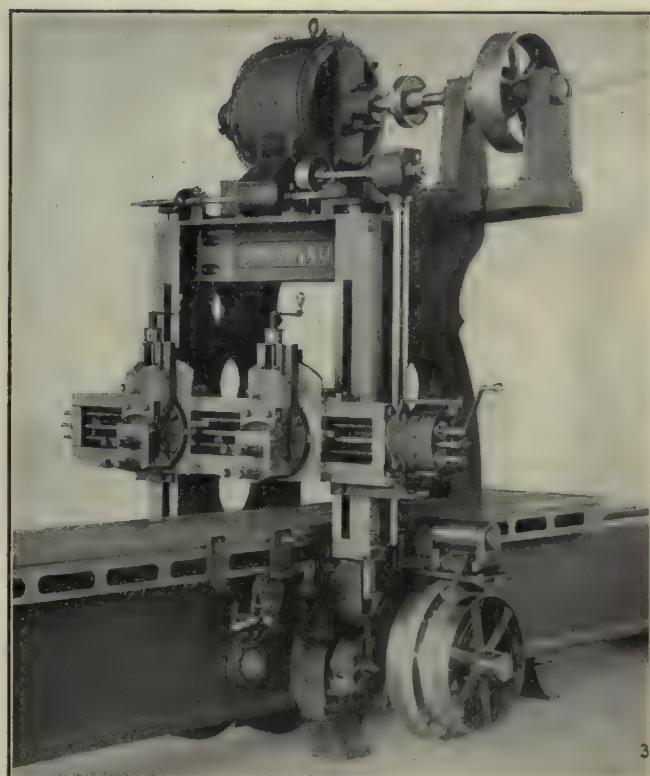
GRINDER COUNTERSHAFT

The pulley is 9 in. in diameter, is splined to the shaft and has a longitudinal movement of 14 in. on the shaft. Movement along the shaft is accomplished by means of two handles attached to a rope passing over pulleys and fastened to an arm forked at one end and fitted to a channel in the hub of the pulley. The hangers have universal bearing adjustment, and ring-type oilers are used.

Thirty-Inch Planer

A new motor-driven planer that has recently made its appearance on the market is shown in the accompanying illustration. The machine is of the 30 x 30-in. size and is the product of the Cincinnati Planer Co., Oakley, Cincinnati, Ohio.

The top of the bed between the V's is closed except at the gearing sections, thereby eliminating danger to the workman. To do away with overhung construction, all driving gears are placed inside the bed and are supported on two bearings. Bronze bushings are used, and the driving pulley is of aluminum. The cam slots for the shifting mechanism are milled into the outside of a round casting instead of being of the ordinary flat type. The



MOTOR-DRIVEN PLANER

cam is supported by a bracket bolted against the housings. The bracket also provides an extra support for the belt arms. A drip pan is fastened to the lower side of the bracket to prevent any oil from the shifting device reaching the belt. The vertical housings are of the box type and are fastened to the base by a tongue-and-groove arrangement as well as by the customary bolts and dowel pins that are used in fastening machine parts of this general type.

A special type of reinforced arch is used to give additional strength for the torsional stresses created by overhung cutting tools. The saddle is carried up to the full length of the tool slide, and an extra clamp is provided at the extreme end. Taper gibs are used at the top of the saddle, and the clapper box has a rectangular clamp.

Rail heads have rapid power traverse operated from the top of the machine through a pair of bevel gears and a friction clutch. An automatic limit stop for both the upward and the downward action of the elevating mechanism is also included. All gears are covered. The machine may be had either with or without motor drive, but the housings of all machines are made with pads, to which the motor brackets may be attached at any time.

Magnetic-Chuck Fixtures

The illustrations show three different forms of magnetic-chuck fixtures now being marketed by Lawson & Co., 90 West St., New York City, for the purpose of holding small or irregular-shaped pieces on the ordinary type of magnetic chuck. Fig. 1 shows the device in the form of parallels, Fig. 2 in the form of a V-block, and Fig. 3 in the form of a protractor block with a V-shaped top. The fixtures are made up of alternate sections of steel and a nonmagnetic material and are placed on the chuck in line with the poles, thus acting as extended polepieces. It is claimed that the fixtures have from 80 to 85 per cent. of the holding power of the chuck, depending upon the arrangement of the tie-plate and the projection of the lower pole. Chucks with diagonal polepieces do not interfere with the operation of the fixture, unless the polepieces are at such an angle that two or more are covered by a single steel section of the fixture. For use with this form of chuck, the parallels and blocks are made up with sections at the proper angle to agree with that of the polepieces. The protractor block is made with a 90-deg. V, as shown in Fig. 3, or with a flat top.

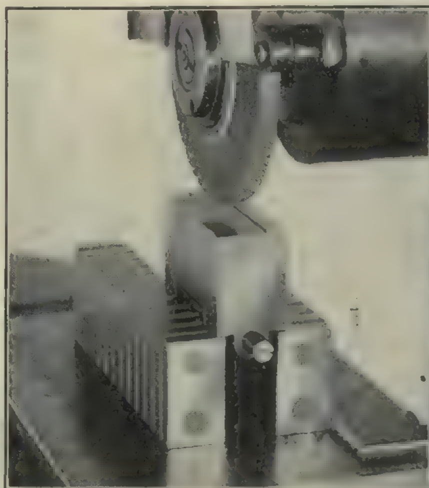


FIG. 1. MAGNETIC PARALLELS

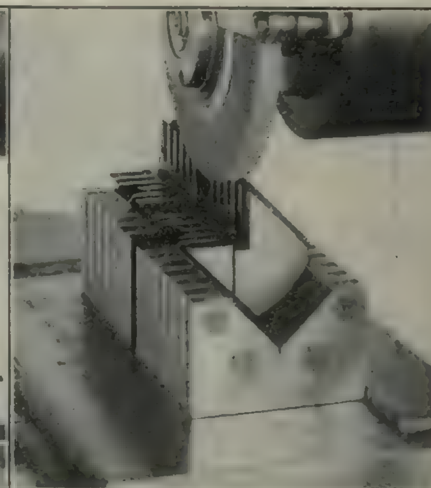


FIG. 2. MAGNETIC V-BLOCK

FIG. 3. MAGNETIC PROTRACTOR BLOCK

At the present time the parallels are made in two sizes, 1 x $1\frac{3}{4}$ x 6 in. and $\frac{5}{8}$ x 1 x 4 in., while the V and protractor blocks measure $1\frac{3}{4}$ x $2\frac{3}{4}$ x $3\frac{1}{2}$ inches.

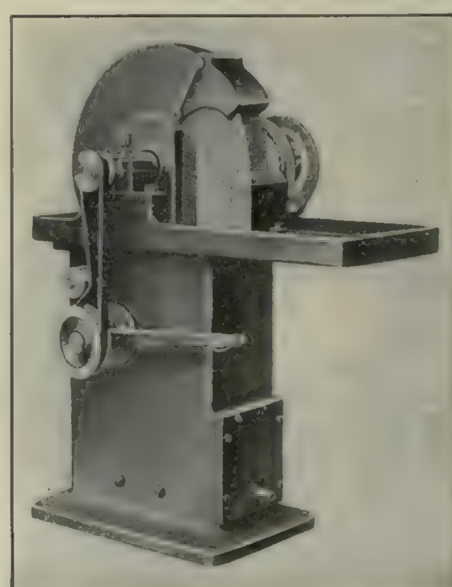
Punch-Press Guard

The G. H. Scott Machine Co., 118 Noble Court, Cleveland, Ohio, has placed on the market a guard for punch presses, known as the Scott press guard. The device operates entirely independently of the foot treadle, leaves the work visible and does not interfere with the free use of the operator's hands.

A cam and roller serve to operate the mechanism, which descends ahead of the ram; and unless it reaches the lowest point for which it is adjusted, the ram will stop until the obstruction is removed. This feature protects not only the workman, but the dies as well.

Tool Grinder

The illustration pictures a new heavy-duty wet tool grinder recently placed on the market by the Noble & Westbrook Manufacturing Co., Hartford, Conn. The arbor is of high-carbon crucible steel, ground to size, and runs in split cast-iron bearings. The feature of the machine is the water system, which does away with all pans, valves and pumps. The water is fed by means of a chain, and it is claimed that the arrangement will neither flood the machine nor wet the operator. The machine is made in two sizes, for a 20 x $2\frac{1}{2}$-in. or for a 24 x 3-in. wheel. The specifications for the larger machine are given under the illustration.


WATER TOOL GRINDER

Size of wheel, 24 x 3 in.; base dimensions, 18 x 28 in. height to top of rest, 38 in.; bearings, $1\frac{11}{16}$ x 7 in.; diameter of hole in wheel, $2\frac{1}{2}$ in.; pulleys on arbor, 7 x 4 in.; speed of wheel 850 r.p.m.; weight of machine, about 1100 pounds.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., June 2, 1917—To the various people who may have been laboring under the misapprehension that the Bureau of Standards is an ornamental institution, let me say that I expect to have very shortly some definite and concrete illustrations as to the sort of real work that is being done there. In the meantime it is interesting to mention one of its useful activities which has a direct bearing on our participation in the war. With the stoppage of the supply of optical glass from Germany, it became a serious problem to secure the material for enough lenses for the field glasses, range finders and other instruments used by the army and navy. So the Bureau of Standards set to work, and after 2½ years of continuous study it has succeeded in making a glass that is entirely satisfactory; and it is supplying a small quantity regularly. The capacity is now being enlarged to take care of all the needs of both the army and the navy. Furthermore, it makes us independent of Germany or other sources in the future, which is in itself a notable achievement.

One of the busiest departments in the new order of things is the Shipping Board, if one can judge by the number of people who are in and around the offices. Though there has been some talk to the contrary, real progress is being made in the matter of getting ships. Sixty contracts for wooden ships have already been let and about a dozen for steel ships, so that work may be said to be actually under way. This statement does not mean that all the details of equipment have been decided upon, but this matter is receiving careful attention and there is not likely to be any delay from that source.

The Problem of Airplanes

No one is trying to gloss over the shortcomings of our own airplanes, for, as explained before, it is necessary actually to build and try out hundreds of machines before we can arrive at the same perfection of manufacturing that has been attained by the French. But there are good machines built in this country, even though the production is not as large as it should be; and the question of production is a vital problem at this time. The problem is receiving very close attention, however, from those high in the affairs of the Council of National Defense, and the manufacturing capacity of the country will be made available as soon as the present plans are completed.

To this end a production board has been organized for the aircraft division of the Council of National Defense. This board is now hard at work on ways and means to increase our available supply of motors and planes, principally the former. The automobile shop is the logical place to look for air-motor construction, but there are only a few shops that are experienced in the high-grade motor work demanded for successful motors of this type. A much lower grade of workmanship is plenty good enough in most automobile work.

This does not mean that some machines will not be bought abroad, because that is the logical thing to do if they can be secured more quickly. Then too, these machines will serve to show us just how the French meet the many problems of construction, also the designing and the workmanship that have proved so successful in their own case; altogether it should be an excellent object lesson in every way.

The Labor Problem

One of the vital questions at the present moment, as voiced by President Wilson in a recent address, is that of conserving our man power, or supply of labor, as well as the other resources of the country. We are very apt to think of long hours and overtime work as the first step in securing the necessary increase of output, but that is because we do not fully realize that the shorter workday has proved an economic as well as a political success.

Great Britain made the mistake of lengthening the hours of labor at the beginning of the war and has come to regret the step very keenly, as can be seen in recent reports issued by the British Health of Munitions Workers Committee and reproduced, in part at least, in bulletin No. 221 of the United States Bureau of Labor Statistics. The investigation of this committee led to a restoration of the former hours—even in their reduction in many cases—and proved what has been contended by investigators in this country, that long hours tend to increase accidents and to cause a lowering of the stamina of the worker, thereby increasing the liability to illness and consequent loss of time. Both these results have a direct influence on production, and the present emergency is not the time to take chances by lowering any of the safeguards, either as to hours or conditions, which have been built up as the result of investigation and agreement between the employer and the employee. It may in fact be just the time to add to the efficiency of the shops by adopting methods that we have merely been discussing for the past year or so.

The report of the American Chamber of Commerce in Berlin, just before the break with Germany, said among other things: "Compulsory workmen's insurance has raised the working classes in Germany in respect to health, economy and standing in the community, and it is

certain that with their aid only, Germany has maintained her position in the markets of the world. Furthermore, hundreds of thousands now fighting on the field of battle for their fatherland may trace their health and capacity to the timely and proper treatment received with the aid of the sickness insurance." When we realize that the man or woman in the factory is just as essential to success in this war as the armies at the front, we must not overlook a single chance to make them more efficient or to conserve their capacity for production.

Not Enough Work Yet for All Who Wish To Help

As I have pointed out before, it is not so much finding men who will do the work, as finding the work for them to do at this stage of the war. Engineering men of all kinds throng Washington in the endeavor to find some way in which they can be of service. Too often they go away disappointed—not because of any fault on the part of those who are doing the planning and the organizing, but because the time is not ripe to start the wheels of manufacture in motion on as large a scale as might be expected. Yet some things are going forward that it is perhaps best not to talk about too freely just now. While the censorship bill had its fangs extracted, it is better to err on the side of not giving all the information that might be perfectly safe for the enemy to know than to assist in the slightest degree in any counter movements that might possibly be launched.

As an example of the desire to help, we may cite the registration of over 10,000 mining engineers and chemists. Their names are now being tabulated by the Bureau of Mines for the Council of National Defense. This list includes several thousand chemists who are skilled in the manufacture of explosives and iron and steel, both invaluable in the conduct of the war.

Many Laboratories Offered for Government Use

In addition to this, many laboratories have been offered for Government use, including the complete working staff in many cases. Some of the state and college laboratories that have been offered are those belonging to Minnesota School of Mines, Minnesota Mines Experiment Station, Clark University, New York State School of Clay Working and Ceramics, Alfred University, University of Texas, University of Cincinnati, Louisville University, Ohio State University and Johns Hopkins University. A larger number of private and commercial laboratories have been offered in the same way, such as those of the General Electric Co., the Central Testing Laboratory, the Mechanical Rubber Co. and many others.

The next step is to assign work for these laboratories to do, and this requires more initiative on the part of those who have the power to start things moving than seems yet to have been displayed. Of course, no one wants things to go off half-cocked, but eight weeks of war and two years of previous planning and preparation seem to many to be sufficient time to get some of the larger problems under way. There must be many lines of investigation that can be turned over to these laboratories, with their trained staffs, at short notice. If departmental red tape stands in the way, there is need of someone with a broad-ax to loosen a few of the knots. The desire to avoid mistakes is highly commendable; but if they can only be avoided by remaining inactive, the lack of them may be more costly than a fair average of mistakes themselves. Mistakes are bound to be made, and those who make them are bound to be criticized, for it is far easier to see the right way after we have gone the other; but inaction will also be harshly criticized, particularly if continued too long.

Several Important Decisions Have Been Made

Let us not forget, however, that the rifle question is settled, and settled right. And let us remember further that, should there be difficulty as to lack of proper ammunition, it will be a military problem due to lack of system in stores and in transport and not a mechanical error in any way. Then too, several important decisions have been made regarding artillery-ammunition changes, all of which seem to be along the lines of a proper consideration of the exigencies of the case; and steps are being taken to get artillery by the best means possible. But a number of lines seem to be at a standstill, although a little more public information might show the situation to be better than it seems on the surface. The fact remains, however, that hundreds of good men who might be of great service in various departments are literally begging for something to do in order to help things along.

In urging the little economies that make up a grand total when multiplied by the hundred million people who go to make up our country, we are all very apt to overlook little extravagances and unnecessary things of our own. Even the official Bulletin, in printing War Department orders, wastes from 8 to 10 per cent. of the space used by repeating the phrase, "The travel directed is necessary in the military service," after many of the announcements of officers ordered to take various trips. This means more typesetting, more ink and more paper, all of which are well worth saving.

Establishment of Priority Board

Nearly all machine-tool builders receive requests to hurry some orders, as the machines are wanted for Government work. The manufacturers are often at a loss to know just how to meet the situation. All wish to assist the Government in every way possible, but they have no way of determining which machines should have precedence. To meet this situation, a Priority Board has been appointed as a part of the Council of National Defense. This board is headed by General Ayleshire, to whom all inquiries of this kind can be sent. The address is the Munsey Building, Washington, D. C.

While it is well to be patient in everything and to bear in mind that none of us realize what a man-size job we have undertaken, it is difficult to reconcile some of the methods with what we consider efficiency in the business world. Just as an example, let me cite the case of a motor truck that was recently submitted to the army for test, to see if it met all specifications and was satisfactory enough to be considered in ordering. This truck happens to be made within a comparatively short distance of Washington, and yet the builder was informed that the truck would have to be sent to San Antonio, Tex., to be tested, this being the point designated for such tests. For the sake of speed and efficiency it seems as though exceptions could be made to advantage in cases as extreme as this. Flexibility must come through the power to make exceptions. It is difficult to find an adequate reason for such a requirement in times of peace, and impossible at the crisis through which the country is passing at the present time.—Fred H. Colvin.

Lapping Hardened-Steel Surfaces

By A. Brown

I should like to add a few comments to the remarks of Earl E. Cline, on page 59, on lapping hardened-steel surfaces.

A circular motion in lapping (according to my experience) is fatal to a flat surface, because the pressure is not uniform around the whole of the circle and the cutting is faster at the corners, where the area of the metal is less.

The dimensions given as necessary for a lapping finish—that is, 0.0001 to 0.00005 in.—are too small, unless the surface to be lapped is very small, certainly not more than ½ in. square. My experience has been that, as the table of the grinder rides on a film of oil and the weight constantly changes position as the feed goes over, it is impossible to grind as accurately as that; and I may say that I have spent much time in endeavoring to obtain accurate results. The bigger the surface the less flat is the result from the grinder, and it is generally rounding from back to front. I obtain best results by grinding to 0.0005 in. and lapping to 0.00005 in. on a type-metal lap charged with flour emery, dry, cleaning the lap occasionally with benzine and finishing on a cast-iron lap. If a very high polish is needed, I use crocus powder on the cast-iron lap. All laps must be free from loose particles. Experience is needed for lapping, but a good maxim is, "Look after the middle, and the edges will take care of themselves."

With regard to measuring, I would have a standard measuring machine, and everybody's micrometer would have to conform to the machine. It is so difficult to obtain dial measuring machines in which the movement is not either too lively or too sluggish to be dependable. My experience is that it is next to impossible to trust your measuring capabilities to the 0.0001 in. for more than four or five hours daily. After that you become *measurement tired* and should devote the rest of the day to less exacting work.

Military-Truck Specifications

At the meeting of the Standards Committee of the Society of Automotive Engineers, held in Cleveland, the military-truck specifications, which had been prepared by the War Department Motor Transport Board in consultation with the Truck Standards Division, the Transmission Division, the Springs Division and the Electrical Equipment Division of the society, were submitted for general consideration and the work was approved.

It was decided by the Standards Committee to request that the designation of the military trucks be by arbitrary terms rather than by nominal terms of capacity. The War Department has accordingly ordered that the smaller military truck heretofore designated 1½-ton shall be named Class A truck, and the truck formerly designated 3-ton shall be called Class B truck. The trucks have a greater capacity than their former nominal designations indicated. An engine of a minimum size of 312 cu.in. is specified for the Class A truck. This means that, if a four-cylinder engine is used, it would have a bore and stroke of 4¼ and 5½ in. respectively. Likewise, a four-cylinder engine of the Class B truck would have a bore and stroke of 4½ and 6½ in., the minimum engine size being 413½ cu.in.

The Truck Standards Division of the Society of Automotive Engineers is still conducting work with regard to the military-truck specifications. A meeting will be held in Washington at an early date to take up details with reference to parts and features not ordinarily found in commercial practice.

New Publication

Manufacture of Artillery Ammunition—By the Editing Staff of the "American Machinist." Seven hundred and fifty-nine 6 x 9-in. pages; 669 illustrations; cloth. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $6.

Reviewed by F. W. Bowley*

The value of the book "Manufacture of Artillery Ammunition," compiled by members of the editorial staff of the "American Machinist," is truthfully stated in the book's own preface, as follows:

"Our vital national need for a textbook dealing with the quantity manufacture of army and navy materials should require little either by explanation or comment."

The authors have approached their subject in a very logical manner. They have selected samples of all parts of complete rounds of various calibers—shrapnel, shell, cartridge cases, fuses, primers and packing materials—and used them as specific illustrations of correct methods of manufacture. Each part in turn has been described completely, the description carrying the part from the raw materials to the finished and assembled product. Complete lists of operations, rates of production, machines used, tools and gages required, with drawings illustrative of each, place the subject before the reader in a clear and lucid manner. Probably the part of the book that appeals most to one more or less familiar with the subject described is the thoroughness with which tools and gages have been handled.

The art of manufacturing artillery ammunition, for it is an art, is a progressive one. Our American manufacturers will, no doubt, improve many of the operations described in the book, but as a textbook and a book of reference the authors have given the industrial men of America a valuable work. Considerable credit is due to the staff of the "American Machinist" for the excellent manner in which they have handled a subject new to the vast majority of our mechanical engineers, but they should be specially commended for having recognized and then overcome the need for just such a text.

*First lieutenant, Ordnance Department, U. S. A.

Personals

William E. Hayes has been appointed superintendent of the new Government armor-plate plant to be erected at Charleston, West Virginia.

W. H. Blount, formerly chief draftsman of Sleeper & Hartley, Inc., Worcester, Mass., has been appointed superintendent of Plant No. 1 of that company.

L. S. Mesker, formerly representing the Kearney & Trecker Co., Milwaukee, Wis., has become connected with the sales department of the Cleveland Milling Machine Company.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice-president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeting at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

The American Drop Forge Association will hold its fourth annual convention in Cleveland, Ohio, on June 14, 15 and 16. A number of technical papers and several exhibits will be presented.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, excepting July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Quotations were current as follows at the points and dates indicated:

	June 1, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham..	$40.00	$37.00	$15.00
No. 2X Northern Foundry, New York..	46.00	42.50	20.75
No. 2 Northern Foundry, Chicago.....	46.00	42.00	19.00
Bessemer, Pittsburgh	45.95	43.95	21.95
Basic, Pittsburgh	42.00	40.00	18.95
No. 2X, Philadelphia...............	45.50	42.50	20.50
No. 2, Valley..........................	43.00	42.00	18.50
No. 2, Southern Cincinnati...........	42.90	39.90	17.90
Basic, Eastern Pennsylvania..........	42.50	38.00	20.50
Gray forge, Pittsburgh...............	40.95	39.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	June 1, 1917	One Month Ago	One Year Ago	June 1, 1917	One Year Ago	June 1, 1917	One Year Ago
Structural shapes ...	5.00	5.00	3.50	5.00	3.25	5.00	3.10
Soft steel bars.....	4.75	4.75	3.55	4.50	3.25	4.50	3.10
Soft steel bar shapes	4.75	4.75	3.50	4.50	3.25	4.50	3.10
Plates	8.00	7.00	4.10	7.00	3.65	6.50	3.50

BAR IRON—Prices in cents per pound at the places named are as follows:

	June 1, 1917	One Year Ago
Pittsburgh, mill	4.00	2.65
Warehouse, New York..................	4.60	3.25
Warehouse, Cleveland	4.45	3.25
Warehouse, Chicago	4.50	3.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		June 1, 1917	One Month Ago	One Year Ago	June 1, 1917	One Year Ago	June 1, 1917	One Year Ago
*No. 28 black......	7.25	9.50	8.00	3.65	8.25	3.20	7.50	3.20
*No. 26 black......	7.15	9.40	7.90	3.55	8.15	3.10	7.40	3.10
*Nos. 22 and 24 black	7.10	9.35	7.85	3.50	8.10	3.05	7.35	3.05
Nos. 18 and 20 black	7.05	9.30	7.80	3.45	8.05	3.00	7.30	3.00
No. 16 blue annealed	7.25	9.20	7.20	4.70	7.95	3.70	7.70	3.60
No. 14 blue annealed	7.00	9.10	7.20	4.60	7.85	3.60	7.60	3.50
No. 12 blue annealed	6.75	9.05	7.50	4.50	7.80	3.50	7.55	3.45
No. 10 blue annealed	6.50	9.00	7.50	4.55	7.75	3.55	7.50	3.40
*No. 28 galvanized..	9.25	12.00	9.75	5.65	10.00	5.50	9.50	5.50
*No. 26 galvanized..	8.95	11.70	9.45	5.35	9.70	5.20	9.20	5.20
*No. 24 galvanized..	8.80	11.55	9.30	5.20	9.55	5.05	9.05	5.05

*For corrugated sheets add 25c. per 100 lb.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	June 1, 1917	One Year Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 10%
Chicago	List plus 5%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	45%
Cleveland	50%	55%
Chicago	45%	50%

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	June 1, 1917	One Year Ago
New York	$13.00@19.00	$6.00
Cleveland	12.30	6.30
Chicago	11.50	5.25

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*

⅜, 11/32, 5/16, ¼, 7/32, 3/16......	19.00
No. 8, 5/32 and No. 10	20.00@30.00
⅛	
No. 12	
3/32, No. 14 and 1/16..	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods

3/16 by 12 in. long.........	16.00
¼ by 19 in. long.........	14.00
⅜ by 19 in long.........	12.00
½ by 21 in. long.........	12.00

*Special Welding Wire

⅛	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York June 1, 1917	Cleveland June 1, 1917	Chicago June 1, 1917
Tire	4.80	4.50	4.50
Toe calk	4.75	5.00	4.75
Openhearth spring steel...	6.50@ 7.00	7.00	7.50@ 8.50
"Crucible" spring steel....	8.00	11.00	12.00
Carbon tool steel, base price	12.00	12.00	....
Special base cast steel....	15.00@18.00	19.00	....

*In bars.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card in effect May 1, 1917:

BUTT WELD

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
⅛, ¼ and ⅜..	42%	15½%	¾ to 1½.....	38%	22%
½	46%	31½%			

LAP WELD

2	42%	27½%	1¼	23%	8%
2½ to 6......	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4......	33%	20%
			4½ to 6......	33%	20%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜..	38%	20½%	¾ to 1½.....	38%	23%
½	43%	30½%			
¾ to 1½.....	47%	34½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	1¼	24%	8%
2½ to 4......	43%	31½%	1½	30%	16%
4½ to 6......	42%	30½%	2	32%	19%
			2¼ to 4......	34%	22%
			4½ to 6......	33%	21%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	44%	28%	43%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	June 1, 1917	One Month Ago	One Year Ago
Copper, electrolytic (carload lots)*....	30.50	32.00	30.00
Tin	64.50	58.50	48.00
Lead	11.50	10.50	7.50
Spelter	9.50	9.75	15.00

*Third-quarter copper; for spot copper the market price is 32½ to 33c.

ST. LOUIS

Lead	11.00	10.25	7.37½
Spelter	9.25	9.25	14.75

At the places named, the following prices in cents per pound prevail:

	New York			Cleveland		Chicago	
	June 1, 1917	One Month Ago	One Year Ago	June 1, 1917	One Year Ago	June 1, 1917	One Year Ago
Copper sheets, base.	42.00	44.00	37.50	42.00	37.50	42.50	37.00
Copper wire (carload lots)	39.50	39.50	37.50	39.00	32.50	40.00	37.50
Brass pipe, base...	47.50	47.50	44.50	48.00	38.00	47.50	38.50
Brass sheets	45.00	45.00	46.50	41.00	44.00	43.50	46.00
Solder ½ and ½ (case lots)	39.75	33.87½	44.50	39.50	38.00	39.50	38.50

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	June 1, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	....
New York	45.50	45.50	$44.50
Cleveland	42.00	42.00	38.00
Chicago	42.50	42.50	40.00

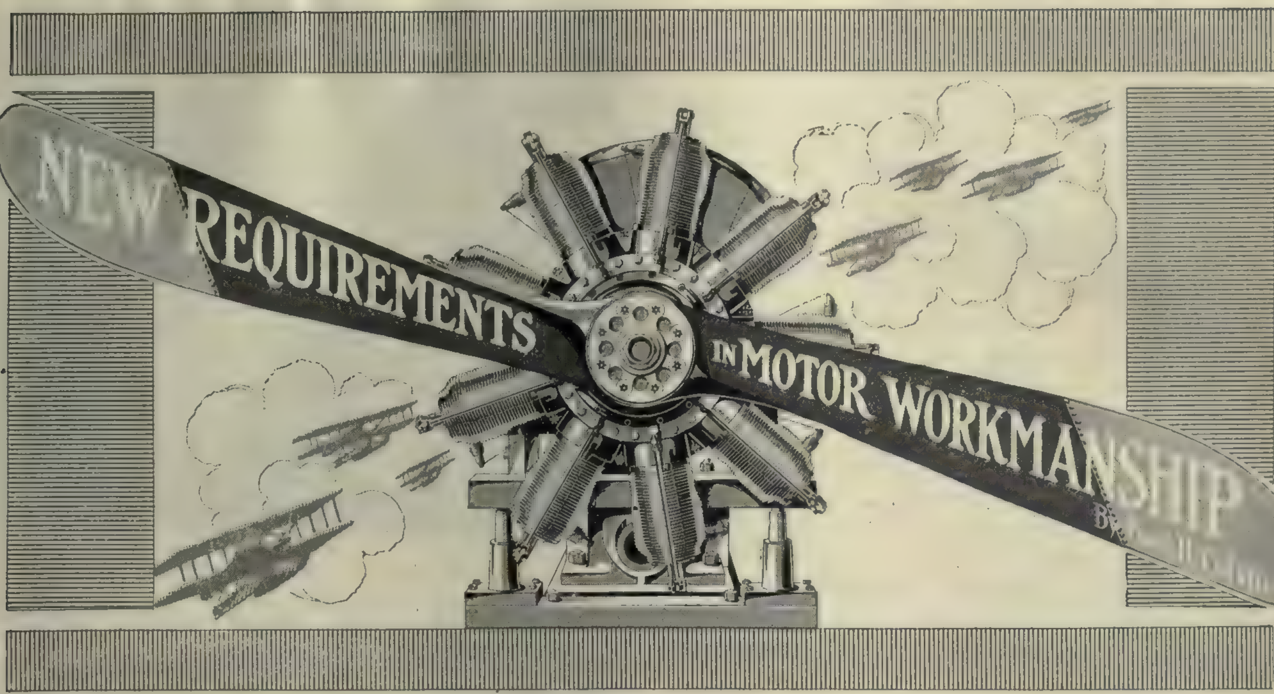
ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill.. 19.00

	In Casks		Broken Lots	
	June 1, 1917	One Year Ago	June 1, 1917	One Year Ago
New York	22.00	26.00	23.00	26.50
Cleveland	23.00	26.50	23.25	27.00
Chicago	22.50	26.50	23.50	27.00

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	June 1, 1917	One Year Ago
New York	23.00	28.00
Cleveland	28.00	52.50
Chicago	29.50	46.00



The Gnome type of motor, with its revolving high-power cylinders and its light weight, has made necessary new tolerances in motor-building methods. It has, under the careful construction of the General Vehicle Co., Long Island City, N. Y., set a new high-water mark in motor-building workmanship, a grade that can only be attained by a long and costly experience involving high-class equipment, specially designed and accurately made tools and fixtures and a staff of highly skilled workmen. The airplane has not only changed our mode of travel, but our ideas of motor design, the method of motor construction and the quality of our workmanship. Beginning with the automobile motor of the earlier days, which sufficed for short flights, the necessity for continued efforts soon developed the weak spots in the motor, and improvements both in design and workmanship began to be made. For while the automobile motor rarely runs at over 25 per cent. of its maximum power, the airplane motor is nearly always at top speed; and as the propeller is always connected to the motor, this means developing its full power. Consequently, far greater constant stresses are imposed on every part than are ever put on automobile motors, except perhaps during a hard-fought race of several hundred miles. The General Vehicle Co. had previously built high-grade motors of the Mercedes design, but even this experience had to be discarded, or at least so improved upon that little now remains of the older shop practices and methods. Workmanship that was plenty good enough for the type of motors then being built was not sufficiently accurate to give the best results with the type of motor where a tolerance of 0.01 mm. (0.004 in.) is in many cases the maximum that can be allowed and where in some of the fits all tolerance, so far as can be stated in definite figures, is practically eliminated.

SYNOPSIS—The limits of accuracy imposed by the builders of this motor place it in a class which is rarely equaled in commercial manufacturing. The result is an extremely light motor which can be used with good results on high-speed scouting planes.

The Gnome type of motor is a highly interesting mechanism, consisting of nine radial cylinders held in a central crank case, in which the crankshaft is stationary and the cylinders revolve, carrying the propeller with them. The odd number of cylinders makes it possible to

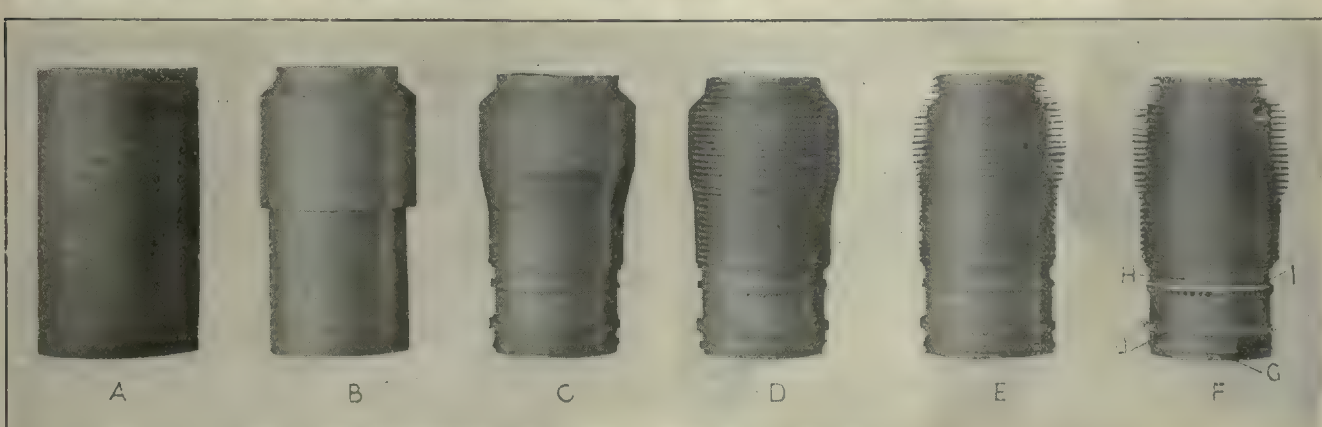


FIG. 1. FROM BILLET TO FINISHED CYLINDER

secure a uniform period of explosion; for when it is remembered that each alternate cylinder fires as it revolves, it will be seen how this affects the sequence.

While the Gnome is simple in principle the design is intricate, even though refined through years of patient study and experiment. It cannot fail to elicit admiration, but it also presents problems in manufacture which require the best mechanical brains for their solution. The operation of the motor will be considered after the construction of some of the many parts.

The cylinders are machined from 6-in. solid steel bars, which are sawed into blanks 11 in. in length and weighing about 97 lb. The first operation is to drill a $2\frac{1}{16}$-in. hole through the center of the block. A heavy-duty drilling machine performs this work, then the block goes to the Gisholt lathe for further operations.

Fig. 1 shows six stages of the progress of a cylinder, a few of the intermediate steps being omitted. These give, however, a good idea of the work done. The turning of the gills, or cooling flanges, is a difficult proposition, owing to the depth of the cut and the thin metal that forms the gills. This operation requires the utmost care of tools and the use of a good lubricant to prevent the metal from tearing as the tools approach their full depth. These gills are only 0.6 mm., or 0.0237 in., thick at the top, tapering to a thickness of 1.4 mm. (0.0553 in.) at the base, and are 16 mm. (0.632 in.) deep. After drilling, the cylinder blocks go to the Gisholt department for boring and turning, a rough-boring operation being shown in Fig. 2. After the first bar has trued up the drilled hole, boring bars with long pilots are used for the boring that follows. The blanks are then held on an expanding mandrel and rough-turned, after which the second boring takes place, as shown in Fig. 2. The previous turning of the outside true with the hole eliminates the difficulty of having the boring bar run out of true.

After the cylinder has been bored, it is held on an expanded mandrel and the gills are turned, as in Fig. 3. These are first roughed out, and then the gills near the head of the cylinder are finished. This plan allows the spark-plug hole to be bored and the threaded thimble to be welded in place before the rest of the cylinder is finished. This welding is a very particular job, and every spindle is tested for leakage. The cylinder is run backward for this operation, on account of the gang of tools being held in a special holder at the back of the cross-slide. The crank case is a forging, finished in dies, and is a very difficult piece to machine. The inner, or joining, surfaces are faced, the bolt holes drilled and the two parts bolted together, so that the holes for the radial cylinders can be properly bored and ground. This radial boring is divided into two operations, the holes being rough-bored on one machine, while the final finished boring is done on the Lucas horizontal boring machine, shown in Fig. 4. As can be seen, the work is held on a special indexing fixture and the boring bar is driven through a universal joint with a stiff spring to take out any fore and aft motion in the bar. The boring bar itself is supported in the two bearings A and B, the latter being on the inside of the crank case. This arrangement gives a short, rigid boring bar and enables extreme accuracy to be secured. It will also be noticed that long or extension nuts with crosshandles are used for quick clamping. They not only save time, but are much more convenient in every way.

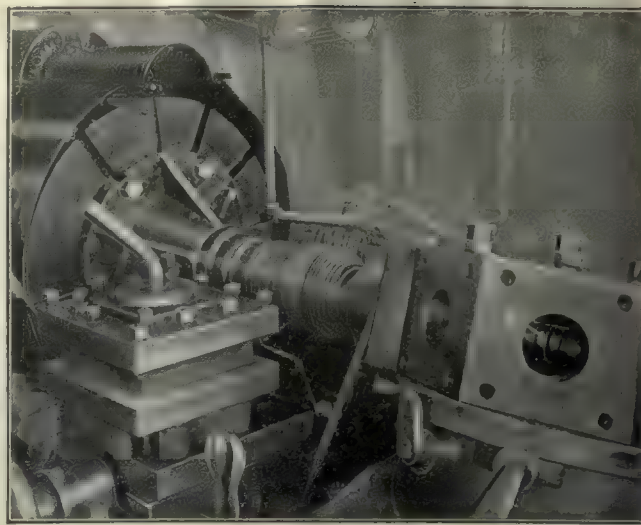


FIG. 3. TURNING THE COOLING GILLS

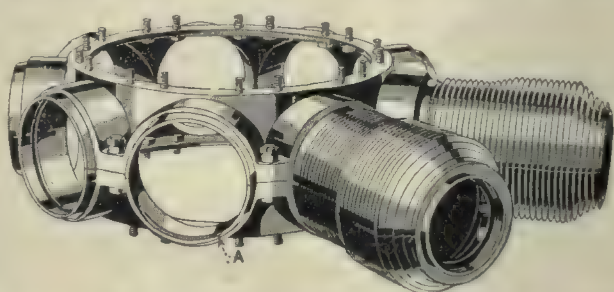


FIG. 6. HOW THE CYLINDERS FIT THE CRANK CASE

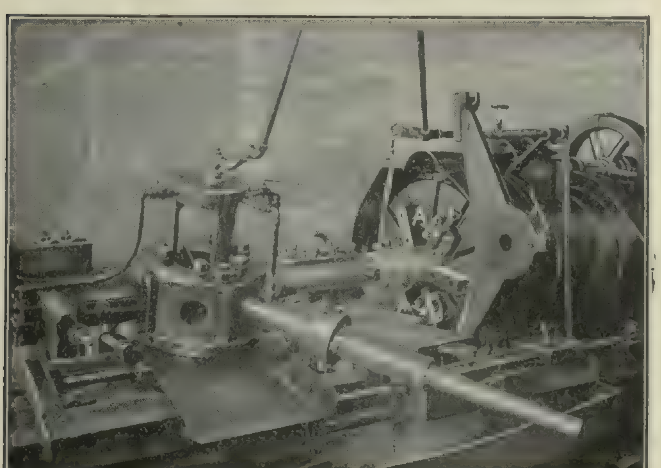


FIG. 2. ROUGH-BORING THE CYLINDERS

Even the extreme accuracy of this method of boring is not sufficient for this point, which is perhaps the most important in the entire motor; for this crank case clamps the cylinder by means of the collar C (in both Figs. 4 and 5), which fits into the recess in the cylinder at I, Fig. 1, and must not only fit as to diameter, but as to length, so as to prevent any end movement of the cylinder. The flange J bears in the enlarged portion of the crank-case bore and supports the cylinder, at the same time allowing the gas to be drawn in through the half-round openings that are distributed around this collar. The grinding is done on a Heald cylinder grinder, Fig. 5.

The way in which the cylinders and crank case go together is illustrated in Fig. 6, two of the nine cylinders

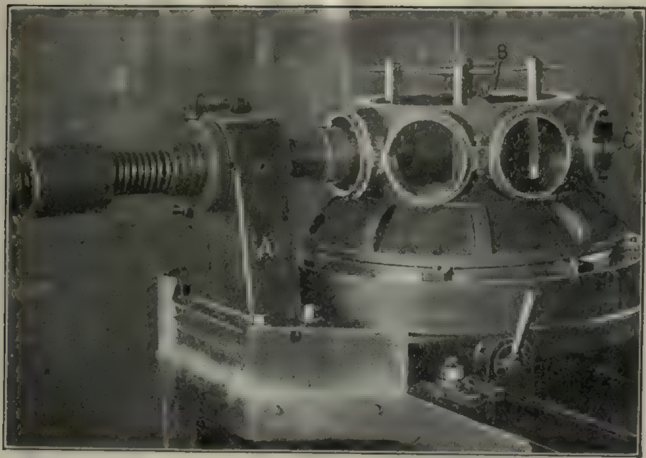


FIG. 4. FINISH-BORING THE CRANK CASE

being shown in place. The photograph also shows the keyway *A*, which is cut in the crank-case collar and which locates the cylinder in its proper position and also effectually prevents turning. It is a thin, flat key with round end, its location in the cylinder being shown at *H*, Fig. 1.

The final finish of the portion of the cylinder that fits into the crank case is secured in an engine lathe in which the bearing and all parts are fitted with the utmost care. The finish is turned with a special forming tool of the right size and shape, the desired size depending on the operator's measurements with the standard micrometer. This is one of the points where small tolerance is allowed, and needless to say, it requires the utmost skill not only to secure the right diameter, but to allow entire interchangeability. The European practice is to fit these cylinders by hand-scraping the crank case. That method, however, makes it difficult to get the cylinders all in the same plane, which is essential for the best results.

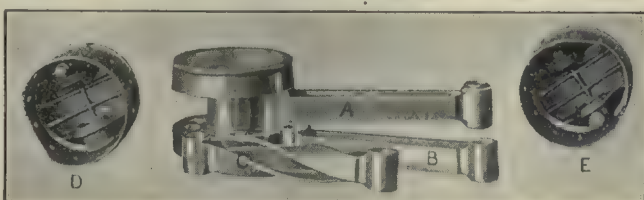


FIG. 7. PISTONS AND CONNECTING-ROD

To give some indication of the kind of fit required, it is only necessary to mention the tests to which the assembled cylinders and crank case are subjected. When the crank case is clamped solidly together, it must neither distort the cylinders nor allow the least shake. To test this, a plug gage is used in the open cylinder end to detect any distortion due to clamping and, if this is found satisfactory, a bar 3 ft. long is screwed in the outer end of the cylinder, by which the inspector endeavors to detect any looseness or play between the cylinder and the crank case. With such a test it can be easily seen that the utmost accuracy is required.

Pistons and Rods

Fig. 7 shows two of the pistons and also something of the connecting-rod construction. These pistons, although of cast iron, are extremely light and presented one of the serious problems in the construction of this motor. The extreme lightness makes it necessary to have a particularly good grade of cast iron, and something of this problem may be gathered from the fact that it was necessary to cast 4000 pistons before the right combination of mixture and other qualities were secured. In order to test this out and not delay construction, a lathe and a drilling machine were hired in a shop adjoining the foundry, so that the castings could be tested and the defects located in the shortest time.

The maximum thickness of the piston wall is about 2 mm. (0.08 in.), which at the extreme end of the skirt is thinned down to about half that amount. It will also be noticed that the piston-pin lugs are not connected to the walls of the piston, but only to the piston head, which is strongly ribbed. The space between the piston-pin boss and the piston wall is produced by a sort of trepanning tool, but it makes a rather delicate operation and is not conducive to securing 100 per cent. perfect product. The maximum tolerance in weight is only 10 grams, or less than one-third of an ounce, which indicates the accuracy required in both the casting and the machining, as the inside of the piston head and the piston-pin bosses are not machined.

The connecting-rods are also unusual, principally from the employment of the main, or "mother," rod, which carries the eight other rods around its center, as can be seen in Fig. 8. All the rods are made from drop-forgings and are machined all over, both in order to secure absolutely uniform weight and to detect any flaw that might exist in the forging. The quality of the material can be seen in the twisted rod in Fig. 7. The mother-rod forging weighs 21 lb.; the finished weight is 5½ lb.

The large central hub to which the eight connecting-rods are pinned is shown at *A*, Fig. 8, a piston being shown in place on one of the smaller rods at *B*. This illustration, as well as the preceding figure, shows how it is necessary to cut away one side of the skirt of the piston in order to clear the next piston at its lower position, as is more clearly shown in Fig. 12. Both Figs. 8 and 12 show the oil holes drilled in the mother rod over each smaller rod, and also the oil tube that runs up one side of each small connecting-rod, being fastened in the channel by the small clip shown.

These connecting-rods are excellent examples of the close workmanship demanded in building this motor, as they must have not only extreme accuracy of bore, but also of center distance, in order to secure both interchangeability and uniform compression in the different cylinders.

Fig. 9 shows one of the methods of testing the alignment of the holes in both the mother rod and one of the smaller rods. Two test bars are run through the pin

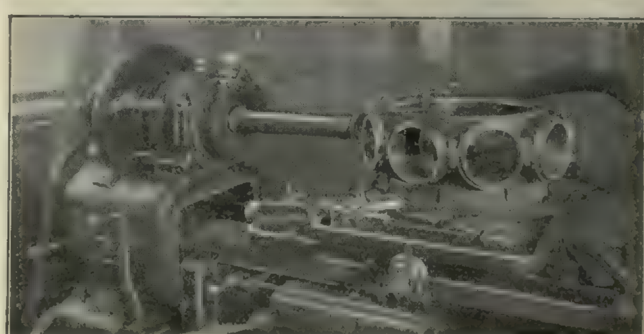


FIG. 5. GRINDING THE CRANK CASE HOLES

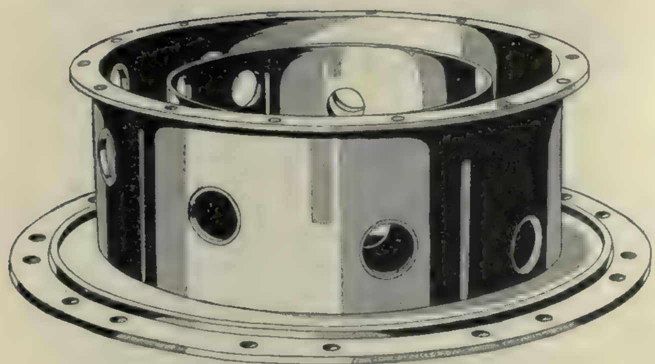


FIG. 11. THE DISTRIBUTORY CASE

holes of the mother rod and rested on the two parallels shown. In this way the hole in the upper end of the rod can be tested by means of the bar and the multiplying indicator C.

The small rods are tested in a similar manner, by supporting the lower test rod in the V-block, both these blocks and the parallels resting on the round surface plate shown. In order to secure uniformity of center distance, several rods are slipped over the same test bar, which is a very severe test, as a slight difference in either center distance or parallelism of the holes will prevent the bars going through the holes. This view of the mother rod B shows the recess D, which it is necessary to cut on each side of the main rod in order to accommodate the end of the small rod that fits next to it. This is a particularly fussy job, as it is necessary to use a bar with an inserted cutter and then feed the cutter out so as to divide the work into as many cuts as may be necessary.

The crankshaft is another interesting portion of the Gnome motor, holes being drilled through the center of both the crankshaft and the crankpin in order to lighten it as much as possible. The crankshaft is made in two parts, the part A, Fig. 10, having the crankpin forged solid with it, and the extension end B being attached to A by a long taper fit at C, a key positioning the two

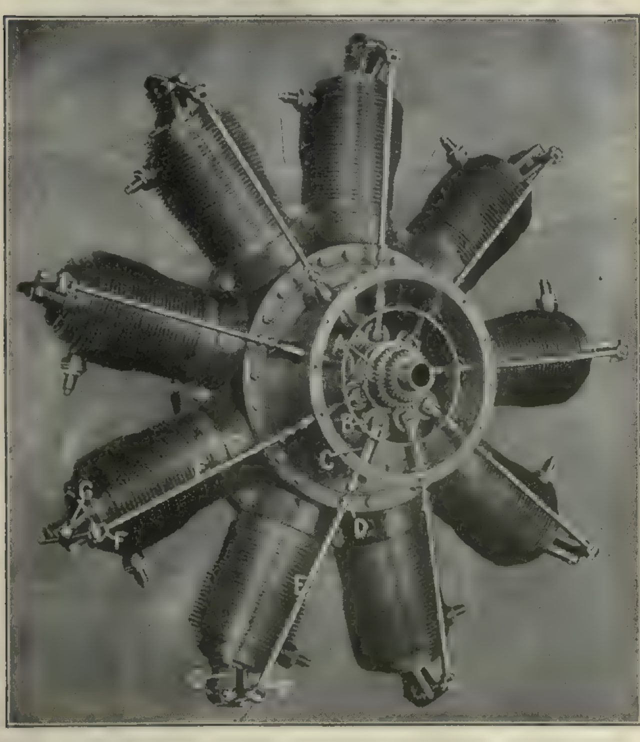


FIG. 13. MOTOR WITH CAMS UNCOVERED

shafts in their proper relation. One of the ball bearings that fit inside the large recess on each side of the mother rod is shown at E.

The end D carries an inner sleeve that forms an oil reservoir between it and the inner surface of the shaft itself. Nine small holes are drilled through the outer shaft so as to connect with this reservoir and allow oil to be forced out to the nine cams that operate the valves on each cylinder. The oiling system will be described more fully in connection with Figs. 12 and 15.

The distributing case that surrounds the cams and carries the valve-stem guides is shown in Fig. 11. It is also made from a forging and is an interesting example of cutting away the greater part of the original metal. This forging weighs 201 lb., while the finished case weighs but 15½ lb. As can be seen in Figs. 13, 14 and 15, it bolts to the side of the crank case on the propeller

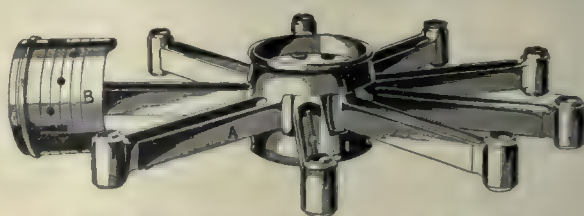


FIG. 8. CONNECTING-RODS ASSEMBLED

end of the motor and consists of an inner and an outer shaft. It is very light, however, the intervening space being bored from the solid. This is virtually a large trepanning operation, after which the holes for the valve-

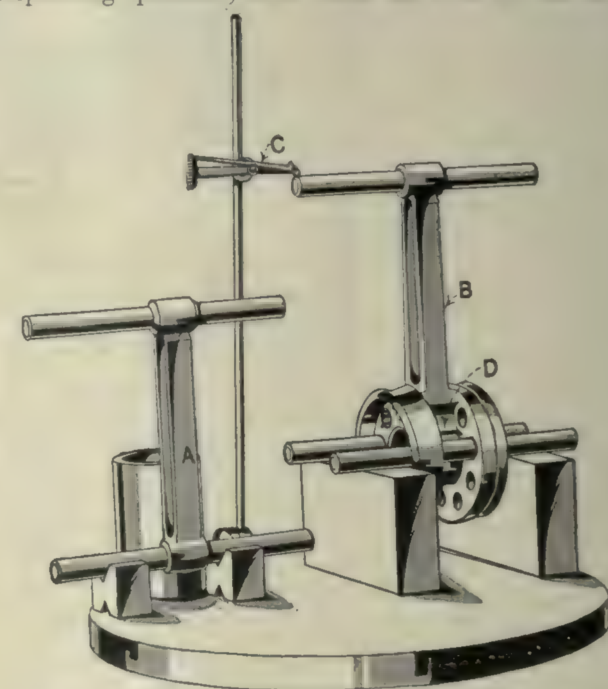


FIG. 9. TESTING CONNECTING-ROD ACCURACY

rod guides are bored radially and with proper regard for the position of the distribution case on the crank case of the motor.

Fig. 12 shows one of these motors assembled so far as the crankshaft, connecting-rod and pistons are concerned. Here we have the mother rod A in place on the crankpin B, and the other connecting-rods assuming their various angles around it. The extreme angles are shown in rods C and D. Here is one reason why the skirt of the piston is cut away on one side and also why there is an open-

ing on the side of the cylinder, for clearance purposes. The other reason is the small clearance of the pistons themselves, as shown at E, Fig. 12.

In assembling, the crankshaft is first put in place and then the mother rod with its piston. Each successive connecting-rod and piston are then threaded into position and connected up until the assembly is complete. Then the extension end of the connecting-rod is put in place with its ball bearing, as shown in Fig. 10, and the outside cover bolted on. Remembering that the cylinders and the crank case revolve around the main portion of the crankshaft, Fig. 12, and that the nest of connecting-rods revolves around the crankpin, we see what produces the reciprocating motion of the piston in the cylinders. The mixture of gas and air is forced into the crank case through the jet inside the crank at F, Figs. 10 and 15, and enters the cylinder when the piston is at its lowest position, through the half-round openings in the guiding flange and the small holes shown below the keyway H, in Fig. 1, and at A and B, in Fig. 15. The returning piston covers the port, and the gas is compressed and fired in the usual way. The exhaust is through a large single valve in the cylinder head, which gives rise to the name "monosupape," or single-valve motor.

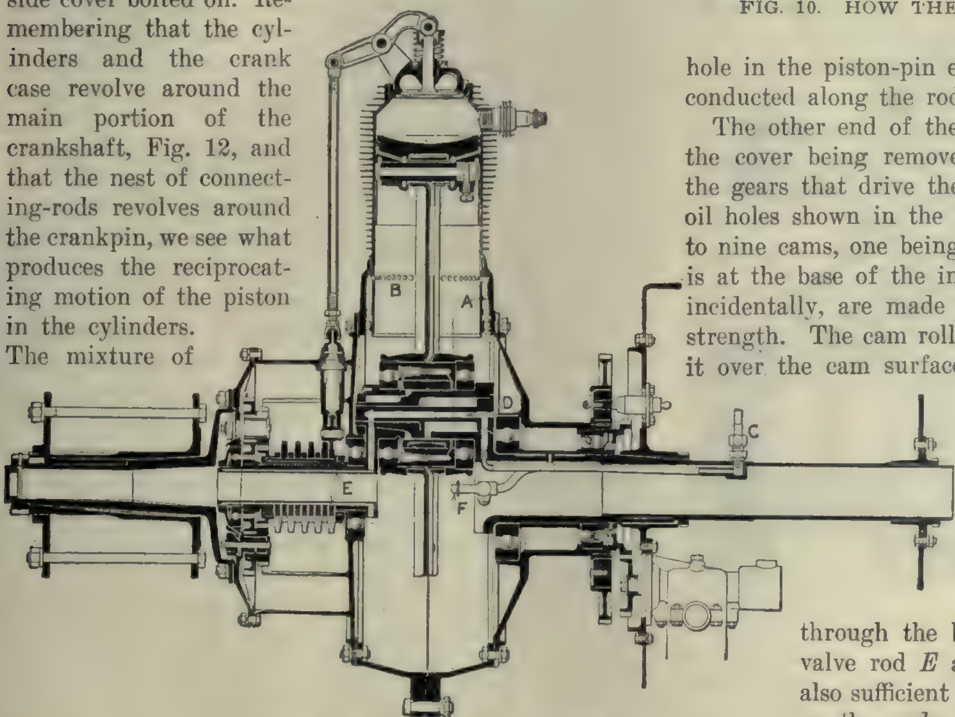


FIG. 15. SECTION OF MOTOR

Fig. 12 shows the oil pipes in position in the channels of the connecting-rods, and also the nine crankpins that form part of the oiling system as well as serving as connections between the mother and the small rods. The ninth pin, in fact, acts only to feed oil to the tube shown on the mother rod at G. Details of this can be seen in Fig. 15.

The lubricating oil comes in at C, through the stationary crankshaft, goes through the stationary crankpin at D, and floods the bearings at E. Some of this oil also goes to the crankpins and is thrown by centrifugal force through the tubes on the rods, through the piston-pin bearings, and in this way oils the piston pins as well as the cylinders. The latter also receive all oil that happens to fly out of any of the holes in the crank case.

With the motor running at 1200 r.p.m. the oil feeds out very rapidly by centrifugal force, and it has been found, in fact, that the oil tubes are unnecessary on the connecting-rods; for if the tubes are omitted, the oil flows out of the crankpin hole and makes a bee-line for the

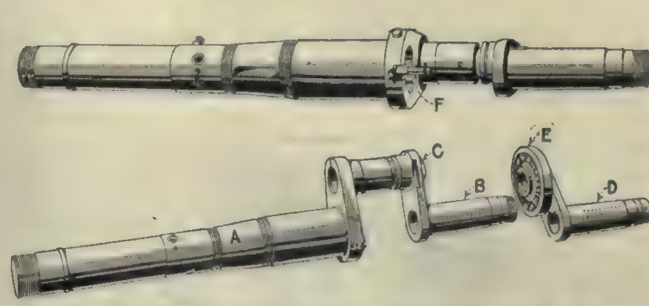


FIG. 10. HOW THE CRANKSHAFT IS BUILT UP

hole in the piston-pin end, just as though it were being conducted along the rod by the tube shown.

The other end of the motor is illustrated in Fig. 13, the cover being removed so as to show the cams and the gears that drive the oil and fuel pumps. The nine oil holes shown in the crankpin in Fig. 10 feed the oil to nine cams, one being shown at A, Fig. 13. The hole is at the base of the incline in each case. These cams, incidentally, are made of a steel of 264,000 lb. tensile strength. The cam roller B picks this oil up and carries it over the cam surface, some of it reaching the small oil holes on each side of these rollers and oiling the bearings of the rollers themselves. The surplus oil from here feeds up through the valve-rod guides, which, it will be remembered, are running 1200 r.p.m. From here it feeds through the ball joint D, through the hollow valve rod E and oils the pin at F. There is also sufficient oil at this point to strike a groove on the under side of the valve lever and feed along to the lever bearing G, so that every bearing is well oiled from the central supply. This, however, requires a large amount of oil, a characteristic of the rotary type of motor. Further details of construction, as well as the general design, can be seen in Fig. 15, which is a sectional view of the assembled motor. This view also shows the method of mounting the propeller.


FIG. 12. HOW THE RODS CONNECT UP

Fig. 14 shows the completed motor with the cover and spark plugs in place, mounted on a stand for testing. Every motor is tested with a 3-hour run and is then disassembled and every part examined. It is then reassembled and run for 20 minutes, after which it is ready for shipment.

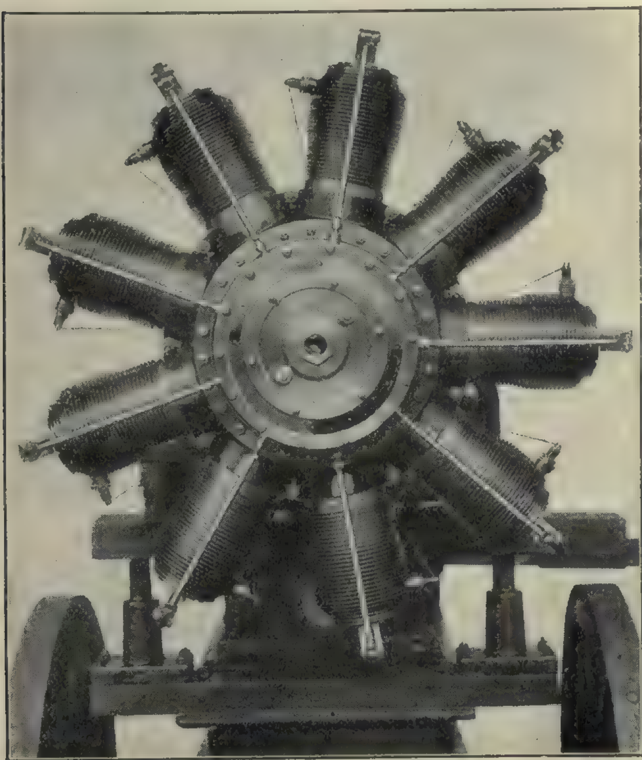


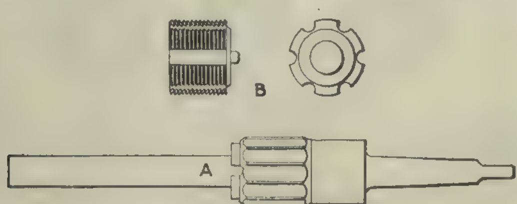
FIG. 14. THE COMPLETED MOTOR

Aligning Tap Driver

By K. F. Rausch

The illustration shows a self-aligning tap driver wherein the tap is provided with tongues that engage in slots in the reamer, the tongue and slot being the driving agent.

The object of the design is to provide both a tool that will insure the positive alignment of a reamed and tapped hole in a member, and one that will serve as a combination reamer and tap driver.



ALIGNING TAP DRIVER

The operation of the tool will easily be understood from the illustration. The pilot A of the arbor that carries the reamer as an integral part is sufficiently long to extend well through the lower hole and into the aligning bushing in the jig. After the reaming operation, the tool is withdrawn far enough to permit the tap B to be slipped into place on the arbor, the pilot being long enough to extend down into the guide bushing in the jig.

Chuck for Shell Adapters

By Charles H. McCarter

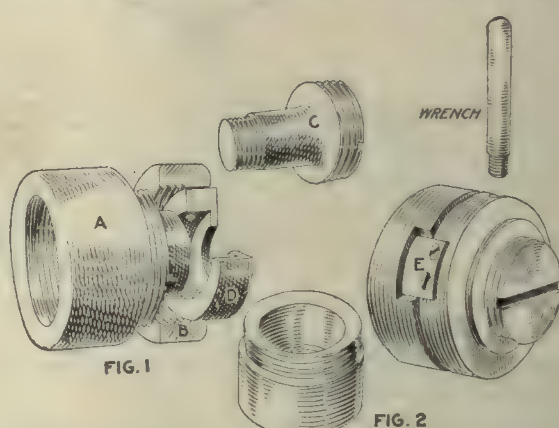
The illustrations show a chuck that has been used for several years on hand screw machines in the manufacture of adapters for shrapnel. It takes the pieces after they have been bored and threaded on one end and cut to length in an automatic machine.

Operation 2, which is then done, consists of turning and necking the piece with a form tool, chasing the thread and cutting the inside bevel, as shown in Fig. 2. The principal feature of the chuck is the left-hand thread on the sleeve, which furnishes a ouick release for the piece when it is finished.

The body of the chuck, at A, Fig. 1, is a piece of machine steel, bored and threaded on one end to fit the screw-machine spindle. The other end is turned and threaded about two-thirds of its length, four per inch, left-hand thread. About $\frac{5}{8}$ in. from the end is left straight, to be used as a bearing for the sleeve B.

This sleeve is a piece of machine steel, bored and threaded to fit the left-hand thread on the body A. The sleeve is fitted with a hardened and ground bushing on one end, which acts as an accurate bearing to bring the sleeve central with the body A and also furnishes a true face as a backing for the work, which is screwed on the stem C. The bushing D can be ground on the face as wear develops; and when too badly worn, it can be replaced.

The stem C is a piece of tool steel turned and ground a snug fit in A. It has a thread turned on the end about $\frac{1}{4}$ in. long, to hold it in A and keep it from turning. After the chuck is assembled and the stem is in proper position, a headless setscrew, which is tapped through the body, holds it in place.



FIGS. 1 AND 2. CHUCK FOR SHELL ADAPTERS

The end of the stem, which projects beyond the sleeve, is threaded to fit the adapters. In actual practice it is well to make the pitch diameter of the stem slightly less than the work, so as to allow for slight differences in the tapped holes. The stem is provided with a slot, so that it can be removed with a screwdriver.

The stop E, Fig. 2, which is of tool steel, is fitted in place on B by two fillister-head screws. The sleeve has a 45-deg. section cut out on its circumference, about $\frac{3}{8}$ in. deep and wide enough to clear the stop. This cut-out section permits the sleeve a forward and backward movement of about 0.015 in., which is enough to release the work.

Designing and Using Broaches

By Charles L. Eaton

SYNOPSIS—The difference between a successful broach and one that is always giving trouble may not be noticeable to those who are not familiar with broaches. This article points out the features that are essential to success, gives the reasons for failure and shows examples of broaches of both types. This information should be of particular value to those who may be contemplating broaching parts of their work.

The broach, like the mule, must be well understood to be of much service. When well designed and well made it is a wonderful help, producing accurate work in minimum time and with unskilled labor. If the broach designer lacks experience, the result is usually pitiable, as the broach is an expensive tool to make, and to its first cost must be added that of the delay ensuing when it goes wrong.

The material upon which it is to work may be dense and tough, and the hole long. The longer the hole the more teeth in contact and the more power required to pull the broach. Never less than two teeth should engage the work at once. I recently saw an attempt made to draw a broach through a steel forging for a British gun part. The piece was finally removed from the broach in a miller.

The designer, as usual with the novice, had placed the teeth too close together, and each tooth was removing too much stock. Too closely spaced teeth in long holes cause clogging of chips, a far more dangerous thing than the average reader will suppose, as it causes seizure and tearing of the work, or it may stop the machine or even break the broach.

A chip of 0.002 in. will behave better in a 1-in. space than will a 0.001-in. chip in ½-in. space. At the same time a broach tooth or, indeed, the edge of any cutting tool will last longer when taking an appreciable cut than when merely scraping.

Nicking the Teeth a Makeshift

Nicking the teeth, except in rare instances, is a makeshift. It is better, when practicable, to increase the tooth space. The contour of the tooth, whether curved or flat, has no appreciable effect on the power required to pull a broach. If you can design a set of broaches that will from the first produce a maximum number of good holes, which means without breaking, tearing the work or getting dull too often, your efforts will exceed those of many a so-called expert tool designer.

On the average broach the flute should be as deep as possible, yet leave a strong pulling section. The space should be well rounded at the bottom, to encourage the chips to flow into the space rather than gather in the corner. The back of the tooth should be concaved slightly, to increase chip room. The land should be generous, but not too wide, for that means loss of chip room. A forward rake to the cutting face is often desirable, but generally makes it too difficult to maintain the exact contour. The top relief should be slight, varying from one degree or less on finishing broaches for soft metals to two or more degrees on roughing broaches for tough springy material.

As to broach material, do not be misled into using low-carbon steel "because it is tough." A broach of high-carbon steel properly hardened has a great deal higher tensile strength than one of low carbon, besides which it has the hardness so essential to lasting qualities. Some have used 80-point carbon steel with some success, but the scleroscope proves that it will not become as hard as 110-point carbon. The material for some of the modern gun parts is about 50-point carbon steel, high in manganese, and the tools used on it must be very hard to hold their cutting edge.

Keep Broaches Sharp

A broach to produce satisfactory work must be kept really sharp. No halfway business will do. When it gets dull, it will tear in spite of good design. It has been found best to run the broach at a very slow speed in order to save the cutting edge, but this can be overdone. Twelve feet per minute is slow enough for tough steel, if annealed.

A broach of 80-point carbon tool steel would not last long in gun work, if hardened in the usual manner. One stunt is to use 60-point to 80-point carbon steel and pack harden it, quenching in oil and tempering as usual. This steel leaves a soft core and makes a "tough" broach. However, it will not have the real strength of a high-carbon tool, and the teeth are likely to be brittle or "peel" off; and if ground a trifle deep, the soft core is approached. The high temperature necessary to harden low-carbon steel renders the broach more liable to distortion. I recommend good tool steel for ordinary broaches. Even higher-carbon special steels may be used economically in short heavy broaches. Have the stock generously over size and have it box annealed after roughing.

High-speed steel is used successfully by some manufacturers but judgment must be exercised in specifying the brand, as not all high-speed steels are as noted for their keen cutting qualities as they are for fast hogging out of metal. I advise using carbon steel and the best of that. Generally speaking, there is no economy in using cheap tool steel in broaches. You might save 5 per cent. in the first cost, but would in all probability regret it later.

Grind All Over

The broach should be ground all over after hardening, when practicable—that is, the face and top of each cutting tooth as well as the shank and pilot. This is not nearly the hardship that the man with the pencil usually supposes. With a good equipment it is actually easy as compared to filing, straightening and stoning, besides which the broach will do its work twice as well and last longer. However careful the heat-treatment, some distortion will be present. Grinding eliminates nine-tenths of the trouble brought about by this distortion. To facilitate the grinding, it is best to graduate the teeth of the broach uniformly, thus enabling the tool maker to swing or tilt the work and grind the contour in long strokes.

Heat-treatment of broaches should not be undertaken except by experts in this particular line. It requires specially constructed furnaces, special quenching and tempering baths and a definite knowledge of the temperatures required for the steel used. I would no more permit the hardening of a broach by an ordinary tool hardener than I would intrust the repair of a high-priced watch to the village blacksmith.

It is impossible to rely on the location of a broach hole within certain limits, so for close work the stock is left to finish from the broach hole. Some designers maintain that it is necessary to pilot on one part of the contour while cutting the rest, even in symmetrical shapes; but generally speaking, this is not the case. A well-made broach will not drift much. A rear support running on machined guides proves a great help.

A well-designed pulling head is not met in every shop using broaches. The notched broach shank, engaged by a latch in the head, is dangerously weak, though easy to operate. It, of course, cannot be relied upon for accurate location. Some use a slot and key. This is costly in manufacture, uncertain as to location unless perfectly made, and weak.

The best method I have yet seen for round or symmetrical broaches is that known as the "clothes-pin." Whatever the size or shape of the pilot, excepting flat broaches for keyways, etc., the shank is made the next smaller standard size in eighths, thus making it convenient to use the same pulling head for any number of broaches within certain limits. The shank is milled with two opposite parallel and concentric flats, not too near the end, leaving a cross-section about half the area of the shank. These flats may be ground, if extreme accuracy is demanded. Through the pulling head and at right angles to the hole for the shank is bored and reamed a taper hole, say Brown & Sharpe, so proportioned that it will have a diameter somewhat greater than the shank hole at the intersection.

The clothes-pin is a bolt of tool steel, fitted to the taper hole and protruding an inch or so on either side. This is slotted from the small end to fit the milled broach shank, and a bent handle of round steel is screwed into the large end. The edges of the slot are milled flat where it engages the broach shank, to act as a pulling surface. The clothes-pin is to be spring tempered and may be ground, if desired. This kind of broach is simple to build, quick to operate and one that may be relied upon to give almost any degree of accuracy of angular location.

Fig. 1 illustrates a set of four broaches designed for use in hard tough steel, the hole being about $4\frac{1}{2}$ in. long. Previous to the broaching operation a 1.6-in. diameter hole was bored and reamed and the ends faced. Each broach has 48 teeth $\frac{3}{8}$ in. apart, with a uniform increase in diameter of 0.0025 in. per tooth, the last six being of the same diameter. The shank of each broach is $1\frac{1}{2}$ in. in diameter, of the clothes-pin type. There is no cutting action on the radial sides of the teeth, the keys being smoothed with a file to fit the gage.

Fig. 2 shows a method that failed dismally and utterly. The designer decided that a flat cut was enough easier to pull to indicate this form. On the No. 1 broach, dimension *A* was mercilessly increased 0.020 in. down to 0.002 in. per tooth, diminishing as the cut became wider. The 80-point carbon steel selected was not equal to the task imposed upon it, and the broach promptly got dull. Then as the teeth got deeper into the metal, the machine stopped in spite of a new belt and much dressing. There were six teeth in contact, with insufficient chip room.

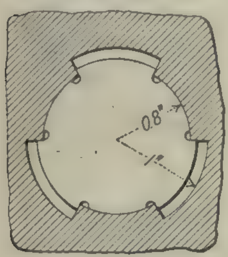


FIG. 1

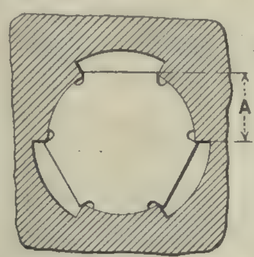


FIG. 2

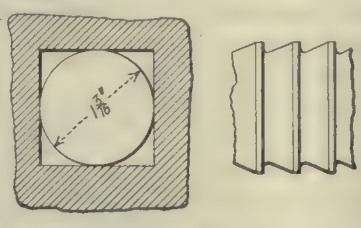


FIG. 3

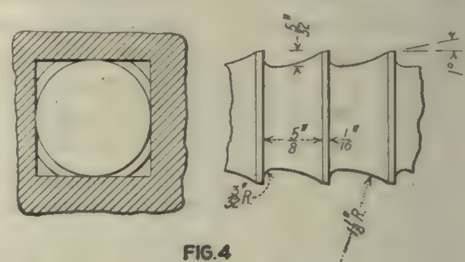


FIG. 4

FIGS. 1 TO 4. VARIOUS SUCCESSFUL AND UNSUCCESSFUL BROACHES

Fig. 1—A broach for hard, tough steel. Fig. 2—A broach that proved to be a failure. Fig. 3—An attempt to broach a square hole at one operation. Fig. 4—Broaching a square hole with two operations

Fig. 3 shows how an attempt was made to broach a square hole in one operation, and Fig. 4 illustrates how it is being done in two.

A stream of lard oil flowing on the broach where it enters the work insures proper lubrication. Compounds may be used, if of sufficient body.

As a last word, remember that it is better to operate twice or even three times on a piece and have the product satisfactory than to suffer the humiliating expense and delay that usually follow an attempt to remove all the stock in one operation.

Graduations on Feed Dials

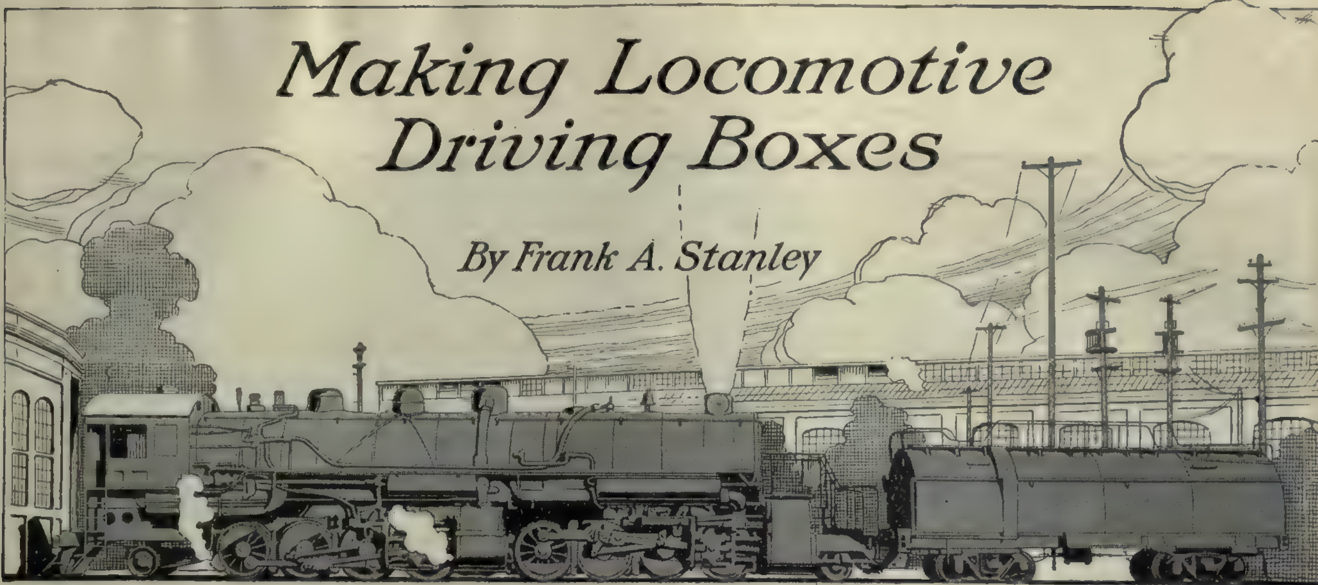
By Loyle D. Dobbs

The article on page 378 by Ross Lewis reminds me of an old 18-in. shaper made by the Barker & Chard Machine Tool Co., of Cincinnati, Ohio. This shaper has been in our plant longer than anyone can remember. It has been in operation for over 17 years, and it may have been second-hand when it was purchased.

The crossfeed screw has four threads to the inch, and the dial is graduated with 125 divisions. This makes each division equivalent to 0.002 in. The first time that I discovered the dial, it was covered with oil and dirt that had been there so long that it took some work with a piece of emery cloth to put the dial into commission. When I first used this dial, I thought that it was graduated to 0.001 in., but I soon discovered what was the matter. It is very inconvenient in work where every job is different, and I heartily agree with Mr. Lewis that there should be uniform graduations on all machine tools.

Making Locomotive Driving Boxes

By Frank A. Stanley



SYNOPSIS—Methods of babbitting driving boxes, both for axle bearings and side liners, are shown in this article, as are also the methods employed at the Southern Pacific shops at Sparks, Nev., for boring and planing driving boxes and shoes.

The standard 10 x 12-in. driving box used on locomotives of the Southern Pacific system is illustrated by Fig. 1, and the methods of machining this type of box in the Sparks, Nev., shops of this railroad are represented by the other illustrations.

As indicated by the drawing referred to, the driver box is of cast steel, with heavy half-brass pressed into place for the axle bearing and with brass liners on the sides of the box for the bearing surfaces between shoes and wedges. The end of the box is babbitted to provide a thrust or lateral bearing surface. The brass liners at the sides, like the babbitt lateral bearing, are formed by pouring the molten metal into place and afterward finishing to required dimensions. The liner metal is anchored by pouring into dovetailed grooves formed at an angle to the vertical center line of the box, and the babbitt thrust bearing is similarly anchored by dovetailed annular channels and plugs in the face of the cast-steel box. Details of these features are clearly shown on the drawing. Figs. 2 and 3 illustrate the equipment developed for the melting and pouring of both brass liners and babbitt side bearings, and the sequence of operations for the babbitting process is shown by Figs. 4, 5 and 6.

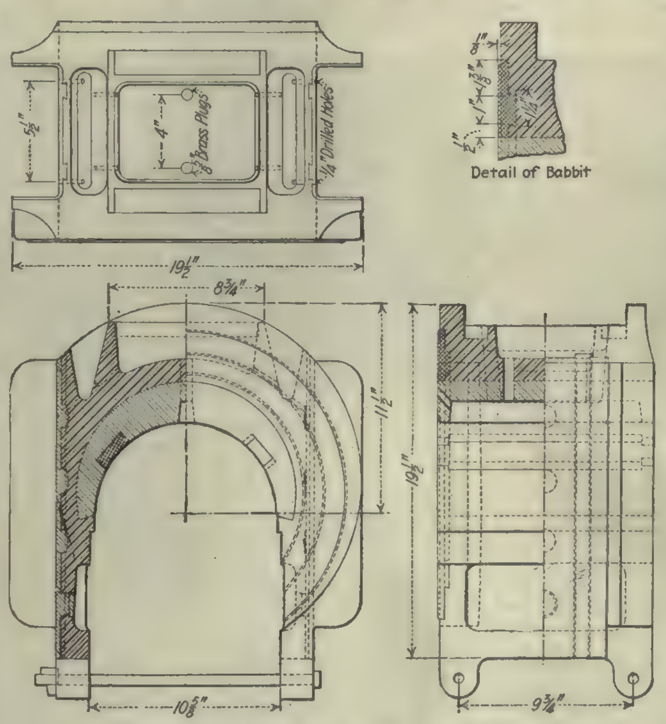


FIG. 1. DETAILS OF THE STANDARD 10 x 12-IN. LOCOMOTIVE DRIVING BOXES

Referring to Fig. 2, it will be seen that the babbitting outfit consists of a pair of melting pots made of heavy boiler plate and heated by means of oil fuel, the pipe for the oil and the pressure pipe for spraying the liquid being shown at the front of the apparatus. The pouring ladle, is fitted with a long wooden handle similar to that for a spade or shovel, so that the workman may dip and pour the molten metal conveniently and without danger of burning his hands.

Fig. 4 represents a box with the main brass forced into its seat and the box end ready for the placing of the clay dam around the edge and the subsequent pouring of the babbitt metal. Fig. 5 shows the box with a block secured in the brass to limit the flow of molten metal inward and with clay around the outer edge to confine the metal flowing in that direction. Fig. 6 is the box already poured and ready for the machining of the journal bearing and the babbitt thrust. It may be of interest at this point to call attention to one or two points in connection with the fitting up of the brass and the forcing of it into place in the box; operations which take place, of course, prior to the pouring of the babbitt lateral surface. The brass is of very heavy section, as will be seen upon reference to Figs. 1 and 4. As the increase in thickness toward the center of the brass means that the outer circumference is eccentric to the bore, it is obvious that, to turn the outer diameter under these conditions, some form of arbor is essential that shall throw the brass off center an amount equal to the eccentricity between the outside surface of the brass, which must be turned to size.

The arbor for this purpose is sketched in Fig. 7. It is about 4 in. in diameter by 24 in. long and has at one end a tight flange nearly as large in diameter as the outside of the brass to be turned. At the other end is a similar flange, but easily fitted on the arbor, so that it may be adjusted by means of a nut mounted upon the threaded end of the arbor, as indicated. The latter flange carries three setscrews A for clamping the journal brass endwise against the opposite flange, which is pressed upon the end of the arbor. Along the middle of the arbor are three screws, tapped in at right angles to the axis of the arbor to form supports for the work. These screws are adjusted to throw the brass the requisite distance off center, so that the outside diameter will be turned to the desired degree of eccentricity in respect to the bore of the brass.

To insure a snug fit of the brass in its seat in the driving box, the outside is turned straight from end to end to a radius 0.003 in. oversize; and the circumferential measurement or distance from B to B is left $\frac{1}{64}$ in. long, so that the brass requires about 5 or 6 tons' pressure to force it into place in the box. The brass is left long to allow for finishing to length after the babbitt has been poured for the lateral bearing surface. In Figs. 4, 5 and 6 the end of the brass will be seen projecting above the end of the box. The machining of the metal will be referred to later in this article, and the operations will be illustrated.

The brass liners at the sides of the box that form the bearing surfaces in contact with the frame shoes and wedges are poured in the manner indicated in Fig. 8, which is another view of the melting furnace illustrated in Fig. 3. In Fig. 8 the melting machine is seen in action, and a box ready for the pouring of the brass liners will be noticed immediately in front. The furnace is made of an old tank of heavy boiler plate and is operated by oil fuel. It is suspended upon trunnions at the ends and is readily tilted upon its axis to pour the molten metal through the opening plainly to be seen in the side.

FIGS. 2 AND 3. APPARATUS USED FOR MELTING BABBITT FOR DRIVING BOXES

FIGS. 4, 5 AND 6. SEQUENCE OF OPERATIONS FOLLOWED IN BABBITTING DRIVING BOXES

The dovetailed anchor grooves for the liners have already been mentioned, and their dimensions and location will be understood from Fig. 1. As there shown, these liners are finished to a thickness of $\frac{1}{4}$ in.; when poured, they are in the rough approximately $\frac{1}{2}$ in. thick.

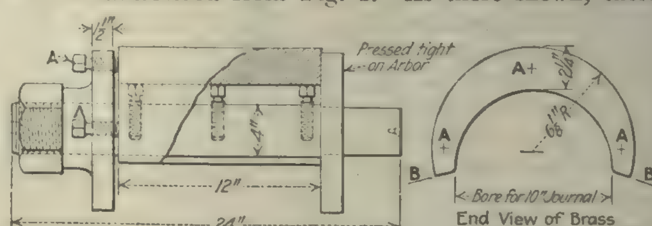


FIG. 7. ARBOR USED FOR TURNING DRIVING-BOX BRASSES

Fig. 9 represents the method of holding and boring the brasses on the vertical mill, the driver box resting upon

parallels upon the table while two straps are used at each side to draw the work down snugly by means of its side flanges. Ordinarily, there is $\frac{1}{8}$ in. of metal to be removed from each side in the boring operation, and this is done at butts up against a platen stop, and succeeding boxes are held against end movement by the boxes in front.

The corresponding surfaces on shoes and wedges are planed in the manner represented by Fig. 11, which is

FIG. 8. POURING THE SIDE LINERS

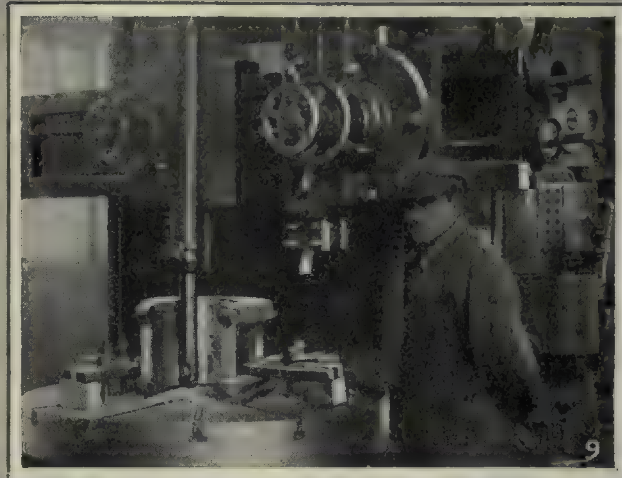


FIG. 9. BORING THE BRASSES

one cut with a cutting speed of nearly 100 ft. per min. and a tool feed of $\frac{1}{64}$ in. The babbitt thrust surface is faced off at the same speed of the boring-mill table, but with a feed of $\frac{1}{8}$ to $\frac{1}{4}$ in. per revolution of work. The amount of babbitt to be removed in this facing process ranges from also a string planing operation with four castings secured in line on the platen. The method of locating and holding these parts is clearly indicated in the photograph. The final illustration in this article, Fig. 12, shows the manner in which the oil grooves are cut in the driver-

FIGS. 10 AND 11. PLANING BOXES, SHOES AND WEDGES

FIG. 12. CUTTING THE OIL GROOVES

$\frac{1}{2}$ to $\frac{3}{4}$ in., and at this depth of cut the surface is machined with one pass of the tool.

Planing is naturally accomplished with several boxes placed in a string or row, as in Fig. 10. The leading box box brasses by means of a pneumatic chipping hammer. It will be noticed that for this work the operator's eyes are well protected from flying chips and other dirt by safety goggles.

System of Machinery Maintenance

By William L. Weber

SYNOPSIS—What is "anyone's job" is usually "no one's job." This is frequently true of machinery maintenance. A system for this purpose that has been in successful operation for some time at the factories of the Hamilton Manufacturing Co., Two Rivers, Wis., is described in this article.

The methods generally employed by large establishments for recording and directing the care, attention and maintenance of machinery and equipment are, in general, anything but satisfactory. One man is usually selected to look after certain devices while another, who is chosen to take care of and pay attention to other tools, may either overlap the duties of the first or leave a gap that will result in one or more pieces of apparatus becoming wrecked or badly disabled before the attention of the management is arrested.

There are thousands of well-conducted establishments that are operating under various systems designed for the purpose of obtaining and maintaining shop costs, power records and the like, but until the system of inspection now in vogue in the factories of the Hamilton Manufacturing Co. was developed, no means had been in existence for the proper and intelligent direction of machinists, engineers, electricians, millwrights, beltmen, master mechanics, apprentices, steam fitters and the like.

In each of the power plants, machine shop, electricians' shop, pipe fitters' shop, factory manager's office and master mechanic's office are "Inspection Charts" in frames under glass. These inspection charts are blueprints of a tracing that is changed from time to time as the mechanical equipment may be altered.

One of these inspection charts is shown in the table. It will be observed that at the top a series of numbers from 1 to 31 indicate the dates of the month. Under the head "Machine" is indicated the particular device or devices that are to receive attention. Under the head "Location" is a brief note that would assist a stranger to locate the devices enumerated. Under the head "Instructions" will be noticed the duties to be performed by the men responsible for the operation of the factory.

Each of the men so responsible is known by a symbol given on the chart.

On arriving at the plant each morning, every man who is guided by this chart examines the vertical line under the date of that particular day and there learns what duties he is to perform aside from his regular work. Having noted this, he proceeds to his destination, where he finds a chart, shown in the illustration, and known as an "Inspection Record," on which he makes entry of the date and the duties performed, signing his name and thus making an automatic record that the particular motor, elevator, pump, engine, boiler, belt, bearing, fire-

INSPECTION CHART FOR

Machine	Location	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Duties
Fire pump	Old power h'se.	O		O		O		O		O		O		O		O		O		O		O		O		O		O		O		O	See instruction 1
General service pump	Old power h'se.	O						O						O						O						O						O	See instruction 2
Sprinkler risers	Entire plant	S							S							S							S							S			See instruction 3
Belt driven elevators	Entire plant		S							S							S							S							S		See instruction 4
Electric elevators	Warehouse		S	E						S	E						S	E						S	E						S	E	See instruction 5
Power motors	Entire plant	E							E							E							E							E			See instruction 6
Power motors	Entire plant	E														E																	See instruction 7
Steam heating	Entire plant	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	See instruction 8
Sprinkler tank	Next to office	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	See instruction 9
J.E.H.-windmill	Residence		M							M	S						M								M	S					M		See instruction 10
G.S.H.-pumps	Residence										S															S							See instruction 11
Air compressor	1st steel		S				S				S				S				S				S				S				S		See instruction 12
Air compressor	4th warehouse		S				S				S				S				S				S				S				S		See instruction 13
Portable elec. drills	Steel plant	E							E							E							E							E			See instruction 14
Alcohol feeder	2nd steel	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	See instruction 15
Main belt, engine	New power h'se.	B		B		B		B		B		B		B		B		B		B		B		B		B		B		B			See instruction 16
Main belt generator	New power h'se	B		B		B		B		B		B		B		B		B		B		B		B		B		B		B			See instruction 17
Intake from river	Lumber yard	O						O						O						O						O							See instruction 18
Johnson pump	Office basem't	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S	See instruction 19
Main belt of engine	Old power h'se.		B				B				B				B				B				B				B				B		See instruction 20
Low pressure traps	Entire plant		S							S							S							S							S		See instruction 21
High pressure traps	Entire plant		S				S				S			S				S				S					S						See instruction 22
Hamilton flats	See plans		S										S									S											See instruction 23
Fire-doors	Entire plant				W							W							W							W							See instruction 24
Fire-pails and hose	Entire plant				W							W							W							W							See instruction 25
Plant inspection	Entire plant															X																	See instruction 26
H. P. Hamilton	Residence										S														S								See instruction 27
Lumber dry kilns	Entire plant					S							S							S						S							See instruction 28
Steel enamel ovens	3rd steel					S							S							S						S							See instruction 29
Wood enamel ovens	4th warehouse					S							S							S						S							See instruction 30
Air brush equipment	4th warehouse										S														S								See instruction 31
Air brush equipment	3rd steel										S														S								See instruction 32
Dictaphones	Main office		M							M							M							M						M			See instruction 33
Roofs and downspouts	Entire plant															A																	See instruction 34
Time clocks	Entire plant															J																J	See instruction 35
Time clocks	Entire plant		J							J							J							J						J			See instruction 36
Double spindle shapers	Entire plant															W																	See instruction 37

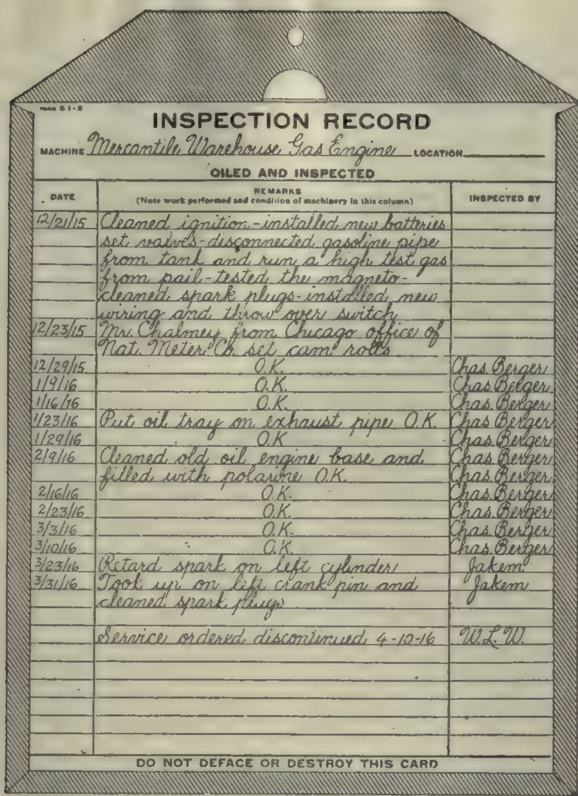
SYMBOLS

Master mechanic	A
Assistant mechanic	X
Engineer old power house	O
Engineer new power house	N
Electrician	E
Steam fitter	S
Millwright	W
Machinist	M
Machinist apprentice	J
Belt repair man	B

NOTE:—When inspection discloses apparatus out of order, it must be reported to the Mechanical Superintendent's Office at once and the person making such report can prove himself blameless only by personally witnessing the making out of a shop order for the execution of the work reported. In case date indicated falls on Sunday or a Holiday, the work must be performed the day previous. The yellow Inspection Record must show your signature and date in order to prove that you or your substitute executed the work as above. Inspection Records must be hung in conspicuous locations and kept up-to-date. REMEMBER THAT YOUR WORK IS WATCHED BY OFFICIALS AT THE INSPECTION RECORD.

9. During the time of year when outside temperature is 40° F., or less, temperature observations shall be made twice in the forenoon and twice in the afternoon. Also once at 10 P.M., and at 4 A.M., by the night man.
The water shall never be allowed to get colder than 40°. Each time heating steam is turned on, Engineer shall go into tank pit and see if properly operating.

22. Make general inspection and see that traps are in working order and not blowing through. Location—Three in fan room 1st, New "B," one N.P.H. on boiler header, two in building "C" in basement on glue heaters, one on 2nd floor steel plant, six in machine shop on enamel kilns, one in warehouse basement, one on 3rd floor warehouse, two in type shop, on glue pots, two in old power house.



INSPECTION RECORD

MACHINE Mercantile Warehouse Gas Engine LOCATION

OILED AND INSPECTED

DATE	REMARKS (Note work performed and condition of machinery in this column)	INSPECTED BY
12/21/15	Cleaned ignition-installed new batteries set valves-disconnected gasoline pipe from tank and run a high test gas from pail-tested the magneto-cleaned spark plugs-installed new wiring and throw over switch	
12/23/15	Mr. Chalmey from Chicago office of Nat. Meter Co. set cam rolls	
12/29/15	O.K.	Chas. Berger
1/9/16	O.K.	Chas. Berger
1/16/16	O.K.	Chas. Berger
1/23/16	Put oil tray on exhaust pipe O.K.	Chas. Berger
1/29/16	O.K	Chas. Berger
2/9/16	Cleaned old oil engine base and filled with polarine O.K.	Chas. Berger
2/16/16	O.K.	Chas. Berger
2/23/16	O.K.	Chas. Berger
3/3/16	O.K.	Chas. Berger
3/10/16	O.K.	Chas. Berger
3/23/16	Retard spark on left cylinder	Jakem
3/31/16	Took up on left crank pin and cleaned spark plugs	Jakem
	Service ordered discontinued 4-10-16	W.L.W.

DO NOT DEFACE OR DESTROY THIS CARD

THE INSPECTION RECORD

doors, fire-pails, sprinkler system or fire-pump has had its quota of care and attention. This inspection record is held in position by a steel slip frame, as shown, and its face is protected by transparent celluloid. The advantages of this system are numerous, the principal ones, however, being that the apparatus gets full care and attention. The evidence of this is constantly apparent and open to examination by officials of the company, inspectors and others interested.

In this particular establishment a careful accounting of maintenance costs is kept, and it has been found that the repairs account is reduced in a marked degree by reason of the inspection chart and record system. Not only is the repairs account reduced, but many shutdowns are avoided due to the "stitch in time."

Underwriters' inspectors have been pleasantly surprised on a number of occasions to see an inspection record hanging just within the entrance of the door of each building, giving mute evidence of the fact that the fire-pails and fire-doors were in good condition, while at each riser on the sprinkler system was found a record of when the electrical signaling apparatus had been tried and other data pertaining to its condition.

It is an easy matter for the factory manager to find out through the inspection record when a boiler has been washed out last, without asking questions of the engineer. He may ascertain the condition of the main-drive belt, when a certain motor has been oiled and wiped, and when the dust has been blown from the armatures. He may also learn all about the behavior and care of the various dry kilns and enameling ovens, and even the roofing of each building now tells its own story.

The cost of supervision is materially reduced by reason of the fact that the factory manager has no occa-

INDIRECT EQUIPMENT

Instructions

1. Run pump with discharge open to atmosphere until water is lifted and passed through. This will keep valves free and in working condition. While pump is moving pass cylinder oil through lubricator freely and oil outside parts.

2. This pump to receive regular daily attention, but every week the number of strokes per minute in actual service, and number of S.P.M. with water discharge valve closed (steam throttle same position), shall be recorded on inspection sheet.

3. The systems are to receive same general attention as at present. Special nspection to be made and gage pressures indicated must be entered on inspection sheets. All claims to be tested and annunciator drops in power houses observed. If not in proper working order report to Master Mechanic's office.

4. Oil all parts and carefully examine lubrication inside of worm gear box. Inspect all safety appliances, cables, gates, and overhead sheaves. Also all belting driving the machine, supporting bolts and nuts, both on the hoisting apparatus and overhead work.

5. Run the elevator and observe the condition of the motor and controller. Make immediate repairs, however small. See to lubrication of all bearings and worm gear. Examine all Safety Appliances and see that all overhead work is safe.

6. Oil bearings, and on D.C. motors see that brushes and commutators are in good order. Examine belts carefully and see that nuts and bolts by which the motors are suspended are tight. Wipe all dust from all parts clean.

7. Blow dust from windings with compressed air and wipe clean. This means that motors and compensators shall be well kept so far as *cleanliness* in every respect is concerned.

8. Change valves from live steam to exhaust steam 7 A.M., and reverse at 6 P.M. during the heating period of the year. Located on second floor steel plant; second and fourth floor warehouse. Wind the thermostats twice each day—located viz., six in steel plant, two in warehouse.

10. The machinist shall oil, clean and maintain the windmill. The fitter shall oil, clean and maintain the Johnson pump, thermostats and batteries, also the vacuum sweepers.

11. Examine and oil centrifugal pump. See that Johnson pump is oiled and screen cleaned. Wipe and oil the vacuum sweeping outfit.

12. Carefully examine all bearings and drive belt. See that oil in crank case is of proper height. Change oil in crank case every 90 days. When oil is tapped off, wash out with kerosene before putting in fresh oil. Requires 5 gal. to fill. Use auto oil.

13. Steam fitter will examine the oiling devices and see that there is sufficient oil in crank case. Electrician will clean and oil the motor and compensator.

14. Oil and repair. The inspection record is in Master Mechanic's office.

15. Put 1 pt. wood alcohol into feeder, located second floor steel plant, at 8 A.M. and 3 P.M., each day during cold weather, to prevent freezing of pipes.

16. Examine belt carefully for open laps and make immediate repairs, if any are found.

17. Same instruction as No. 16.

18. Examine general condition of bulkhead at river front and suction well.

19. Inspect the pump and motor twice each day when in operation and keep well cleaned and oiled.

20. Same instruction as No. 16.

21. Inspect each morning during heating term of year and see that traps are in working order. Located—two in old fan house—one in old machine shop.

23. In cold weather see that all plumbing is protected against frost. Get information from Mrs. Cady in main office about keys and vacant flats. Drain all pipes and put salt in hopper traps. Disconnect and remove water meters when places are unoccupied. City Power Plant Superintendent must be notified when water and current are shut off.

24. Examine every fire-door in plant and see that they are in working order and not obstructed.

25. See that all fire-pails are in place and filled; also that water is not stagnant. See that hose connected to sprinkler-risers is in good working condition.

26. Make complete tour of entire plant and observe general condition of machinery. Collect written notes of observations.

27. Clean and oil Johnson serivce pump and vacuum sweeper machine. When possible, operate the device to see that it is in proper working order.

28. Inspect all valves, piping, thermostats and controls. Interview man in charge, get complaints and information regarding the behavior of apparatus. When not in working order, notify the Master Mechanic.

29. Same as instruction No. 28.

30. Same as instruction No. 28.

31. Examine general conditions and have repairs needed made at once. These devices must be kept in the best of condition, and no time must be lost in keeping the apparatus in good working shape. The productive capacity demands it.

32. Same instruction as No. 31.

33. Examine all dictaphones—oil same—wipe all parts *clean*. See that cylinder shaving machine in basement is in working order.

34. Make inspection of all roots and report to Master Mechanic.

35. Reset time clocks for dates.

36. Wind time clocks and set same. Report trouble to Mr. Tibbals.

37. Have an order entered in Master Mechanic's office and quarter-turn the bearings on double spindle shaper, third floor Factory C—second floor, Factory New B.

sion to question the care of and attention to apparatus. This not only increases his efficiency by giving him more time to devote to other things, but it also increases the efficiency of the men affected by the system. Another important advantage is that if one of the men who is guided by a symbol should happen to be absent for any reason, his understudy or helper carries out the instructions indicated by the inspection chart.

The elasticity and applicability of the system are at once apparent. It may be applied to any industry and is not at all expensive to adopt. Each week since it was introduced the Hamilton Manufacturing Co. has found need for changes, these being adequately met by drawing up a new set of blueprints.

The Industrial Progress of Spain*

By H. S. Moos

For many years Spain has been depending upon England, France and Germany for goods of all kinds. These countries, and principally Germany, have dominated the Spanish market, due to their commercial organizations, to the establishment of branches of French, English and German banking institutions, to the facility with which the European manufacturers adapted themselves to trade conditions in Spain, to their sending out of Spanish-speaking salesmen, to the establishment of branch offices with goods on consignment and the granting of easy terms of payment. People in Spain have always been accustomed to having prices quoted, delivered in Spain, duty and freight paid. It has always been customary in dealing with substantial firms to grant from three to six months' credit against acceptance of drafts.

Americans should remember that the problem of maintaining their proper place in the world trade after the war is at bottom just a problem in ordinary efficiency. If we, as American business men, individually and collectively can produce and distribute with as little waste of material, man-power and opportunity as our foreign competitors, we shall get on comfortably. If we do not, our interest must sooner or later suffer. The big fact is that success must eventually come to the most efficient.

It is important for American manufacturers to know that Spain is beginning to take a more prominent position than heretofore. With the outbreak of the European War the country had been suddenly cut off from its accustomed sources of supply, and a great paralyzation of the industrial life in Spain started on account of the disorganization of the market. Slowly during the second year only of the war, Spanish industries began practically to realize to what extent they had been depending on foreign markets, and chiefly due to individual efforts, industrial life in Spain acquired in many branches a degree of activity never obtained in previous peace times.

Few Realize the Immense Natural Resources

The extraordinary natural resources of the country have not been so well known. Few people know that Spain is very rich in minerals, possessing the best-situated iron and copper mines in Europe, and that Spain is a large producer of other ores, which were purchased almost entirely by England, Germany and Belgium before the European War. The following mining industries have been greatly developed in Spain, and a capital of about $350,000,000 is today invested in the Spanish mining industry: Iron, copper, lead, silver, zinc, tin, sulphur, asphalt, manganese and coal (anthracite, lignite and bituminous). Platinum was discovered about three years ago in the district of Seville.

The railroads of the country are controlled by French, Belgian and Spanish capital, and about 15,200 km. (10,000 miles) of tracks exist. During the last five years about 1000 km. of new lines have been built. The capital of the two largest railroad companies in Spain alone amounts to about $100,000,000, and the receipts of these companies in 1916 showed an excess of $19,000,000 over 1915 receipts. The Spanish Government has recently authorized a law in order to foster and stimulate the construction of new railroads. This law guarantees a minimum of 5% interest on the capital invested in new railroads.

Electrical Developments on a Large Scale

Spain is today a country in which electricity is developed to an astonishing extent. The Cities of Madrid and Valencia are supplied with more than 40,000 hp. produced by hydro-electric plants. In the district of Barcelona a company largely managed by American interests has just finished a concrete dam 330 ft. high and 700 ft. long, the largest in the world, with an electric power plant producing today about 20,000 hp. In the same district a French concern is building in the Pyrenees another hydro-electric plant, to bring 30,000 additional horsepower into the industrial district of Barcelona.

The principal industries in Spain up to the present have been the following: Mining; textiles—the manufacture of cloth for garments, uniforms and velveteen, and the production of blankets, which are extensively made in the Barcelona and Bejar districts. The southern part of Spain is well known for its beautiful lace. The sugar industry in Spain is quite important; 20 cane and 45 beet-sugar factories exist with a large capital invested in them. Cement and gypsum factories have sprung up in Spain in the last few years like mushrooms. Spain is also famous for its manufacture of potteries. Another interesting industry is the chiseled and damaskeened steel industry of Toledo and Eibar. This latter city has about 40,000 inhabitants, and every house is a factory producing pistols, automatics and shotguns. Millions of dollars' worth are exported from this small town to all parts of the world. Another very important industry in Spain is that of shipbuilding, which at the present moment gets particular protection and assistance from the Spanish Government.

Five Large Car-Building Plants

A prominent industry created in Spain in recent years is the railroad and tramway car-building industry. There are five factories in Spain, two of which are very important. The largest plant, located near the French frontier, is manufacturing its own axles, tires and wheels and is turning out thousands of railroad cars per year. A large concern in Barcelona several years ago started the manufacture of locomotives, and this city and Bilbao are well known because they possess large blast furnaces and steel mills manufacturing rails, structural shapes, steel and tin plate.

*Extracts from an address delivered before the Foreign Trade Bureau of the Cincinnati Chamber of Commerce.

An important automobile factory, turning out one of the best-known cars in Europe, exists in Barcelona, and a new truck factory is now under construction for the purpose of building 2000 trucks and tractors per year.

In the Barcelona district alone the following new industries, with products for which the country always had been dependent on Germany, England and other countries, have been created: Rolling mills for sheet-metal and structural shapes, tin plate, factories producing enamels and ironware, electrical supplies and motor factories, textile machinery, machine-tool woodworking and metal-working machinery. New plants have been erected, and several million francs have been invested in these new industries lately. The demands of the European War have opened the machine-tool industry, which did not previously exist at all in Spain, with the exception of four or five small factories, building some woodworking machines, drilling machines, some agricultural and textile machines. In the last two years several new factories have been created with the exclusive object of specializing in the manufacture of machine tools, chiefly lathes, drilling machines and presses. In electrical material, lighting fixtures, large motors and generators, Spain has always been entirely dependent upon Germany and France for her supply. The Government intends to promote the installation of all kinds of industries supplying the country's needs in electrical material.

Large Purchases by Automobile Shops

The automobile industry is improving in Spain surprisingly. One factory established on modern lines, producing a high-class automobile, has bought new machinery amounting to about $300,000 in the United States in the last two years. Aside from this factory three other smaller factories for automobiles have been established in recent years, and additional capital has been raised in Spain by two other concerns in order to build automobiles and airplane motors. Five airplane factories are working in Spain now under important Government contracts and contracts for the Allies.

The annual average imports to Spain are about $200,000,000, and only $28,000,000 comes from the United States. The chief imports were agricultural machinery, industrial and mining machinery, machine tools, locomotives, tramway and railroad material, typewriters, sewing machines, electrical goods, paper, lubricants, oils, chemicals, etc.

The industrial awakening of that country will, for the next 10 years to come, necessitate the establishment of factories that will require raw materials and machinery, tools and equipment; and there is no doubt that, by adopting suitable methods, American products will find a ready market in Spain. The portion of the Spanish commerce to which American industry is entitled can be obtained with the right coöperation, if manufacturers are desirous of getting their share.

Flat Bottoming Drill

By J. A. Raught

On page 300, George R. Richards shows a bottoming drill. Perhaps the method we use would be of interest. Take a regular twist drill and grind the point square with the axis. Then back off the cutting edges, and you have a splendid bottoming drill.

To Reverse Two- and Three-Phase Motors

By A. L. Barret

In all vertical boring mills and in almost all heavy turret lathes having direct motor drive, no provision is made for reversing the direction of the travel of the work table or faceplate. In the case of heavy turret lathes, one will sometimes find a chuck that, owing to a faulty thread in the chuck or on the spindle, will not let go when one wishes to remove it, no matter how long a bar is used for a lever or how many men ride the end of the bar. If it were possible to throw in the back gears and give the machine a little reverse jolt, allowing one of the chuck jaws to strike against a hardwood block placed on the lathe bed, the most obstinate chuck would come off.

To reach this required condition with any machine run by a three-phase motor, it is only necessary to change any two wires of the motor. Then the motor will operate in the opposite direction. Alternating the two wires in the binding posts should be done in about one minute. This trick is part of the ABC to an electrician, but seems to be known to very few machinists.

Some time ago the writer got a job on a vertical boring mill, the pot casting to be bored inside, turned outside and cut into piston rings about 1 in. wide and 20 in. in diameter, for marine engines. The practice at this plant is to cast the parting in the rings at an angle of 45 deg. in the pot casting, pulling the cast slot together with a bolt and nut before machining, thus getting the compression in the ring.

In this case the slot was cast in the wrong direction, so that the slot leaned against the cutting tool, causing the tool to catch and dig in at every revolution. By changing the wires at the motor as explained above, I reversed the direction of the work table. This had the result of making the cast slot lean away from the cutting tool, setting the tool backward for the reverse motion of the work. I had no more trouble with the tool digging into the slot. The joke was on the machinist working next to me, who had run my machine two or three years. He did not see me change the wiring at the motor and spent most of the shift trying to find out where I had found a reverse gear in the boring mill.

[To reverse a two-phase motor connected to a three-wire circuit, cross the two leads of either of the motor windings or cross the two outside legs of the circuit at the switch—never one outside and center leg.—Editor.]

Pulleys with Cast Webs and Steel Rims

By Albert Parkin

During the past year I have had hurry calls for several small pulleys from 3 to 10 in. in diameter. To avoid pattern and foundry delay, I decided to make them myself.

I turned cast-iron hubs the correct size, on which I shrunk a short piece of double-strength steel pipe. The width of the bearing for the pipe on the hub was one-third the width of the pulley face. Pulleys with rims of steel pipe are strong and satisfactory in every way.

Drilling Long Holes of Small Diameter

By J. J. Eyre

Some months ago, a concern manufacturing fuse bodies experienced considerable difficulty in drilling the small hole in the graze pellet. The piece was made of a very tough brass approximately ½ in. in diameter by 1¼ in. long and had a hole 0.052 in. in diameter drilled its entire length, so that it had to be held approximately central. Owing to the drills running off center, poor work exceeded 60 per cent., and the breakage of drills was excessive. I was called upon to design for the drilling machine a jig that would rotate the work during drilling.

Although a special machine has since been designed by another concern for this particular operation, the fixture shown herewith proved so successful in producing accurate results in much greater quantity than with the ordinary box jig that I believe a description of it may be of interest to the readers, as it can readily be applied to similar lines of work.

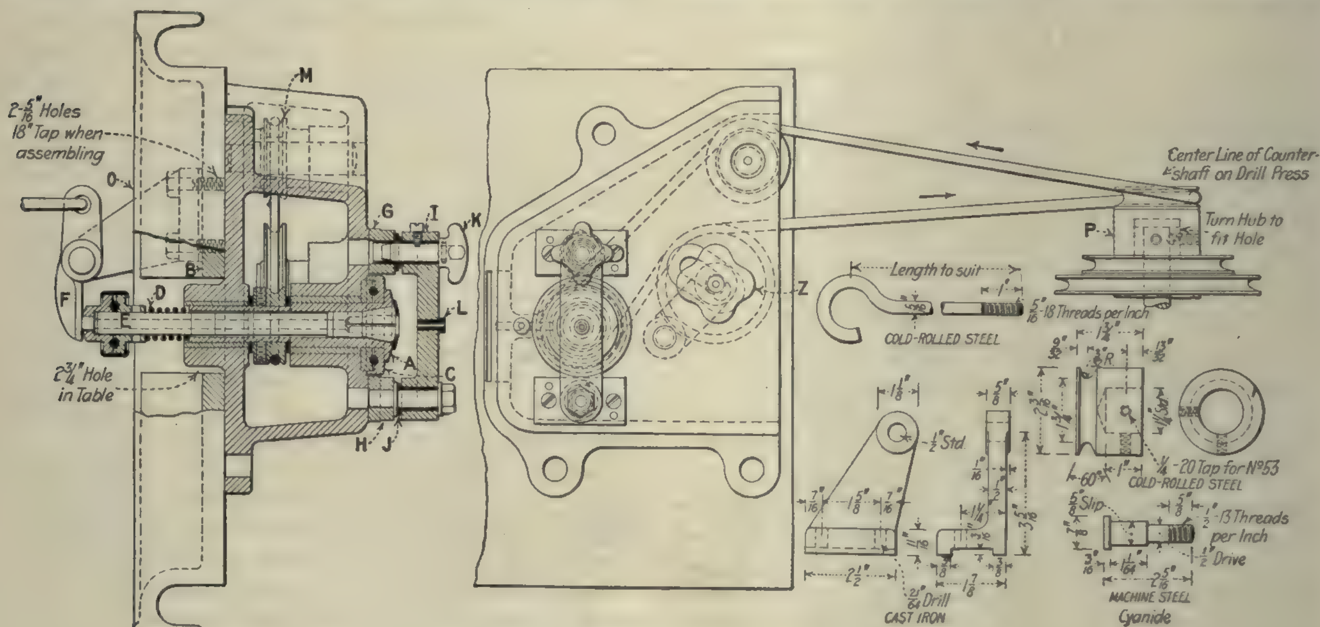
The machine used was a Leland & Gifford high-speed drilling machine running at 8000 r.p.m. To the table of this machine was attached the fixture made for holding and rotating the work. A 2¾-in. hole was bored through the table directly under the center of the drill head for clearance of the lower bearing hub. The fixture, as shown in section, had upper and lower bearings bored and bushed to receive a driving sleeve *A*, which formed the bearing and seat for the draw-in chuck, which was bored out to receive the diameter of the work freely. A smaller hole was drilled the full length of the spindle for chip clearance.

Located on the outside diameter of the driving sleeve, the driving pulley *B* is secured by screws, the upper end of the driving sleeve being supported by the ball race *C*, as shown. The spindle of the draw-in chuck extends through the driving sleeve to below the drill table a sufficient length to allow for a compression spring *D* and a ball race *E* to take the thrust of the treadle leaf illustrated at *F*.

On top of the fixture are fastened two plates *G* and *H* that locate the swinging leaf *I* by means of the fixed pin *J* and the slip pin *K*, which locates the leaf over the center of the chuck. This leaf carries the drill bushing *L*. An upper and a lower bearing are cast inside of the fixture base to locate the belt idler *M*, also a bearing for the belt-tightening pulley, which is carried on the pin and held in proper tension by the screw knob *Z*. Two brackets *O* are fastened to the under side of the drill table to carry the treadle leaf *F* which is actuated by a foot rod and compresses the spring *D* and releases the chuck.

On the top face of the draw-in chuck are fastened three thin metal plates that extend over saw cuts in the chuck to prevent chips from entering it. On the hub in the rear, which carries the two speed pulleys of the machine, is secured the pulley *P*, which drives the $\frac{5}{16}$ round belt. It is set one-quarter turn from the driving-sleeve pulley, which is driven at 1200 r.p.m. In operation the drill and the driving sleeve run continuously. The foot treadle is pressed to open the chuck. The chuck leaf is swung to one side to allow placing the work in the chuck, and the leaf is returned to position and the work drilled, the work being rotated in the opposite direction to that of the drill. A blast of air is directed on the center of the work to remove all chips.

Our expectations were more than realized, for we not only obtained approximately 100 per cent. good work, but drill breakage was far less. With this fixture one girl produced as much work as five or six operators had formerly turned out.



FIXTURE FOR DRILLING LONG HOLES OF SMALL DIAMETER

Engineering Society of Buffalo Elects Officers

At a business meeting of the Engineering Society of Buffalo, on May 9, the following officers were elected for the season of 1917-18: President, F. A. Lidbury; vice president, D. W. Sowers; secretary, F. B. Hubbard; treasurer, W. M. Dollar; directors, H. B. Alverson and F. E. Cardullo.

Electric Spot-Welding Operations on Automobile Lamps

SPECIAL CORRESPONDENCE

SYNOPSIS—This article shows some of the electric spot-welding operations that enter into the manufacture of automobile lamps. This welding method enables the lamps to be reinforced where necessary and simplifies some difficult manufacturing operations.

The C. M. Hall Lamp Co., of Detroit, Mich., manufactures a variety of lamps for automobiles. In many of the operations necessary to the turning out of these accessories Toledo and Detroit electric spot-welding machines are employed to advantage. In Fig. 1 are shown some of the lamps manufactured at the Hall company's factory. Reading from left to right, the two end ones are license tail lamps, the next is a double head light, and in front of this latter is a tail light. In front of the double lamp is a side lamp, the others representing two styles of single head lights made up for some of the smaller cars. A body and the body ring as used on each lamp are shown in Fig. 2. The ring is slipped over the body and secured to it by means of three electric spot welds.

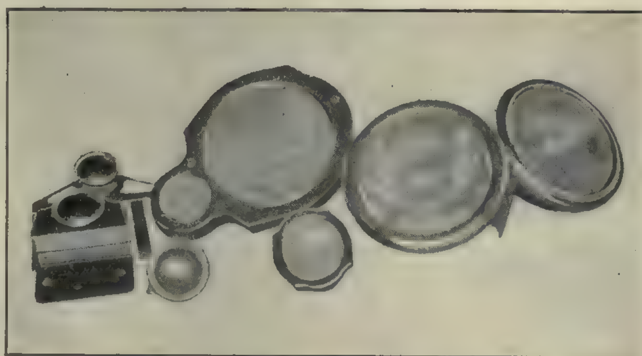


FIG. 1. SOME COMPLETED LAMPS

One of the parts after this operation is shown in Fig. 3. The body and ring are made from 0.031-in. (No. 22 gage) steel, and the average time required to make the three welds is $\frac{1}{4}$ minute.

WELDING STIFFENER AND STUD

The body stiffener is made of two sheets of 0.0375-in. (No. 20 gage) steel. Two of these already formed and blanked to size are shown in Fig. 4. The two plates are placed together and united with two spot welds as shown in Fig. 5. The time required to place two of these sheets together and make the weld is approximately $\frac{1}{4}$ minute.

In Fig. 6 are shown one of the studs and the stiffener parts. After the two sheets which comprise the stiffener have been welded together, the opening and the hole are punched out; two depressions are also made in the part. One of these elements after these operations have been performed is shown at the right of the illustration. The stud is placed in the hole of the stiffener and attached to it with four spot welds.

One of the stiffeners with stud welded in position is shown in Fig. 7. The time required to make the four

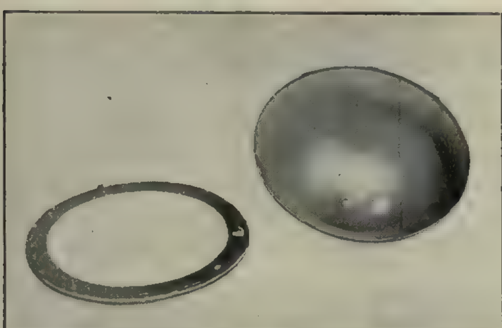


FIG. 2. BODY AND BODY RING

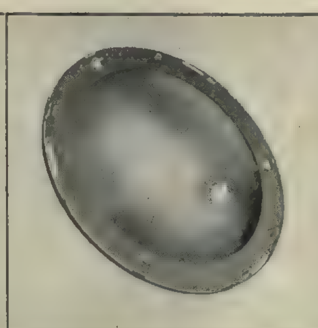


Fig. 3. WELDED RING

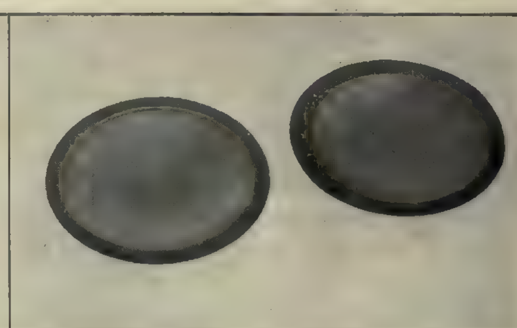


FIG. 4. BODY STIFFENER PLATES

FIG. 5. THE WELDED STIFFENER

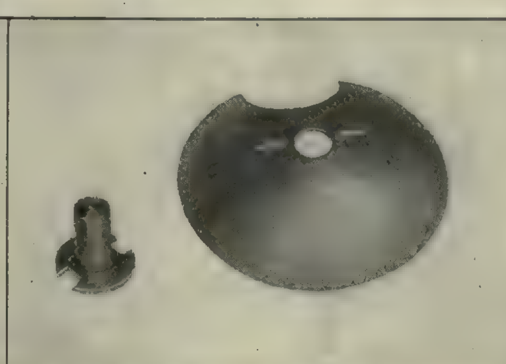


FIG. 6. STUD AND STIFFENER PARTS

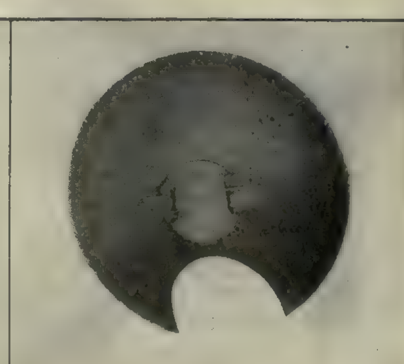


FIG. 7. THE STUD ATTACHED

welds is $\frac{1}{4}$ min. The body connection is made to the shape shown in Fig. 8 at *A*, and the retainer as shown at *B*. The connection is then slid into the retainer as shown at *C* and attached to it with two welds. Both the spot welds. One of the pieces with the stiffener welded in position is shown at *C*. The average time necessary for placing the stiffener in the prop and making the three spot welds is somewhere in the vicinity of 1 minute.

FIG. 8. WELDED CONNECTIONS

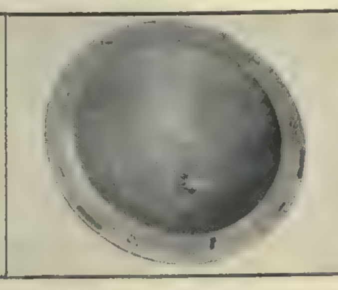


FIG. 9. LAMP BODY

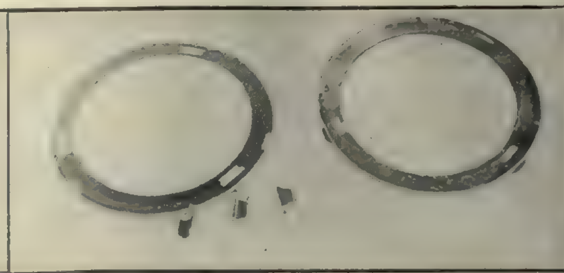


FIG. 10. WELDED BODY RING

connection and the retainer are made of 0.031-in. (No. 22 gage) steel.

The stiffener stud is slid into the hole in the crown of the lamp body and attached to it with seven spot welds. The retainer is also slid into a hole at the side of the lamp body and held to the stiffener with three welds.

The time necessary to spot weld the stiffener and retainer in the lamp body is 1 min. One of the lamp

In Fig. 12 is shown a body band to which a stiffener is spot welded. The band is 0.031 in. (No. 22 gage) and the stiffener is 0.0625 in. (No. 16 gage). To attach the stiffener to the band five spot welds are used, and the average time required is 1 minute.

When making the license plate and glass retainer the latter is attached to the plate with three spot welds. The plate is 0.031 in. (No. 22 gage) and the retainer 0.05 in. (No. 18 gage). The two elements used for this

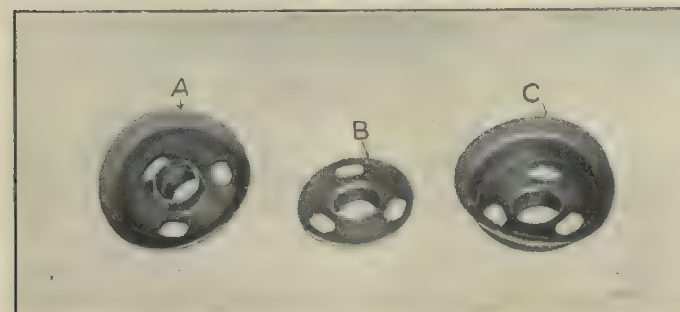


FIG. 11. WELDED BODY PROPS

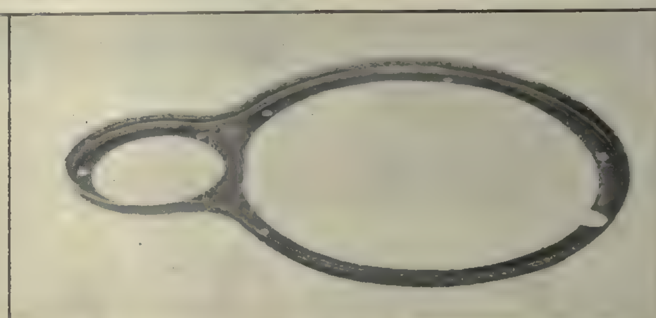


FIG. 12. A WELDED BODY BAND AND STIFFENER

bodies with the stiffener and retainer spot welded in position is shown in Fig. 9. When making the body ring the three clips are attached to it with the electric welder.

At the left of the illustration, Fig. 10, is shown one of the rings, which is 0.0312 in. (No. 22 gage) thick, and three of the clips, which are 0.078 in. (No. 14 gage) thick. The three clips are then attached to the ring, two

part are shown at *A* and *B*, and one with the retainer attached is shown at *C*, Fig. 13.

When making the lamp body and license plate the two elements are attached by means of spot welding.

In Fig. 14, at the left, are shown one of the bodies and license plates. The body is 0.031 in. (No. 22 gage) and the plate 0.0625 in. (No. 16 gage). The two parts

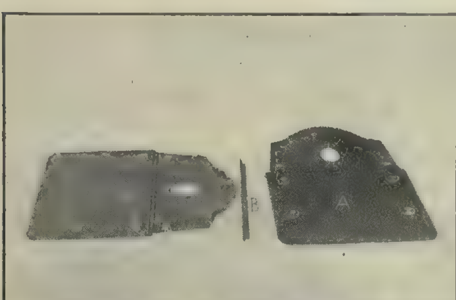


FIG. 13. LICENSE PLATE

FIG. 14. WELDED BODY AND PLATE

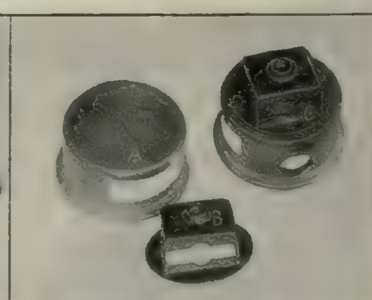


FIG. 15. A BODY AND PROP

spot welds being used for each clip. The time necessary for the operation is 1 min. One of the rings with the clips attached is shown at the right of the illustration.

The body prop is made in two parts, the part proper and a plate, as shown at *A* and *B*, Fig. 11. The stiffener is then placed in the prop and united to it with three

are attached with three spot welds, one of them after the operation being shown at the right. The average time necessary for welding is 1 minute.

Another type of lamp has the prop attached to it with the electric welder. The body and prop for this lamp are shown at *A* and *B* in Fig. 15.

United States Munitions*

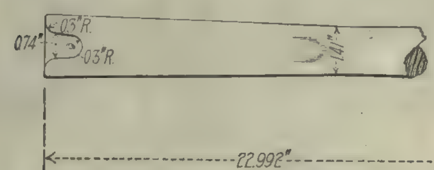
The Springfield Model 1903 Service Rifle

Making the Stock—I

SYNOPSIS—This installment takes up the first of the operations involved in the manufacture of the stock. Many of the details are of considerable interest.

The Government specifications for the blanks from which stocks for the military rifle are made are as follows: Black walnut in the rough, 2⅜ in. thick, 45¼ in. long, measured in a straight line on top of stock, 6 in. wide at butt end and 1 15/16 in. at the tip end, and otherwise to conform in other dimensions and shape to an iron form, actual size, which is furnished to successful bidders. All stocks showing wormholes, sapwood, wind shakes, splits, checks, cracks, knots, crooked grain, any evidence of brashy wood, unseasonable age, belted timber or dry rot will be rejected. The wood must be hard, straight-grained and sound in every particular. Ends of stock must be painted.

The shape and dimensions of the rough blanks just referred to are given in Fig. 1934. The approximate line of grain is also indicated. The shape and dimensions of the finished stock are given in Fig. 1935, and in many cases these dimensions will be all that is needed to understand certain gaging or machining operations, when taken together with the other data accompanying them. Many of the machines used for various operations on both the stock and the hand guard are similar, and in these cases the reader desiring more complete data can refer to like machines used on one or the other of the pieces. The sequence of operations, on the stock of the Springfield rifle, regardless of how the numbers run, is as follows:



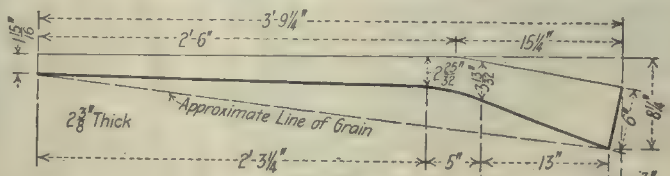
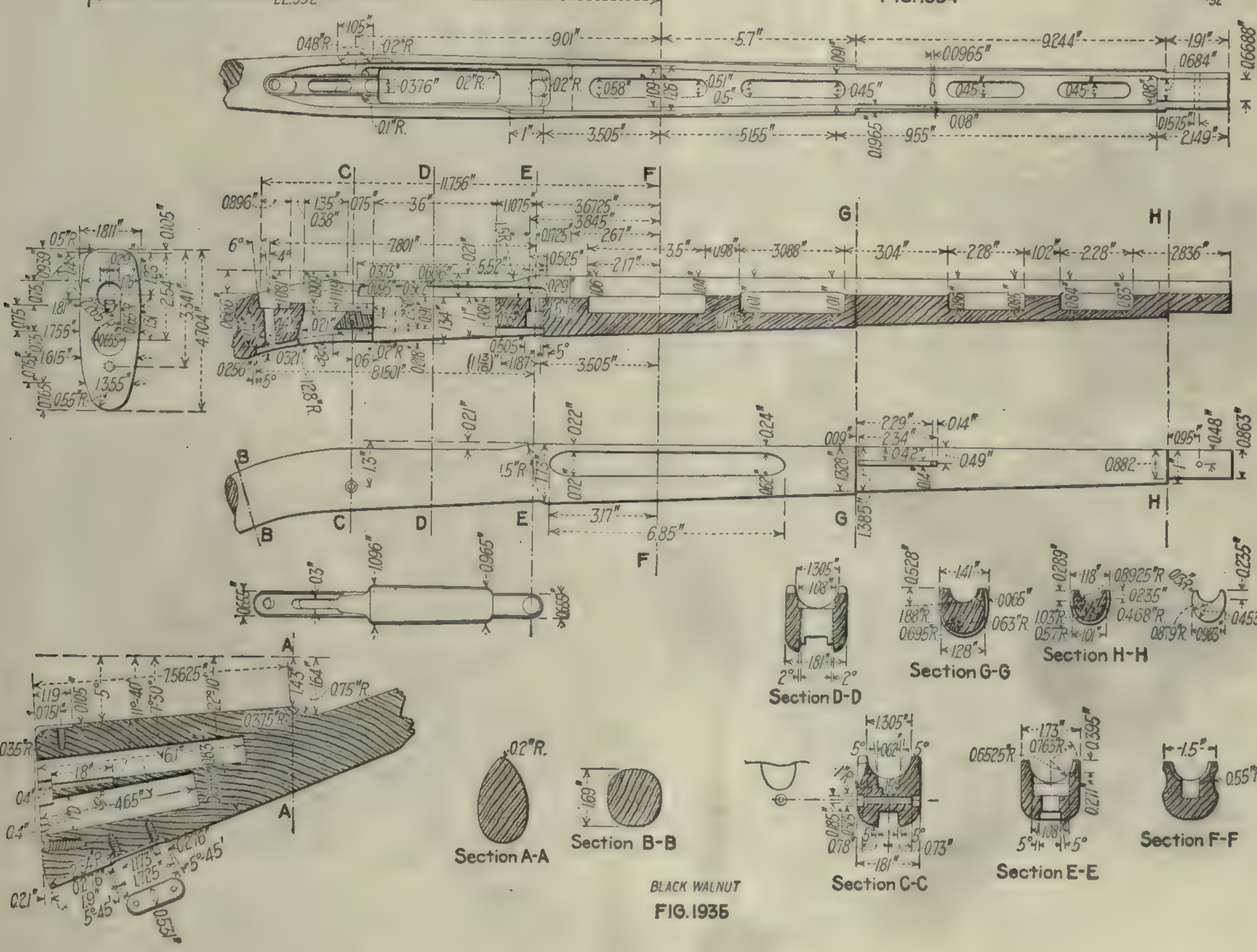
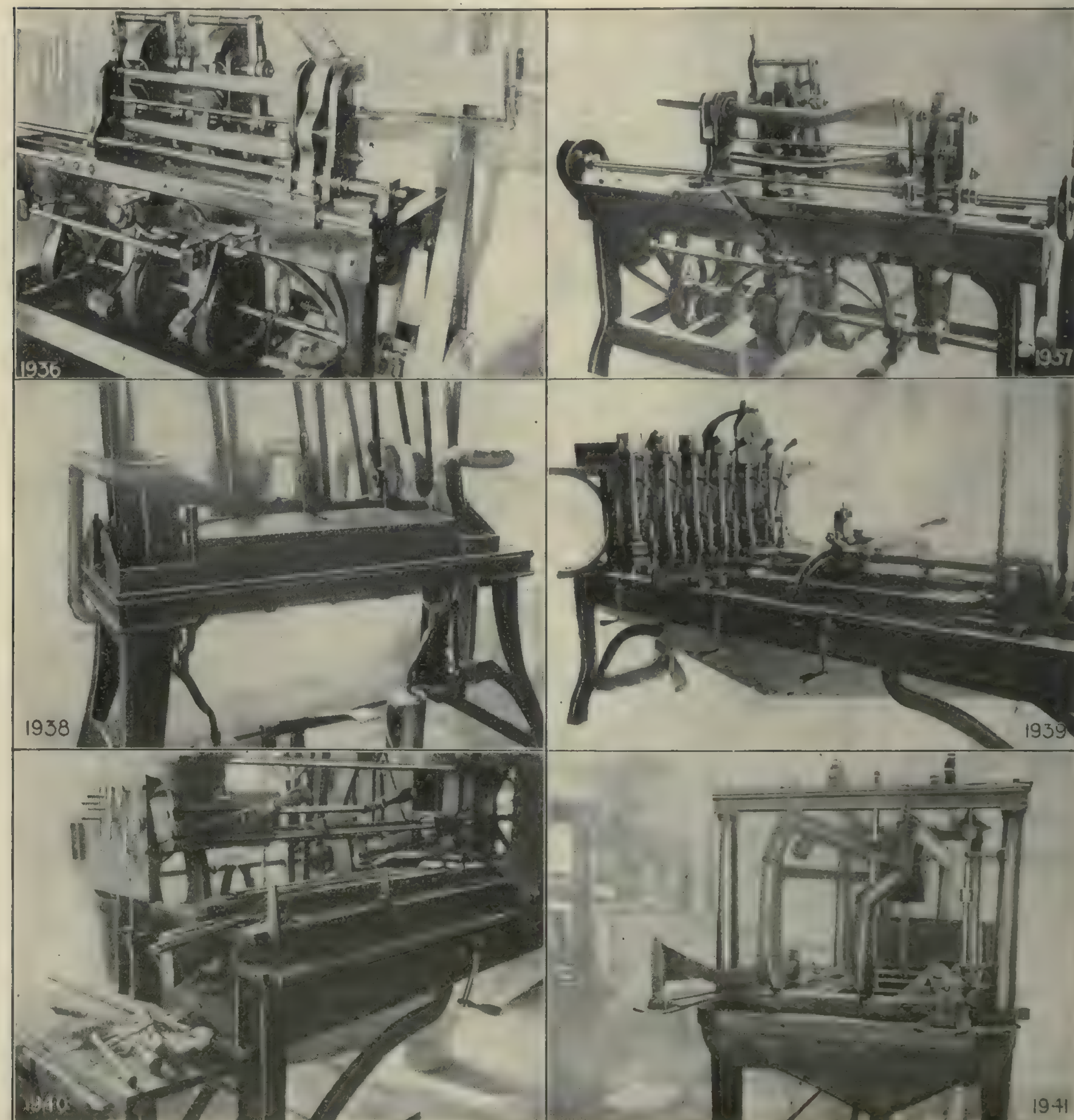


FIG. 1934



BLACK WALNUT
FIG. 1935

1 Square one side
2 Plane to thickness
3–A Rough-face top
3–B Trim ends
3–C Center muzzle end; drill butt for driver pins
4 Mark and saw to pattern to remove stock
4½ Cornering
5–A Rough-turn front end (first rough-turn)
5–B Press in driver plate
5–C Rough-turn rear end (second rough-turn)
5½ Straighten
Inspect
6 Spot for working points
7 Groove for barrel
8 Rough-cut for receiver
9 Profile sides and bottom and top of butt to finish lines
10 Profile top edge to finish
12 Shape butt for plate and trim to length
13 Cut top of butt for tang of plate and bore screw holes
11 Cut for cutoff thumb-piece
14 Turn butt and stock under receiver for finish
22 Cut right top off edge at receiver opening
15 Finish-turn for bands
16 Turn between bands
20 Bore for upper-band screw
Inspect
18 Cut grasping groove
17 Cut for guard, bore guard screw holes and trigger slot
21 Cut for lower-band spring
23 Round edge under upper band (hand)
19 Cut for swivel plate and bore screw holes
24 Fit receiver (hand)
25 Fit guard (hand)
26 Shape to tang of receiver, edges of barrel groove to hand guard, and to guard and swivel plate (hand)
Inspect
27 Shape to butt plate and sand to finish (hand)
30 Oil (boiled linseed)
28 Boring for oiler and thong case, and to lighten stock
29 Fit lower-band spring (hand)
32 Drilling for stock screw
33 Assembling with stock screw
34 Oil with cosmoline
35 Bore for spare-parts container
Inspect



FIGS. 1936 TO 1941. VARIOUS OPERATIONS ON THE STOCK

Fig. 1936—The first rough-turn, operation 5-A. Fig. 1937—The second rough-turn, operation 5-C. Fig. 1938—Spotting for working points, operation 6. Fig. 1939—Right-hand end of barrel-bedding machine. Fig. 1940—Left-hand end of barrel-bedding machine. Fig. 1941—Special shaping machine used for operation 9

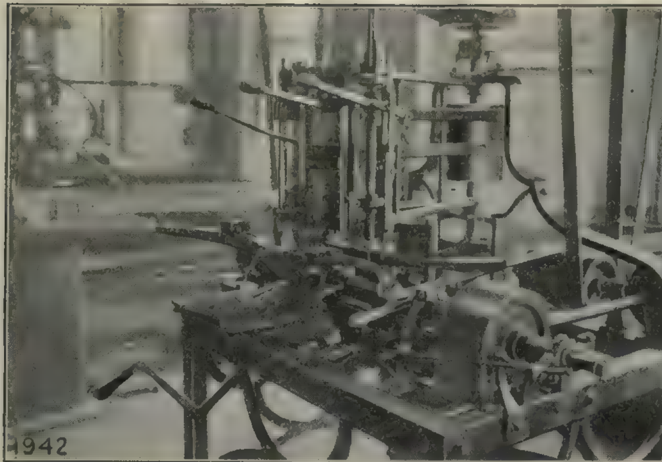


FIG. 1942. BEDDING AND DRILLING MACHINE

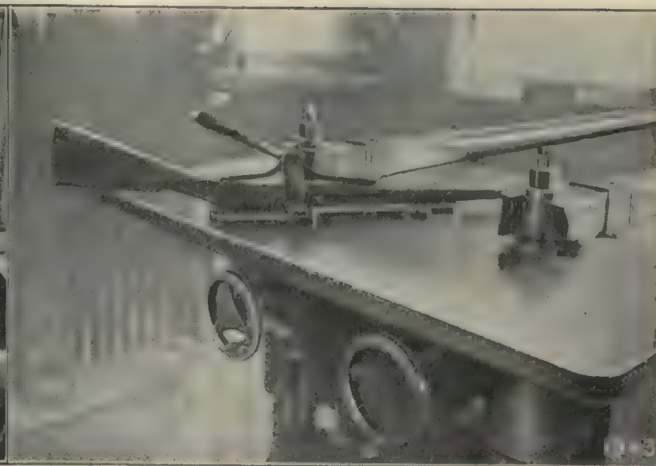


FIG. 1943. CUTTING GRASPING GROOVES, OPERATION 18

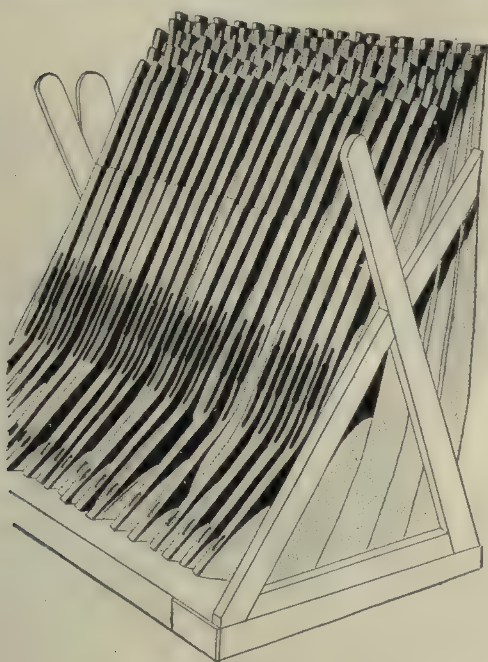


FIG. 1944

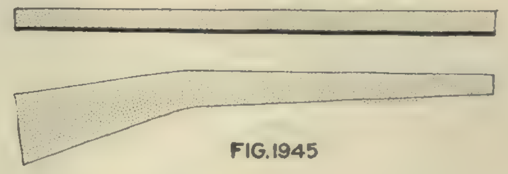


FIG. 1945

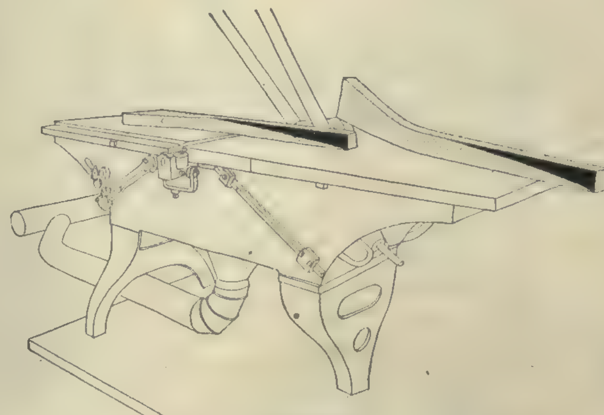


FIG. 1946

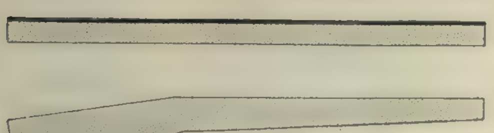


FIG. 1947

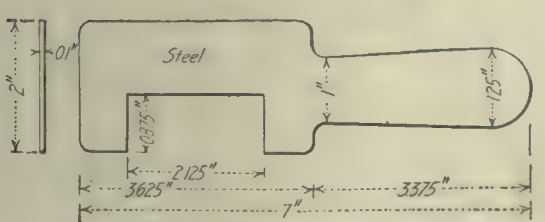


FIG. 1949

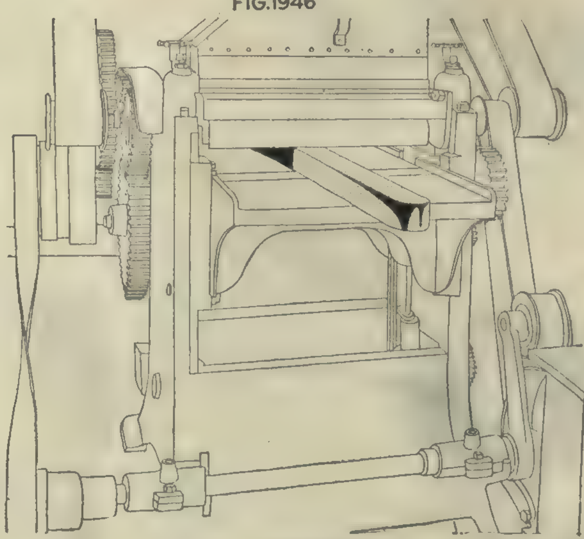


FIG. 1948

OPERATION 1. SQUARE ONE SIDE

Transformation—Fig. 1945. Machine Used—Buzz planer, hand feed, Fig. 1946. Number of Operators per Machine—One. Work-Holding Devices—None. Tool-Holding Devices—Oliver safety planer head. Cutting Tools—Knives in planer head. Number of Cuts—Enough to clean up. Cut Data—Head runs about 3800 r.p.m. Average Life of Tool Between Grindings—700 pieces. Production—1584 in 8 hr.

OPERATION 2. PLANE TO THICKNESS

Transformation—Fig. 1947. Machine Used—Roll-feed planer, Fig. 1948. Number of Operators per Machine—Two. Tool-Holding Devices—Regular planer head. Number of Cuts—One. Cut Data—Head runs about 3800 r.p.m. Average Life of Tool Between Grindings—Stoned, 1000 pieces; ground every 26-hr. run. Gages—Fig. 1949. Production—4840 pieces per 8 hr.

OPERATION 3-A. ROUGH-FACE TOP

Transformation—Fig. 1950. Machine Used—Circular saw, automatic feed, Fig. 1951. Number of Operators per Machine—One. Work-Holding Devices—Handwheel clamps on carriage. Cutting Tools—Circular saw, 20 in. in diameter, 0.12 in. thick, 2-in. pitch. Number of Cuts—One. Cut Data—Runs about 3000 r.p.m. Average Life of Tool Between Grindings—700 pieces. Production—85 per hr.

OPERATION 3-B. TRIMMING ENDS

Transformation—Fig. 1952. Machine Used—Circular saw, sliding carriage. Fig. 1953. Number of Operators per Machine—One. Work-Holding Devices—Saw carriage. Cutting Tools—Circular saw, 17 in. in diameter by 0.09 in. thick, ⅝ pitch. Number of Cuts—Two, one on each end. Cut Data—Saw runs about 4000 r.p.m. Average Life of Tool Between Grindings—1500 pieces. Special Fixtures—Top edge stop; end stop; hinged hold-down hand lever, as shown. Gages—Common rule. Production—85 per hr.

OPERATION 3-C. CENTER MUZZLE END; DRILL BUTT FOR DRIVER PINS

Transformation—Fig. 1954. Machine Used—Special double-end drill, Fig. 1955. Number of Operators per Machine—One. Work-Holding Devices—Bed stops and hand-lever clamp, as shown. Cutting Tools—One ½-in. triangular-point center drill and two 0.306-in. diameter wood bits; three tools fed in at once by foot lever, one enough to make a center and the two in the butt to a depth of 0.3 in. Average Life of Tool Between Grindings—7000 to 8000 pieces. Gages—Fig. 1956. Production—85 per hr.

OPERATION 4. MARK AND SAW TO PATTERN

Transformation—Fig. 1957. Machine Used—Band saw, Fig. 1958. Number of Operators per Machine—One. Cutting Tools—Band saw. Number of Cuts—One on each edge. Average Life of Tool Between Grindings—About 4 or 5 hr. steady sawing. Gages—Fig. 1959. Production—704 per 8 hr. Note—Operator lays templet on stock and marks outline with pencil, then saws to lines.

OPERATION 4½. CORNERING

Transformation—Fig. 1960. Machine Used—Buzz planer. Number of Operators per Machine—One. Number of Cuts—One or two light cuts. Production—2640 per 8 hr. Note—This is simply the removing of the left-hand top edge, in order that the wood will not splinter off in the subsequent turning operation.

OPERATION 5-A. FIRST ROUGH-TURN

Transformation—Fig. 1961. Machine Used—Blanchard type lathe, Fig. 1936. Number of Machines per Operator—Three. Work-Holding Devices—Revolving fixture with two centers and two clamp screws. Tool-Holding Devices—Two wood-milling cutter heads. Cutting Tools—Fig. 1962. Number of Cuts—Two; first cutter is started about 6 in. from end and

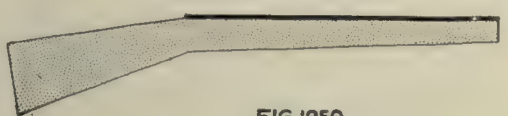


FIG. 1950 OPERATION 3A

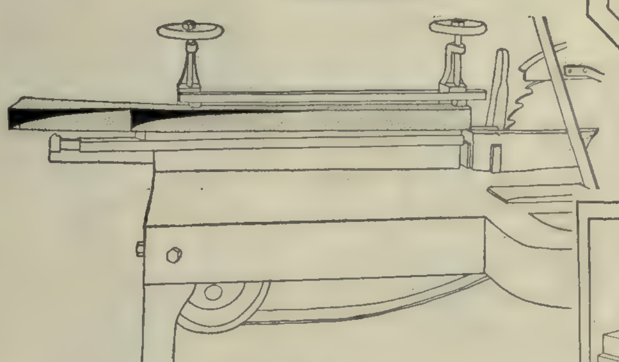


FIG. 1951

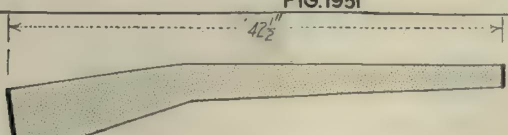


FIG. 1952

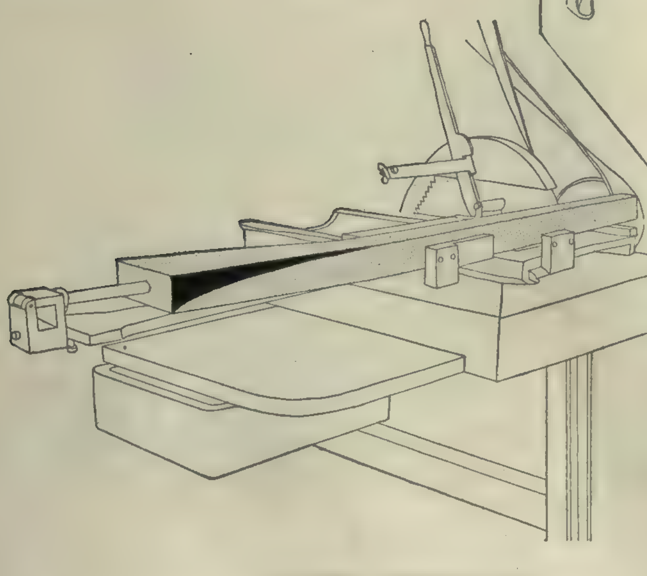


FIG. 1953 OPERATION 3B

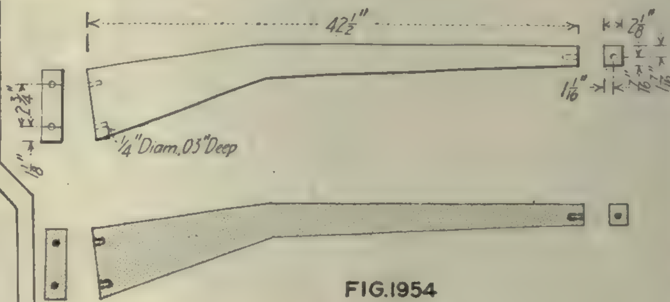


FIG. 1954

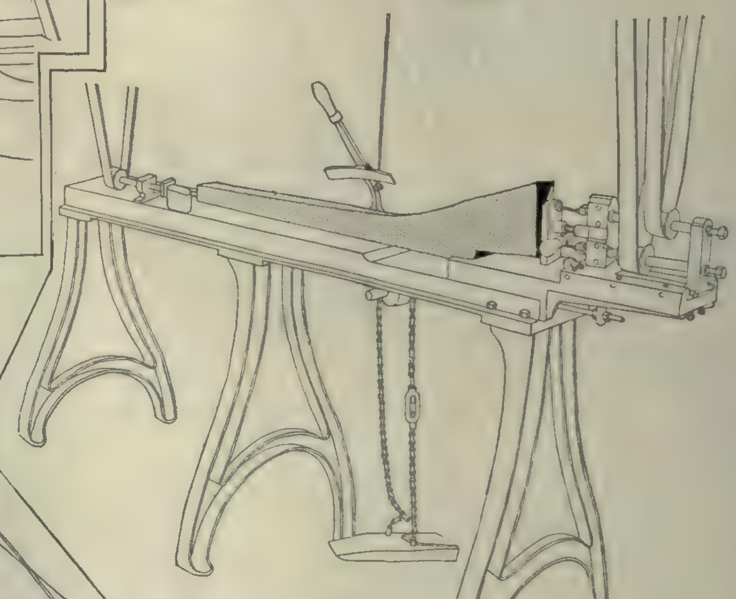


FIG. 1955

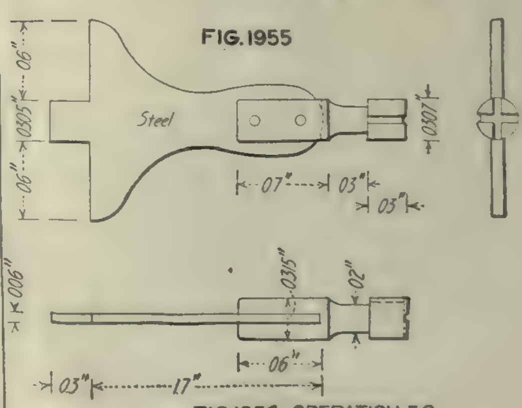


FIG. 1956 OPERATION 3C

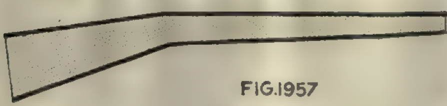


FIG. 1957

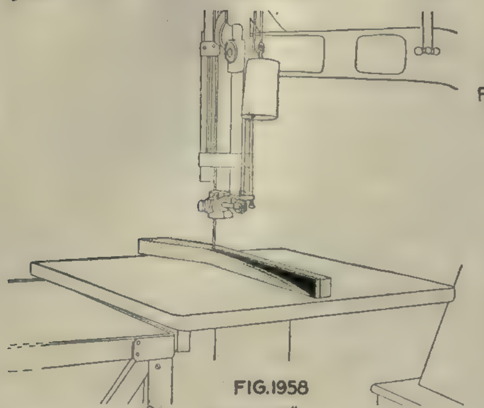


FIG. 1958

NOTE
FIG. 1960 = OP. 45

FIG. 1957, 1958, 1959 } OP. 4
FIG. 1961, 1962, 1963 } OP. 5A

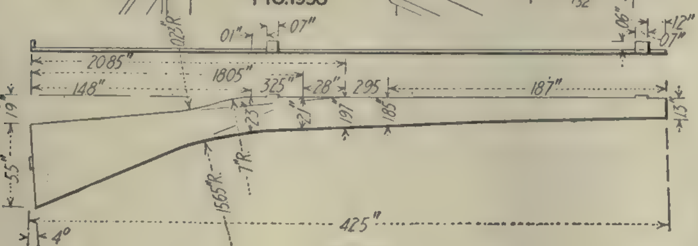


FIG. 1959

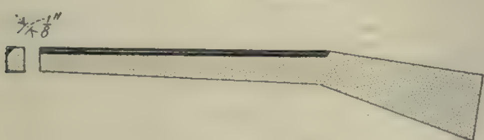


FIG. 1960

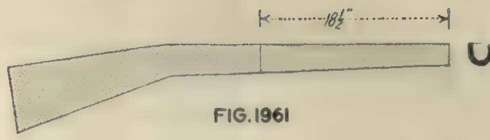


FIG. 1961

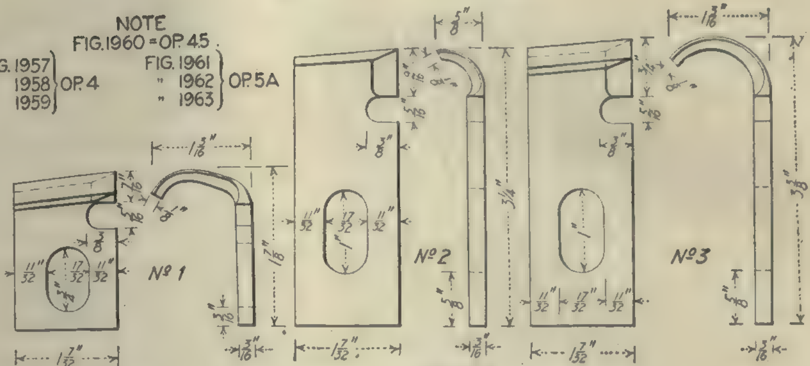


FIG. 1962

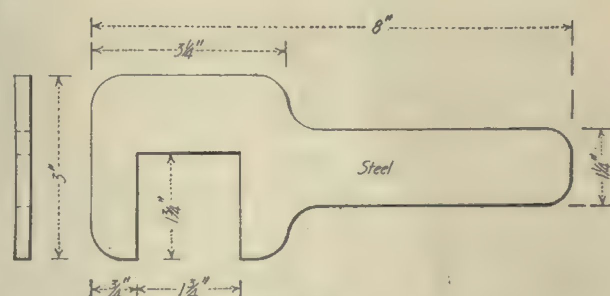


FIG. 1963

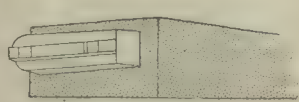


FIG. 1964

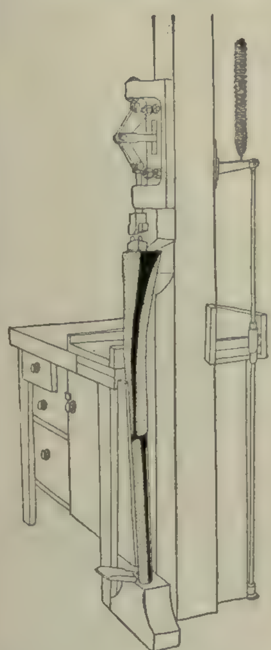


FIG. 1965

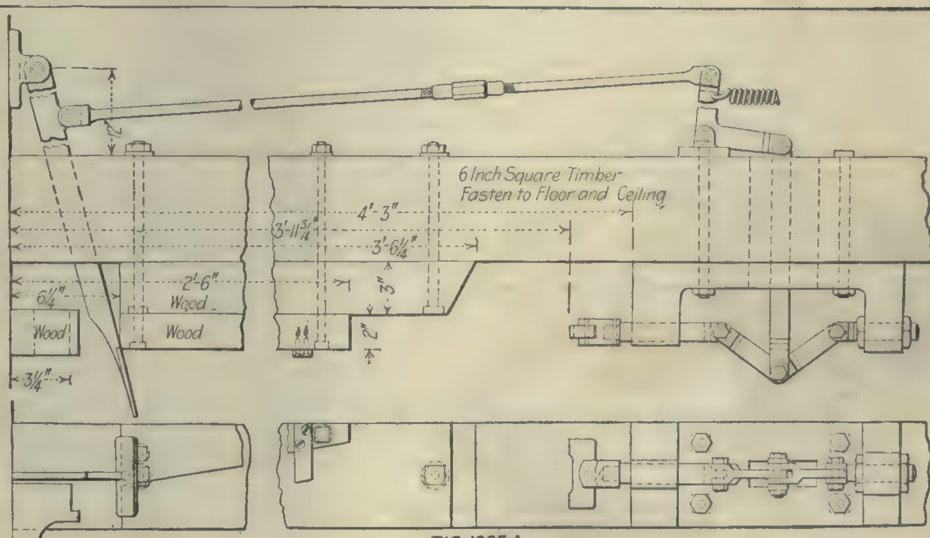


FIG. 1965 A
OPERATION 5B

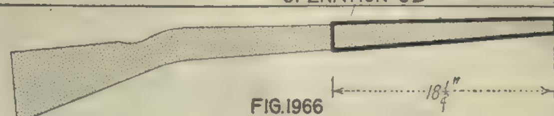


FIG. 1966

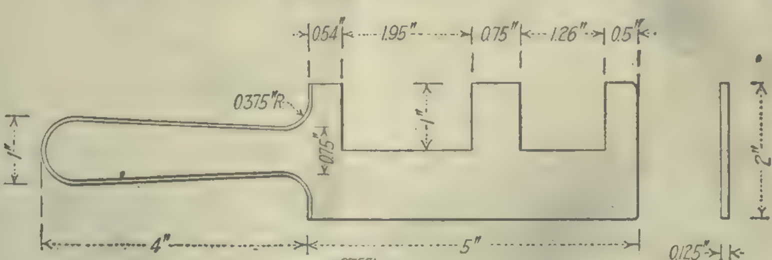


FIG. 1967
OPERATION 5C

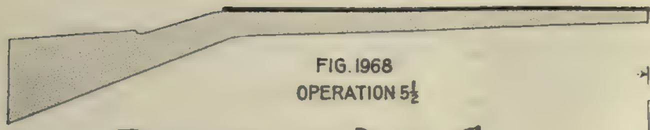


FIG. 1968
OPERATION 5½

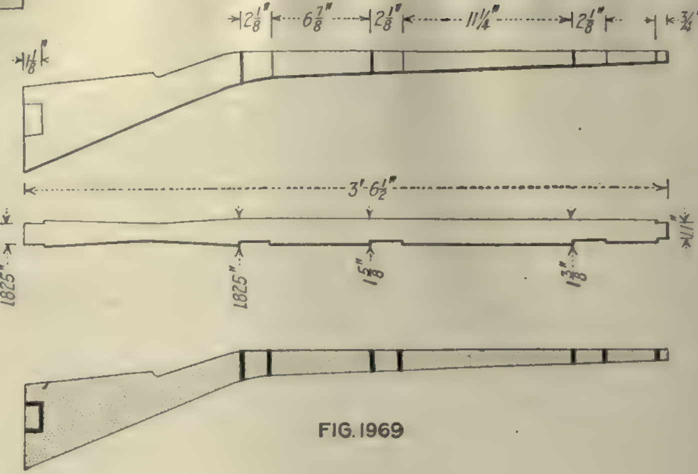


FIG. 1969

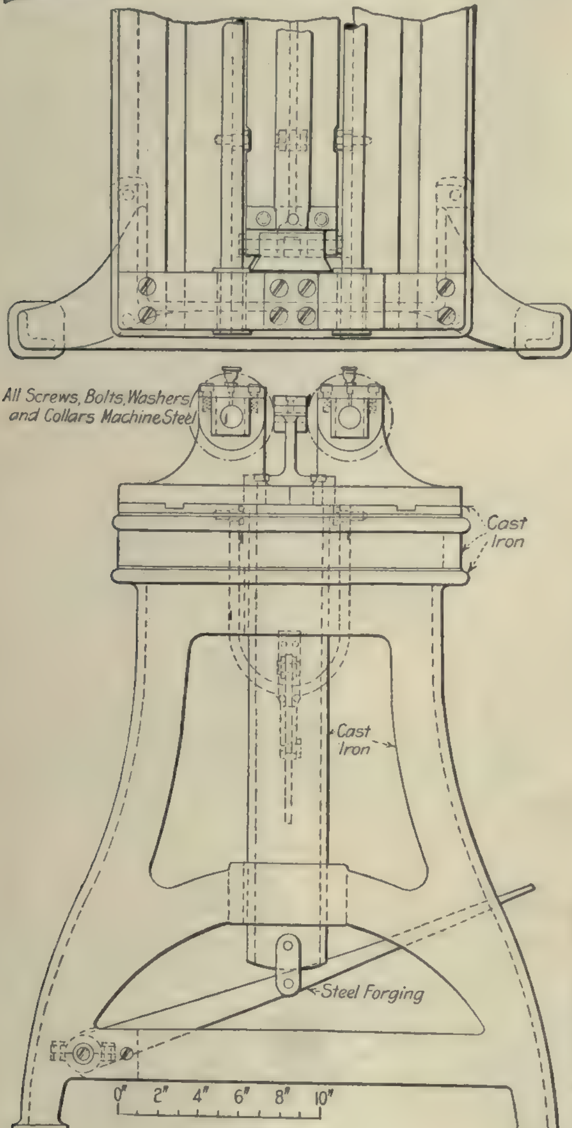


FIG. 1970

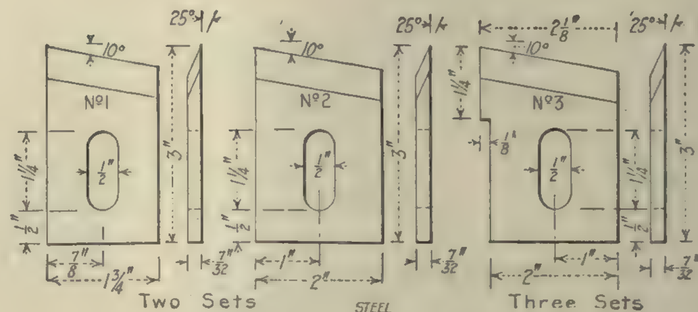


FIG. 1972

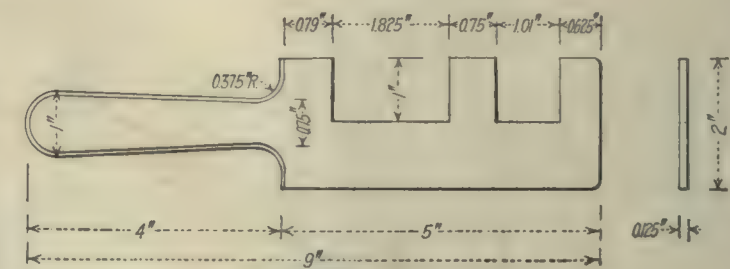


FIG. 1973

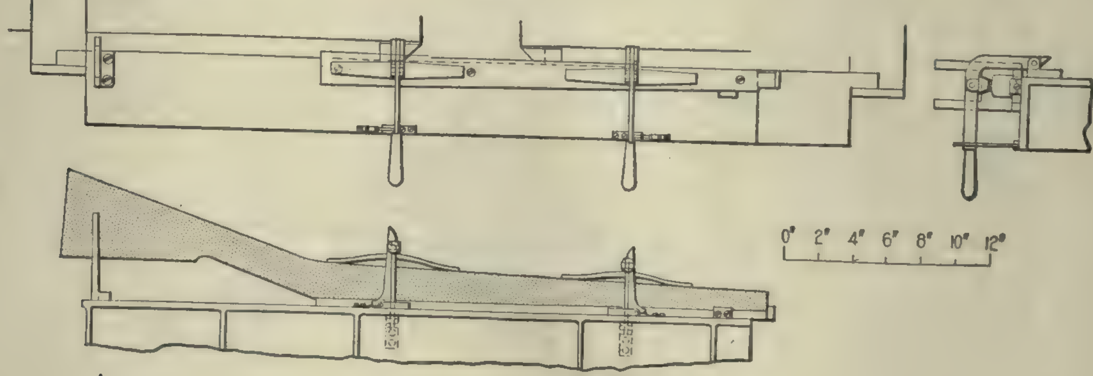


FIG. 1971
OPERATION 6

feeds toward butt; second cutter begins when first has fed along 6 in., the total cut being about 18½ in. Cut Data—Work turns about 50 r.p.m., cutters about 5000 r.p.m. Average Life of Tool Between Grindings—Stoned every 8 hr. Gages—Fig. 1963. Production—300 in 8 hr. for three machines. Note—One operator runs one lathe on this work and two on butts.

OPERATION 5-B. PRESS IN DRIVER PLATE

Transformation—Fig. 1964. Machine Used—Foot press, Fig. 1965. Number of Operators per Machine—One. Special Fixtures—Fig. 1965-A.

OPERATION 5-C. SECOND ROUGH-TURN

Transformation—Fig. 1966. Machine Used—Blanchard type lathe, Fig. 1937. Number of Machines per Operator—Three. Work-Holding Devices—Wedge chuck and driving plate on center, as shown. Tool-Holding Devices—Cutter head. Number of Cuts—One. Cut Data—Work turns about 50 r.p.m., cutter 5000 r.p.m. Average Life of Tool Between Grindings—Stoned every 8 hr. Gages—Fig. 1967, and master form on machine. Production—300 in 8 hr. for three machines.

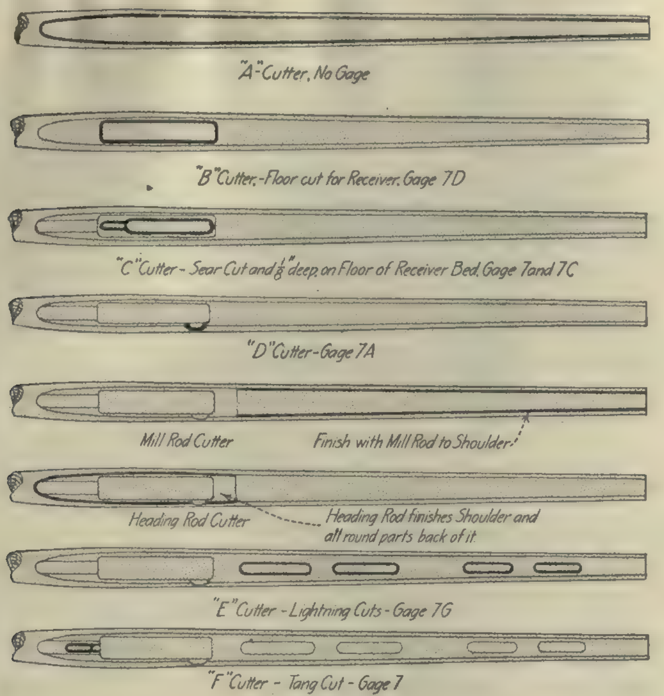


FIG. 1974

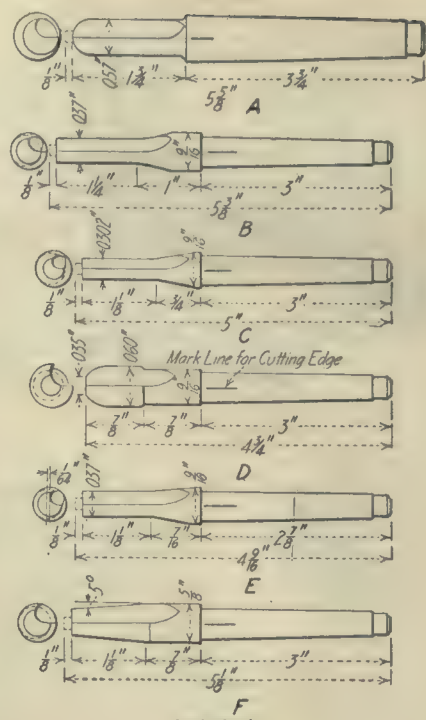


FIG. 1976

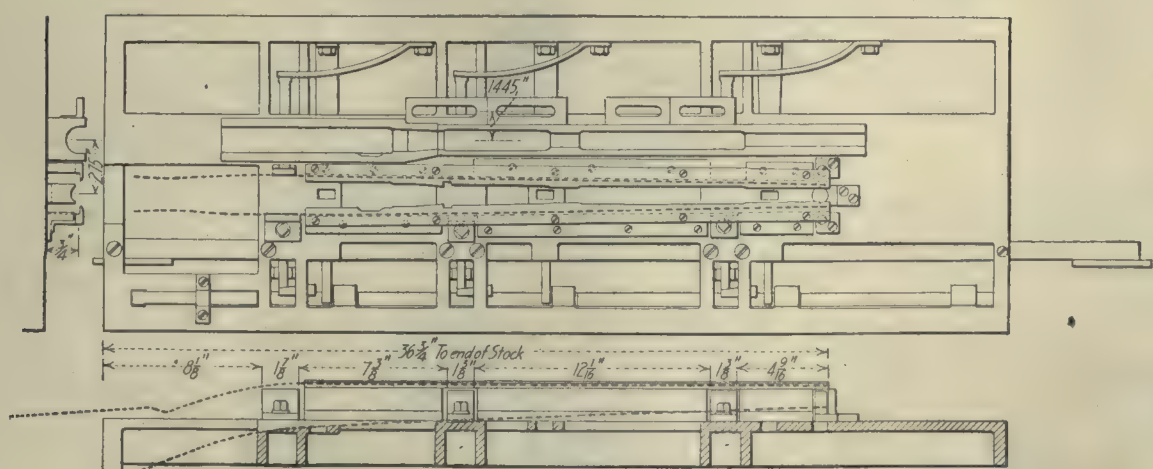


FIG. 1975
OPERATION 7

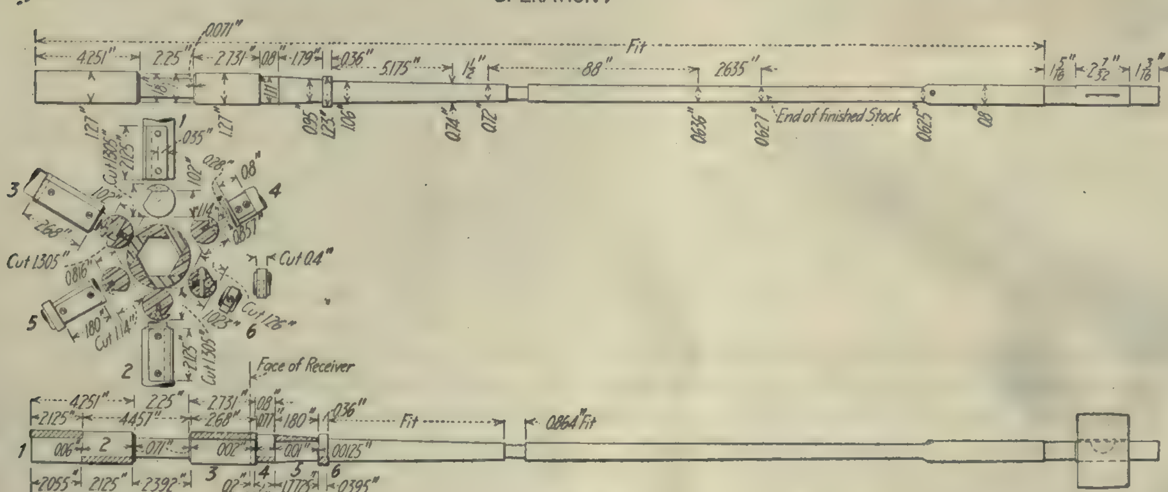


FIG. 1977

OPERATION 5½. STRAIGHTEN

Transformation—Fig. 1968. Machine Used—Buzz planer. Number of Operators per Machine—One. Number of Cuts—Just enough to straighten top edge. Production—2640 per 8 hr. Note—This operation is merely to straighten and smooth the top after the rough-turning is done; after this is done, the inspector goes over all the stocks carefully for the first general inspection, using the various gages and looking for flaws of any kind.

OPERATION 6. SPOT FOR WORKING POINTS

Transformation—Fig. 1969. Machine Used—Special spotting machine, Figs. 1938 and 1970. Number of Operators per Machine—One. Work-Holding Devices—Clamping jig on carrier of vertical slide, Fig. 1971. Tool-Holding Devices—Cutter heads. Cutting Tools—Fig. 1972. Number of Cuts—Seven at once. Average Life of Tool Between Grindings—2000 pieces. Gages—Fig. 1973. Production—1760 per 8 hr. Note—Work is carried down past the cutters and back, stopping above them.

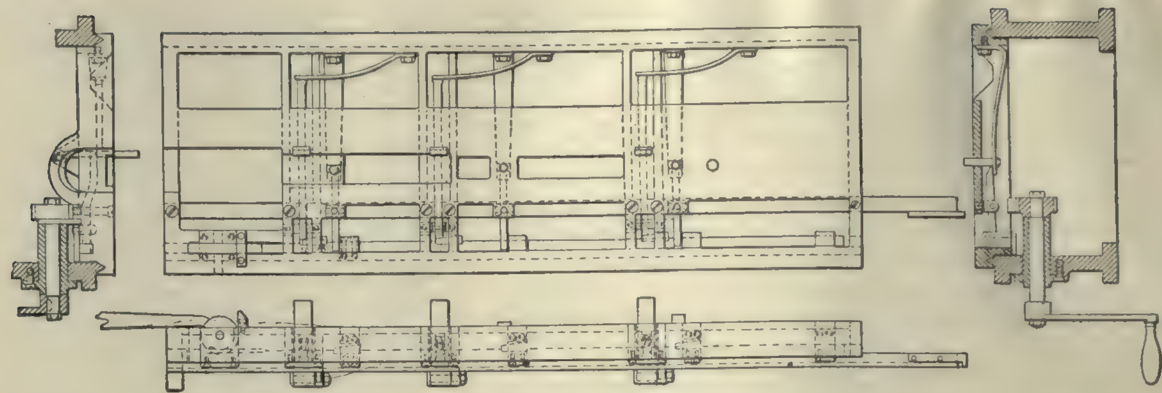


FIG. 1978

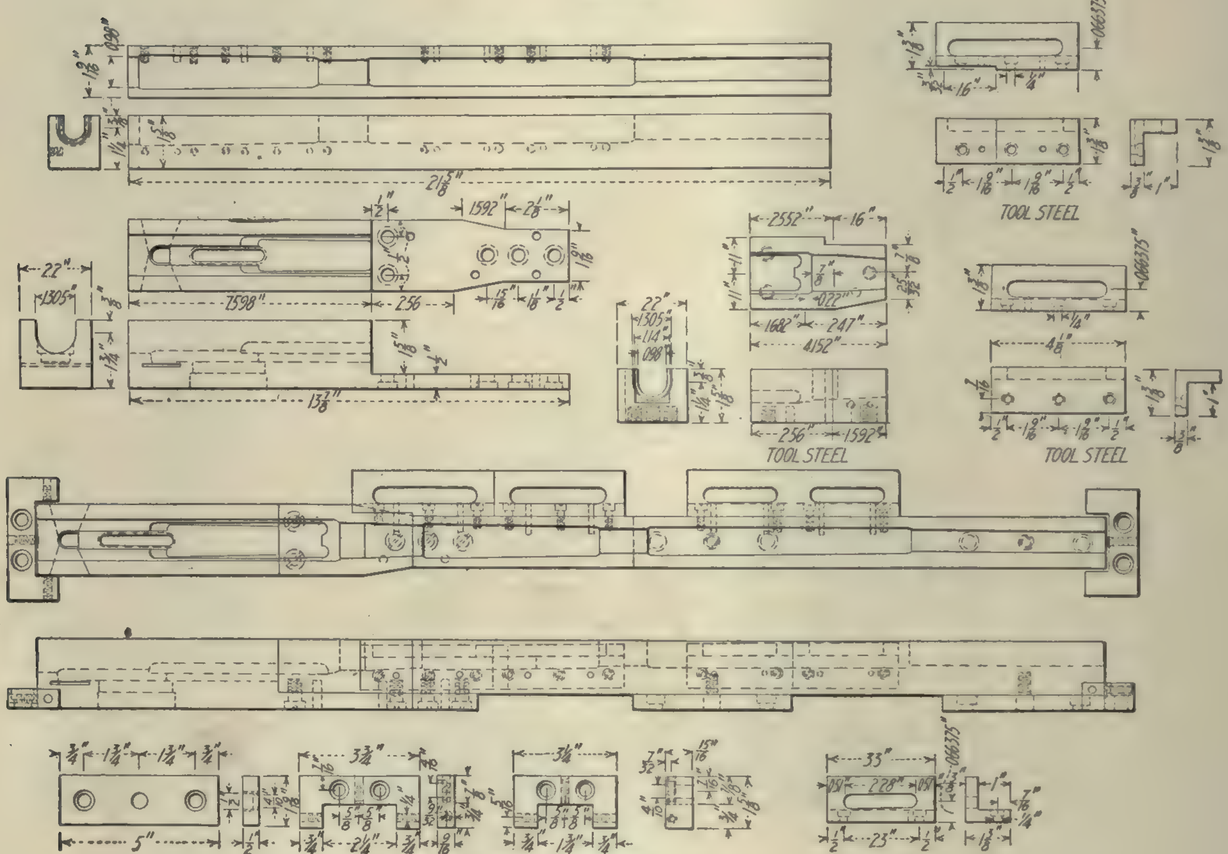


FIG. 1979
OPERATION 7

OPERATION 7. GROOVE FOR BARREL

Transformation—Fig. 1974. Machine Used—Special, made by Ames Manufacturing Co., Chicopee, Mass., Figs. 1939 and 1940. Number of Operators per Machine—One. Work-Holding Devices—Fixture, Fig. 1975. Cutting Tools—Profile tools, Fig. 1976; heading rod, Fig. 1977. Cut Data—Spindles run about 4200 r.p.m. Average Life of Tool Between Grindings—Stoned twice a day. Special Fixtures—Carriage, Fig. 1978; master form, Fig. 1979; mill rod, Fig. 1980; profile spindle heads, Fig. 1981; heading rod frame, Fig. 1982. Gages—Fig. 1983. Production—104 in 8 hr.

In studying the work, it will be seen that under ordinary shop conditions a number of the operations, while listed separately, are done in a "group" by one man who may use several machines or fixtures in succession.

The inspections indicated at various points in the list of operations are of two kinds. The first is what the workman himself gives his output, using the gages furnished for this purpose; and the other is by special inspectors who work in a separate room by themselves. All the work is brought to them at different stages of the process, and it is to the test by these inspectors that reference is made where the word "Inspect" occurs.

The first operation on the rough-sawed stocks is to square one side on a buzz planer, as shown in Fig. 1946, the cut being enough to clean up one side completely. Naturally, no gages are needed. The planing to thickness is done on a roll-feed planer, Fig. 1948, and the sheet-metal gage, Fig. 1949, is used.

For the third operation, or rough-facing the top, a circular saw with automatic feed, Fig. 1951, is used. A thin strip is sawed off the top, squaring it, and with the two planed sides forming temporary working points. Following this, the ends are trimmed in a specially fitted circular saw, Fig. 1953, with stops so arranged that the stock may be reversed and the ends trimmed separately with the same saw.

In centering the muzzle end and drilling the butt end for driver-plate pins, a double-end drilling machine, Fig. 1955, is used. The machine is so arranged that, as the operator presses the lever clamp down, a wire pulls the shifter over and starts the machine. The two drill heads

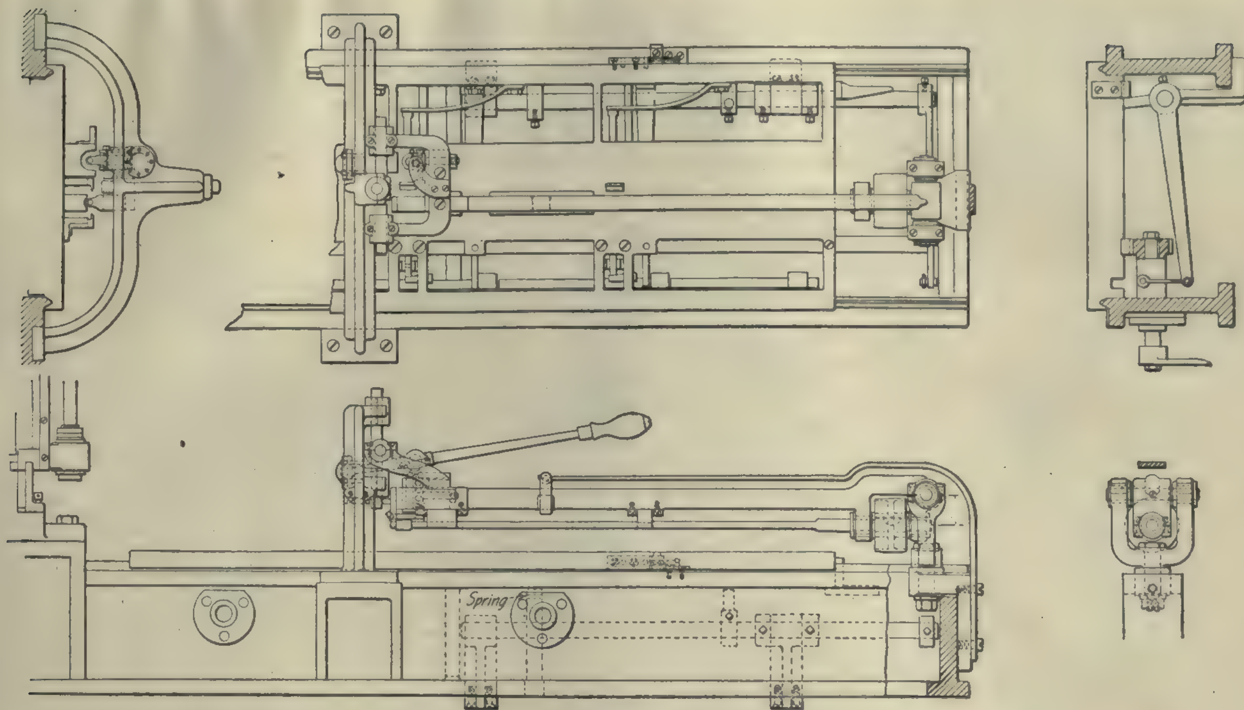


FIG. 1980

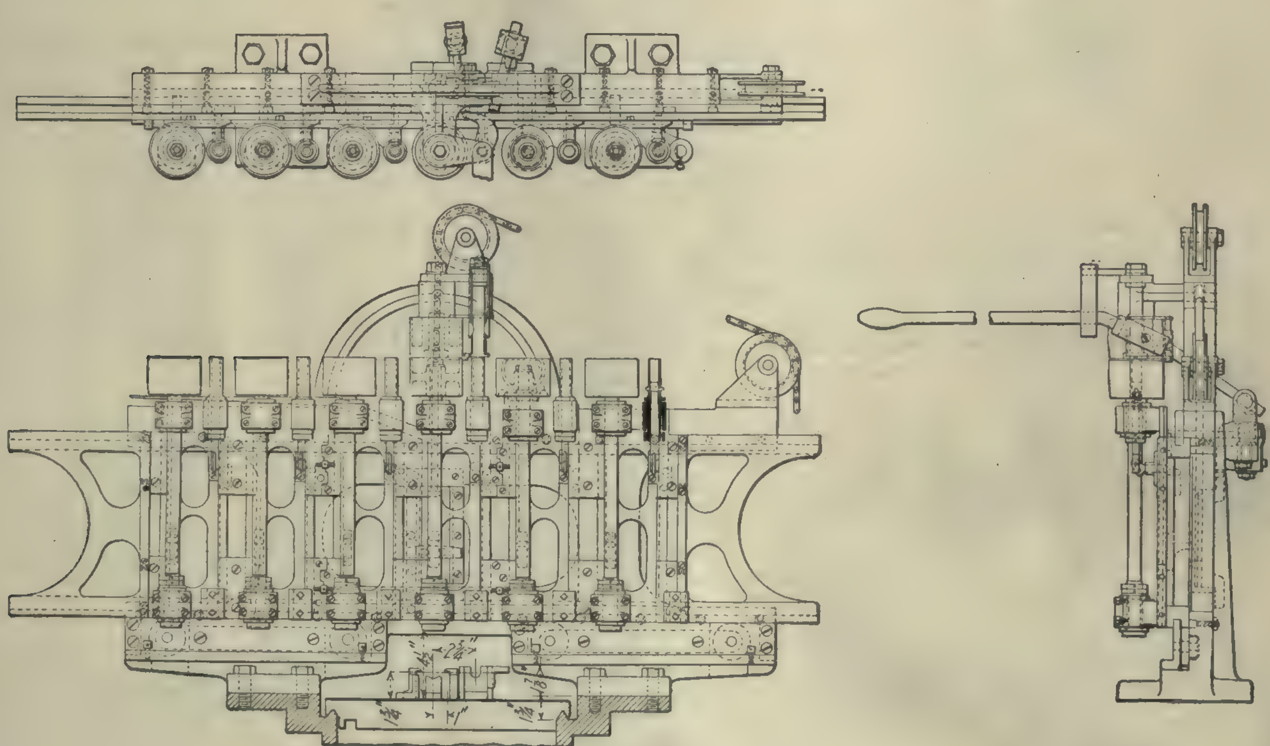


FIG. 1981 OP. 7

are fed in from opposite directions by means of a foot treadle. As the treadle is released, the heads recede; and as the lever is raised to release the work, the machine is stopped. One head carries two wood bits, which feed in about 0.3 in.; the other head carries a triangular-point center drill, which goes in just far enough to make a good center. The size and position of the driver-plate holes are gaged with the gages shown in Fig. 1956.

A templet is laid on the stock and, with the top and ends used to locate from, the lower outline and top of the butt are marked with a pencil and then sawed out with a band saw, Fig. 1958. The templet is illustrated in Fig. 1959.

The "cornering" is the planing off of the left-hand top edge and is done so that the wood will have less tendency to splinter in the following turning operation. The first rough-turning consists in removing the surplus wood under where the barrel of the rifle is to be placed. The rough stock is placed in a revolving fixture on the Blanchard type of lathe, Fig. 1936. The top edge rests on a guide bar and the end center over a center pin. A locating center pin carried on a hinged bracket supports the butt. The machine has two revolving cutters, thereby materially reducing the turning time. A master form guides the cutters, and the gage, Fig. 1963, is used.

A metal driver plate is next pressed into the butt end, using the foot press shown in Figs. 1965 and 1965-A. Then the stock is placed in the lathe, Fig. 1937, and the rest of it is roughed off. The part first turned is wedged into a revolving sleeve to hold it, and the pressed-in driver plate is held in a driving center. One front-end and two tween the cutting heads. The cutting tools used are illustrated in Fig. 1972. Originally, the cutter heads were made in the form of a sort of large end mill, and the shafts were run at right angles to the work; but the present form uses regular cutter heads running parallel to the work. The thickness of the wood through the

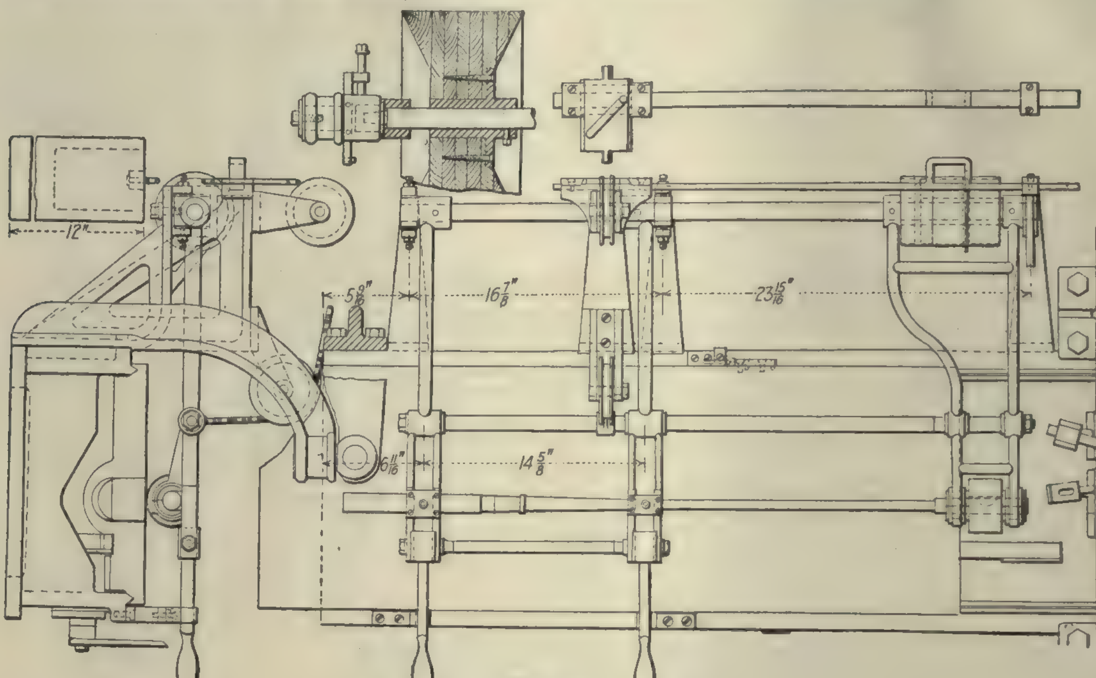


FIG. 1982

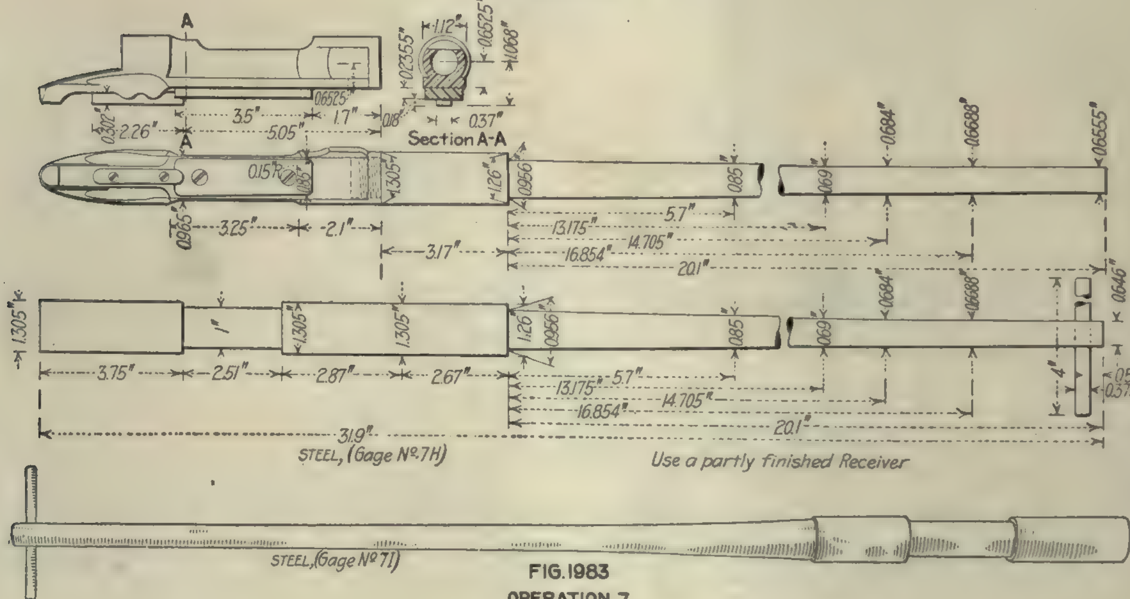


FIG. 1983
OPERATION 7

butt-end turning lathes are worked together, as the first one will turn twice as many pieces as the others. For the second rough-turn, the gage, Fig. 1967, is used.

Straightening is done on a buzz planer and is to smooth up any roughness or slight warp developed in the previous operations. A smooth surface results, to be used in conjunction with the ends for locating in the spotting machine.

This spotting machine is shown in Figs. 1938 and 1970. The stock is placed in a vertical sliding carrier, detailed in Fig. 1971, and is clamped in by means of an eccentrically operated spring clamp. The operator presses down on the foot treadle, and the work is carried downward between the cutting heads... different working spots is tested by the gage shown in Fig. 1973.

The most complicated operation, or rather series of operations, done on a stock is the bedding for the barrel. The stock is locked in the carriage of the machine shown in Fig. 1939. The channel of the bed is first roughed out as close to the finished size as practical without danger of undercutting. The various parallel cuts are then made, using the different vertical cutters in turn, each being guided by a master form set close to the work. The remaining surplus stock is worked out by running the carriage to the right out under the single horizontal cutter or mill rod, which is worked from side to side and up and

down in the bed channel by the hand lever at the right, the carriage being run back and forth by means of the cranks shown hanging down from the front of the bed. Next, the carriage is run through under the vertical spindle head to the opposite end of the machine, Fig. 1940. Here the revolving heading rod is pressed down into the bed by means of the two handles, finishing the cylindrical surfaces and shoulders.

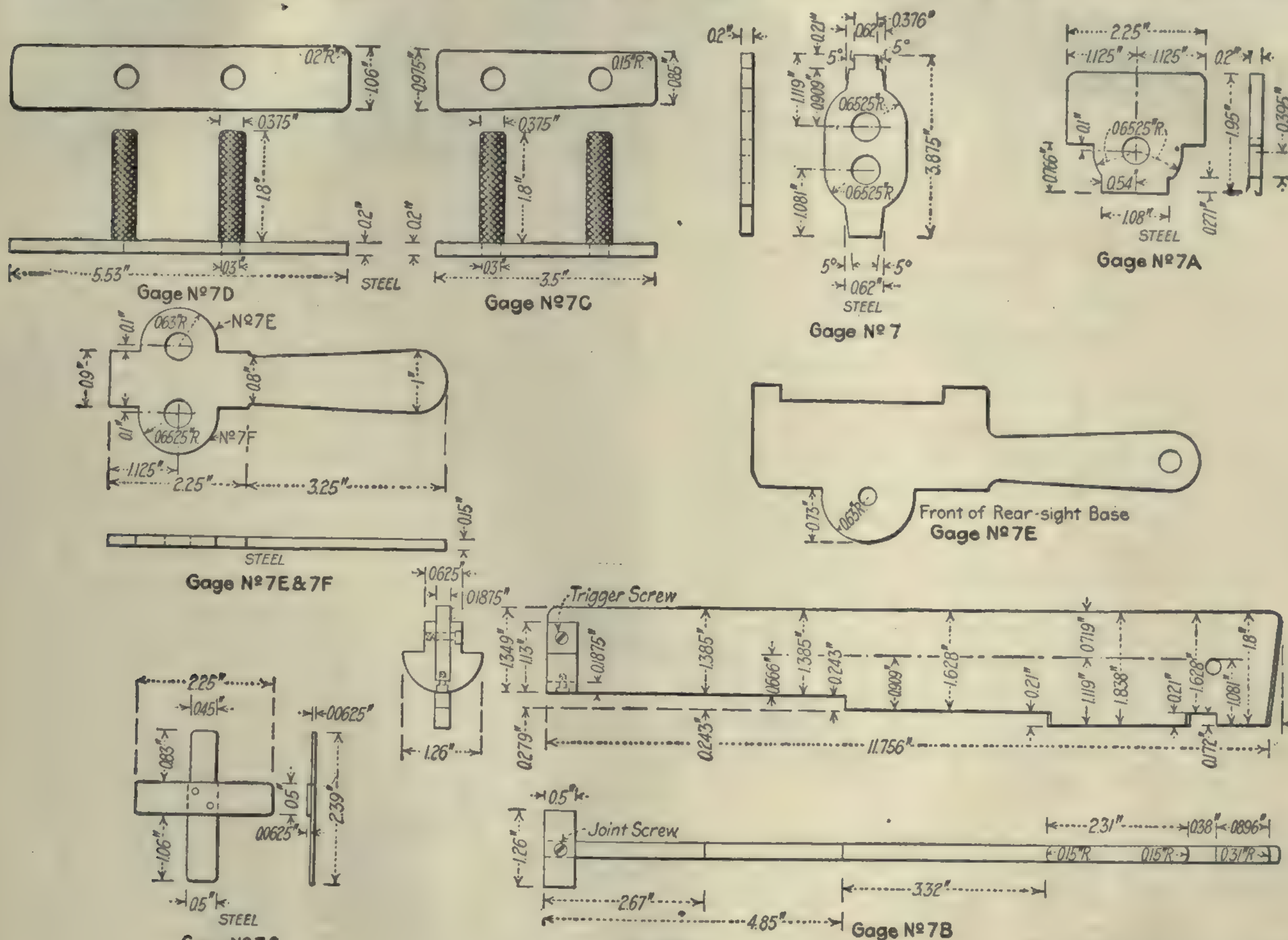


FIG. 1983
OPERATION 7

The transformation, Fig. 1974, will give a good idea of the various steps, and the tools used are illustrated in Figs. 1976 and 1977. The carriage details, forms, rods and the like, may be seen in Figs. 1978 to 1982, and the gages in Fig. 1983.

Machining the Ball on a Rifle Bolt

By Elam Whitney

In the manufacture of rifle parts in this country there is in many cases a wide difference of opinion in regard to the methods and tools employed. This condition is especially noticeable in contract shops engaged in building the jigs, fixtures, etc., for various firms manufacturing military rifles. Standardized tools should be used on rifle parts such as the bolt, trigger and barrel, and an advance in this direction is evidenced by the character of the advertisements appearing for appliances.

A common type of military bolt is illustrated in Fig. 1. In Fig. 2 are shown the method and the tools employed by a large arms company for turning the ball handle in a lathe, an operation that is styled clamp milling. The work *A* is held in the special chuck *B* by the hinge clamp *C*; the cutters, or clamp mills, are shown at *D* and the cutting edges at *E*. It will be seer that the cutters are constructed to support the work. The clamp mills shown make an excellent finish cut, but do not compare favorably in regard to production with the other tools here described, which are used for the same work.

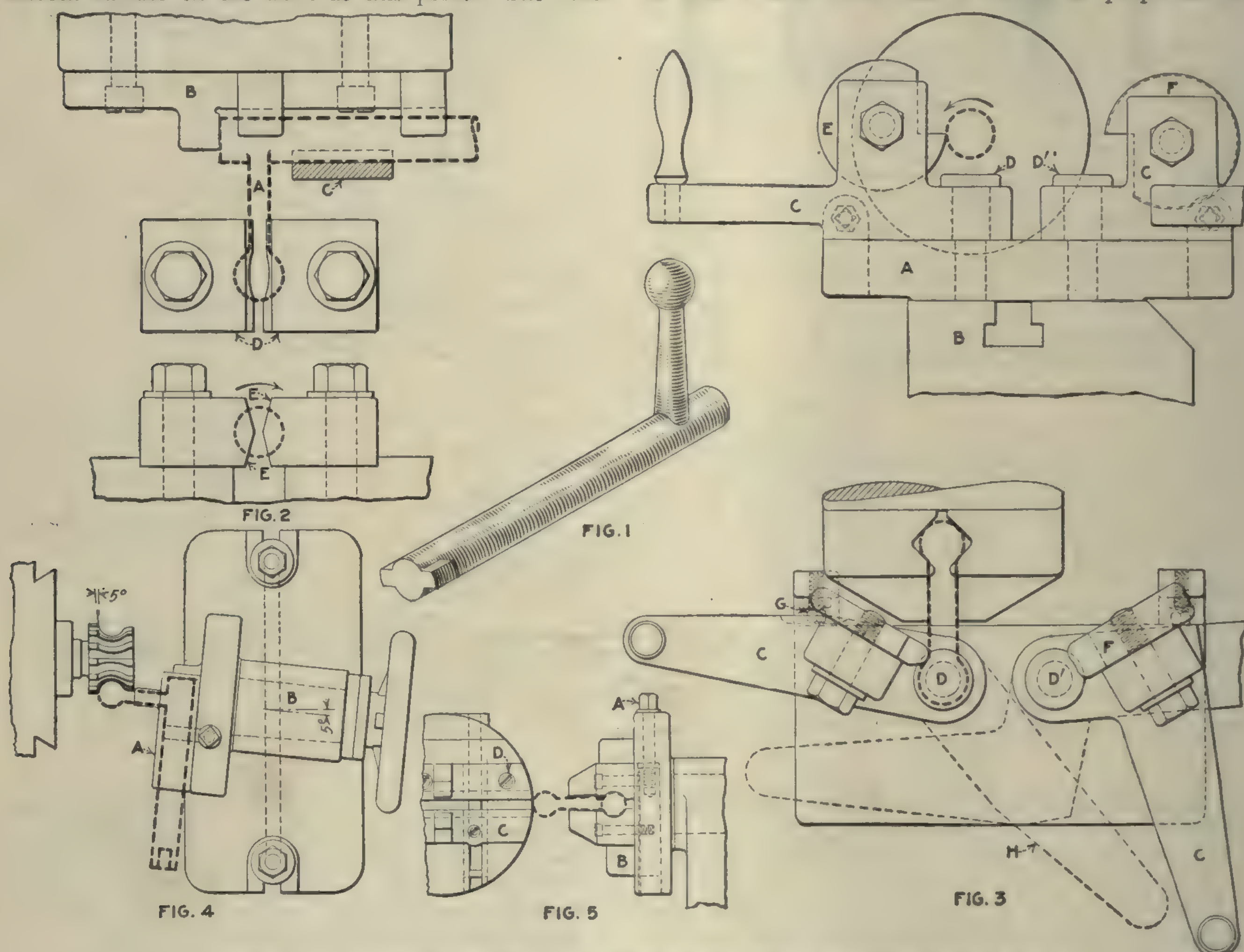
The firm that built these tools also constructed the lathe attachment shown in Fig. 3. It is for the same purpose, but for a different company. It is my intention to show by comparison, not only the efficiency gained by contract shops in using standardized tools, but also the possibilities for standardization.

Referring to Fig. 3, the base *A* is mounted on the cross-slide *B*. This base carries the front and rear toolposts *C*, with handles attached for rotating around the centers *D* and *D'*. The circular-formed roughing cutter *E* is shown mounted on the front toolpost, and the circular-formed finishing cutter is shown at *F*.

In operation the cross-slide is brought against its stop and the front toolpost against the stop *G*. After the work, in the three-jawed chuck, has made several revolutions to form the fillet, the cutter and toolpost are rotated around the stud *D* until the cutter has passed the center line of the work. This position of the toolpost is shown by the dotted outline *H*. The position of the cross-slide is then shifted so as to bring the cutter on the rear toolpost into position—that is, the center of the stud *D'* is brought in line with the center of the work and operated the same as the roughing cutter. The cutters can be operated rapidly and will produce a smooth surface free from tool marks.

In Fig. 4 is shown a rotary milling fixture that was constructed as part of arsenal equipment for a foreign country. This fixture is also used for machining the ball on the bolt handle; and while a second operation is required for finishing, it allows a comparatively heavy feed and the output is equal to that of the other fixtures.

Referring to the plan, Fig. 4, the work is held in the chuck *A*, which is rotated by the spindle and handwheel shown. A feature of this fixture is that the work is mounted at a 5-deg. angle at *B*, which allows the cutter to lap over the center of the ball, thus producing a smooth surface on the work at this point. The other



FIGS. 1 TO 5. VARIOUS DETAILS OF MACHINING THE BALL ON A RIFLE BOLT
Fig. 1—Military-rifle bolt. Fig. 2—Clamp turning tools. Fig. 3—Swinging forming tools. Fig. 4—Rotary milling fixture. Fig. 5—Chuck construction

5-deg. angle is the usual clearance angle found on concave cutters. In Fig. 5 is shown the construction of the chuck. The clamping screw *A* threads into the hook bolt *B*, to which is attached the equalizing clamp *C* operating against the stationary clamp *D*.

Drafting Room Versus Shop

By G. S. H.

I have read with considerable interest the different articles on the drafting room and the shop. There is one thing about the college-bred draftsmen that has not yet been touched upon.

I had finished my apprenticeship as machinist before I started my technical education. This was because my father, who had not had an opportunity to get even a respectable grammar-school education, had advocated it. I am mighty thankful that I did learn the machinist's trade before attending technical school, as I did not have quite the exaggerated idea of my worth when I left as had some of my fellow students.

It seems to me that a great deal of the fault with college draftsmen lies with their professors who give them the impression, not because of what they say so much as by what they do not say, that they are the acme of intelligence and ability. I really believe that 75 per cent. of the technical graduates leave school with an idea of their worth that is out of all proportion to the truth. Again, most of the draftsmen that are contemptible are young fellows, and you know we all had to pass through that "know-it-all" age. If the young draftsmen would keep their eyes and ears open and their mouths shut, they would learn faster and not earn the enmity of the shopmen.

I really believe that 99 per cent. of the draftsmen can sit at the feet of the older machinists, foundrymen and pattern makers to mighty good advantage, if they only would. A good draftsman must have a working knowledge of all the trades related to his line. It is too much to suppose that he can have as good a knowledge as the men working in that trade. This fact is not considered by the critical shopman and is the basis of my contention that the draftsman should cultivate the men in the shop.

IDEAS FROM PRACTICAL MEN

Self-Adjusting Spring Center

By A. Reich

A self-adjusting spring center that has proved very successful for a grinding machine or a lathe is shown herewith. It gives the plan of the device as mounted on a Landis grinder and a section through the operating mechanism. Fig. 2 shows more clearly the method of mounting. The device consists of a taper shank *A*, Fig. 1, held tightly in the spindle of the machine by a draw bolt *B*. The center *C* is held in place within the shank *A* by a setscrew *D* pushed forward by two springs *E* and E_1 and locked tightly in the desired position by three shoes *F* by means of an inside tapered sleeve *G*. This is moved by the hand lever *H*.

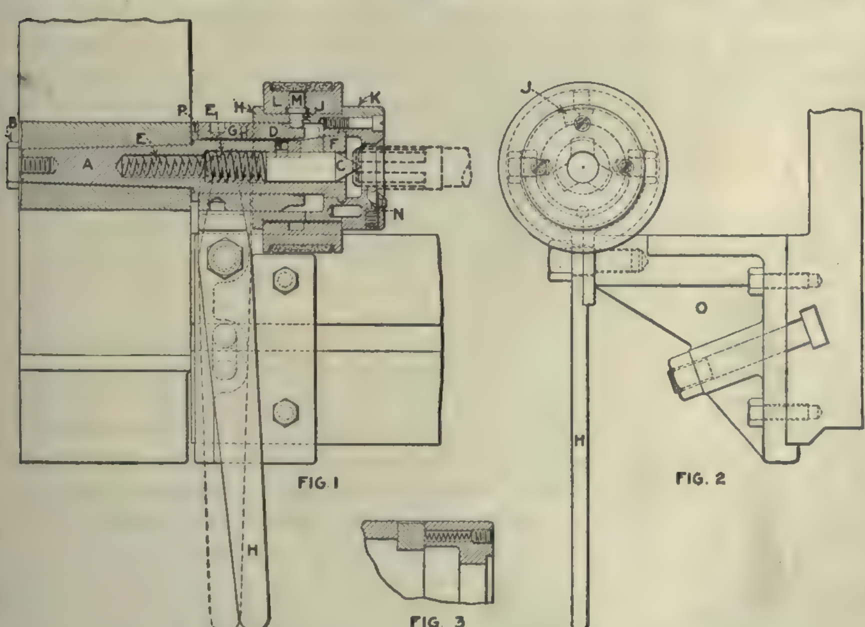
Rotating on the sleeve *G* and the taper shank *A* is a shoulder sleeve, which has a driving dog *J* inserted, to which the work-driving body *K* is fastened.

Fig. 1 shows the driver *J* disengaged, and in Fig. 2 the driver *J*, or chuck, is shown engaged. The pulley *L*, Fig. 1, with a stationary pin *M*, runs constantly from a belt from a countershaft. The work-driving chuck has an adjustable driver *N* which takes the drive of the work on a keyway, spline, square or whatever shape the work might be finished to. This driver *N* is held stationary by two setscrews. The bracket *O*, Fig. 2, is bolted to the table of the machine with a square-head bolt and two hexagon capscrews. On the back of the sleeve *G* is a stop collar *P*, Fig. 1.

When locking the center *C* by shifting the sleeve *G* to the right, the shoes *F* are held tightly and the driver *J*, climbing on the larger diameter of the sleeve *G*, engages the pin *M* and starts the work rotating.

Fig. 3 shows a section of the shoulder sleeve with a spring inserted. This creates friction, so that the driver will not move voluntarily. The device can also be equipped with a stop washer, thus acting at the same time as a thrust bearing. This will enable the operator to work from the other end to a shoulder at the front of the work without any difficulty.

The use of this device, which can be mounted on either a lathe or a grinding machine, has cut the operating time about 30 per cent. There is no measuring to be done, every stop being set. The device is in daily operation and has proved very satisfactory.



FIGS. 1 TO 3. DETAILS OF SELF-ADJUSTING SPRING CENTER

Modeling Clay in the Designing Room

By M. E. Hoag

It often happens that the draftsman is called upon to make drawings of some part or tool, when he has nothing to work from but a mental picture in his own mind or in the mind of another. It is difficult to give the toolmaker an exact idea of what is wanted, even with good drawings. In cases of this kind there is nothing of greater value than a goodly chunk of modeling clay and a few tools for working it into shape. In this way one is also better able to get correct ideas of proportion than he can from drawings. Modeling clay may be obtained from any dealer in art supplies, at about 20c. a pound, and can be had in two kinds—one, which always remains plastic and can be used over and over again; and the other which becomes very hard if allowed to get dry. For general use the plastic form is to be desired, and it may be worked into form with no tools other than the fingers and a jack-knife; but the regular modeling tools will be found of great advantage. With very little practice, a tool or a part form can be worked into shape in a few minutes, saving

the draftsman and toolmaker many a headache and possible mistakes.

Another use for this material is in building up patterns and working models of parts that are to be later cast or drop-forged. This method will insure proper form and clearances and will be found much cheaper than making new patterns or models. If permanent records are wanted, plaster models may be made from the clay forms.

Graduations on the Feed Dials of Machine Tools

By Daniel W. Rogers

I have never run across the custom of stamping the graduated dials on lathes so that they will register the amount of stock removed from the work, as, for instance, graduating the crossfeed dial in thousandths, but marking each thousandth as two.

This arrangement would be all right for lathes, but for planers, millers and shapers, where the tool removed stock from one side of the work only, it would be incorrect. In any case it would not be advisable to have two different kinds of graduations on the different machines in the shop, as it would lead to confusion and the introduction of mistakes and errors in the work.

Classifying Workmen

By H. P. Murphy

While we are on the subject of classifying workmen, let us observe how some of them classify themselves: A man walks into the office and announces that he has seen an advertisement for a brass finisher and, as he has had several years' experience in that line, desires the position. The foreman who is called to interview him finds, after lengthy questioning, that the applicant has never read a blueprint in his life and has spent all his time at a bench vise filing castings. Nevertheless, the man goes away, not only feeling disappointed in not landing the job, but believing the advertisement to be misleading.

Another applicant walks in and, after persuading the foreman that he has had some actual lathe experience, is hired and reports the next day for work. At the end of two or three weeks he has not even provided himself with a pair of pliers, but backs the work off the mandrel by means of a hammer and block.

In response to an advertisement for a screw-machine hand, a young man walks in. He assures the foreman that he can read blueprints, set up his own machine, etc., and has been getting 45c. an hour. After spending 15 minutes studying the first job given him, he confesses that some help will be needed in tooling up. The foreman goes to his assistance. About an hour later he is treated to a fleeting glimpse of the man slipping on his coat and hat and beating it downstairs to the street. Going over to the machine, the foreman finds several dollars' worth of rod in good shape for the scrap heap.

The foreman of the foundry is called downstairs to interview a man who has a card from an employment exchange stating that he is a molder. Owing to the man's limited command of English, the foreman decides to take him into the foundry and let him indicate what job he can fill. Upon looking around, the man shakes his head, and there is nothing to infer but that he never saw a foundry before. The agency is not to blame. Their interpretation is probably as good as ours.

A tinsmith applies, agrees to anything the foreman asks and starts work immediately. Later in the day he comes into the office and says he likes the place and the work so much he is going out to look for a place to locate his family. He then asks for a dollar on account, as he will have to make a deposit for rent. Inquiry of the foreman elicits the information that the man has at least that much coming to him, and the advance is made. That is the last seen of him.

These are some phases of the problem that the small shop is up against. Until the man has actually been put to work and found wanting, or found capable, what other classification can the foreman make than that which the applicant gives himself?

Retruing Automobile Cylinders

By Sam Nelson

The subject of truing automobile cylinders is of interest to repairmen. There are several concerns that make a specialty of doing this class of work. Some of them are grinding, some reboring and others reaming cylinders to true them.

The automobile owners are the ones who must be pleased, for they are the ones upon whom I depend for my living. For that reason, I have made tests the results of which might be of service to others. I have tried regrinding as well as reboring and have made it a point to make a careful and unbiased analysis of the results in order to make sure that I was not fooling myself.

At first I did all my automobile-cylinder truing with a grinding attachment on an ordinary lathe. A man suggested boring cylinders instead of grinding. I agreed to allow a device for that purpose to be installed in my shop, with the understanding that I was to test out its advantages as compared with the grinder. I reluctantly bored out three or four blocks, but could not get the consent of my own mind to allow them to go out without finishing them with the grinding device. I found that, in view of the price that I was getting for some of my Ford work, this method of truing cylinders was consuming more time than I could allow. After boring four or five blocks, I found that my men were becoming more proficient in handling the boring machine and were getting remarkable results. If I had relied upon the appearance of the cylinder walls after regrinding and reboring, I should probably still believe that regrinding is superior to reboring.

I tested the matter out by taking one cylinder block and grinding it, exercising the same amount of care and attention that I did in boring another block. Then I placed the blocks in their respective automobiles and took the compression test before the machines were taken out of my shop. There was nearly two pounds higher compression in the bored job than in the ground job. At the end of three months, the compression in the bored cylinder block showed nearly three pounds better than in the ground cylinder. I used to lap the pistons in by hand; but I found, when my men became proficient with the boring device, that lapping was unnecessary.

Coöperative Remuneration

By A. R. Ireland

I have read with interest a recent article on "Profit Sharing" in your columns and would express my appreciation of the clearness with which some of the difficulties have been stated. Perhaps, however, the subject will be a bit more hopeful if we continue the discussion and clear up two or three other rather common misapprehensions.

In the first place, if we would carry out what most of us desire, I think it would be a mistake to call our plan a profit-sharing plan, unless we should have it clearly understood that the term profit sharing implied something more than a mere distribution of profits. What we are seeking is a plan by which those who participate may by their unusual skill or energy themselves increase their earnings and their compensation.

The workman's share, it has been said, can be covered by wages; and in the main this is true, but not strictly true. Wages are set in advance, and a truly correct apportionment can be made only after the accounts are closed. Hence the justice of what have been called profit-sharing plans.

Most of us may think we are doing our best, but there are very few of us who cannot do better than we are now doing. Any plan is a good plan which encourages any of us to increase our economy, our thoughtfulness, skill or energy; which helps us to avoid waste, to cheapen production or, without increased cost, to increase production. And for increased earnings or greater savings, due to increased effort or more care, increased compensation is surely appropriate.

I do not feel, as your correspondent has stated, that any such plans should be applicable to every business or to any one business under all conditions. Very much is often found to depend upon the foreman or the nationality and the disposition of the men at any given time. Any plan should be tried, continued, discontinued or modified, according to varying circumstances.

Young men in particular like some such plan. In many cases they would go a step farther. They want actually to put their money into the business. They want to manage their own money; and they believe they can make it earn more than savings-banks rates, if they can have it, even in a measure, subject to their own control and reflecting their own exertions.

This opens the door pretty wide; but as an ideal, I think, in every concern there should be some profit- and loss-sharing plan by which any who desire may put money into the business and practically be partners in the business, with the feeling that they are coöperating toward its welfare.

Another thought: We do not shout it from the housetops, but few of us are in business solely for what we can get out of it. Every man worth his salt—on the road, at his desk or in the shop—puts something more than money into the business with which he is connected. He more or less definitely and sincerely tries to maintain some standard or ideal.

It is a poor concern that does not try to do a good job and does not wish to help the world along a bit by some new invention or some improved process, and there are very few concerns that do not wish to do something a little extra for extra-good men.

A good deal has been said about good will and profit sharing; but as I see it, coöperative profit sharing is not the root, but the flower or the fruit of good will. If a plan is gone into to get or to obtain good will as a commercial asset, that plan probably will fail, as it usually fails if it is gone into selfishly by either side, solely to get or to obtain more work or more money; but where there has been really mutual good will, then as in a partnership, where people are drawn together very largely by friendship, all can work for a common success and for common ideals. Each will be willing to do an extra bit for the sake of the others and will be truly glad to see the others prosper and obtain their share. And this is the main thing, after all; it is not any particular plan, but the spirit, that giveth life to any plan.

Finally, as the preachers might say, if any shop managers try a coöperative plan, thinking thereby they will have less work for themselves, they are in a fair way to fool themselves. The men alone are not the only ones who are stimulated by a scheme for coöperative remuneration. When we feel that the men appreciate that they actually are our partners, then we will learn more than ever how to spell "hustle."

I guess the thought of this sometimes keeps some of us back from trying out plans in this direction. We know the more persons we may have joined with us to share in the profits the more eager we shall be and the harder we shall work to get profits. We know the margin is usually narrow, narrower than the men appreciate, and we will want to make it as big as possible. We shall be more gratified than ever if we do well, and more than usually mortified if we fail. Maybe some day the men, too, might feel that added opportunity is not without its burden; and they, too, might feel even happier in success and more chagrined at failure than they do today.

Increased remuneration, as a result of coöperative effort worked out on a more definite basis than is usually represented by the wage scale, is an ideal too old and too persistent to be lightly put aside. None of us may at present be able to solve the problem satisfactorily. Perhaps the time is not yet ripe for a successful solution; but if we take a chance now and then, when conditions seem to warrant, we may, even by our failures, assist our successors to the desired result.

Loose Pulleys

By R. C. Shepherd

As master mechanic for one of the largest chair manufacturers in the country, my duty is to keep the machinery in repair. At first I found that not a day passed that I did not have from one to six loose pulleys to bush. Some of the pulleys were arranged to lubricate with oil and some with cup grease.

I have adopted brass and bronze bushings altogether and have arranged the pulleys to use both oil and grease. The operator is instructed to use oil on all newly bushed pulleys. When a bushing gets worn so that the oil will not stay in the pulley, it is then just about enough larger than the shaft to let cup grease in and thoroughly lubricate the bushing, so grease is used. In this way the life of the loose pulleys is doubled, and the cost of upkeep of shafts and spindles is reduced about three-fourths.

Editorials

Inspection and Rapid Production

One of the greatest stumbling blocks in the way of rapid and economical manufacture of munitions is the problem of inspection. Anyone who questions this statement has only to consult some of those who took contracts for rifles or other complicated munitions.

The indiscriminate placing of close tolerances on parts that did not require them has been responsible for much of this difficulty, but this absurdity promises to be largely eliminated as a result of the work now being done on specifications for our own munition. Then, too, the average man assigned to inspection work has not had the experience, even if he has the authority, to discriminate between the essential and the nonessential dimensions. This matter is something that can be taught in the technical-school shop, so that engineer students can be used to advantage in work of this kind, often releasing an officer for work at which he can be of greater value to the country.

In considering the points to be particularly studied in this connection, emphasis may well be laid on the fact that the prime requisite of any piece is that it function properly and that any variation in construction which still allows the piece to perform its work safely and surely may be considered permissible. A secondary consideration and one that bears closely on the first is the kind of service to which a piece is to be subjected. If it is to be used only once, as in a shell or fuse, a very different class of work may be permitted in some parts than if the piece is to be used many times, as a rifle or cannon. The need for perfect and certain functioning is essential in either case, but the fit of a screw thread is less important when a piece is to be screwed in but once than when it is to be used many times. The fuse, for example, is screwed into a shell but once; and there is no force tending to pull it out as it is fired, but instead the inertia of the fuse tends to keep it in position even without a thread. This thread, then, need not be as perfect as the threads of a rifle sleeve and cocking piece, which move on each other every time the rifle is cocked.

It must not be forgotten, however, that much of the overzealous inspection has been brought about by the sometimes successful attempts on the part of contractors in the past to put something over on the Government, to turn out inferior work and sell it for a good price. This desire is fortunately very little in evidence at the present time, and there is a widespread movement to give the Government exactly what it wants at a fair price. This spirit can be encouraged by eliminating any unnecessary requirements; and on the other hand the surest way to have severe inspection specifications modified is to make it a practice to turn out work that meets the main requirement of functioning properly in all tests. When this is done and the inspector finds that no attempt is made to get inferior work past him, there is not likely to be any further trouble.

Responsible Heads Necessary

It is undoubtedly true, as Lord Northcliffe has recently pointed out, that democracy is a bad warmaker; and it is well that this is so. When all countries are democracies (and the number is growing these days), all will be on an equal footing, and wars will be much less likely than in the past.

But when war comes, as it has come with us, it is well to realize that centralization of power is necessary in order to get the machinery to work and to keep it working at top speed as long as the war lasts. The individual must sink himself into a unit of the common whole much more than is necessary or desirable in times of peace. Individuals of the right caliber must be given more power and be held accountable for results rather than details or methods. While this policy approaches autocracy, it has the distinct difference of having the power to recall in the hands of the people.

The men who are given power to get things done must have a free hand, just as they had in the case of the Johnstown flood and the San Francisco fire. Mistakes are bound to be made, when viewed in the light of after events; but every man who does anything worth while always makes some errors. The main thing is to get things done and keep the number of mistakes as small as possible.

One way in which we can all help is to try to do with as little friction as possible what these men want, whether it all meets with our approval or not. This is not the time for either personal preferences or personal profits, as the greater the profits the higher must be the tax rates.

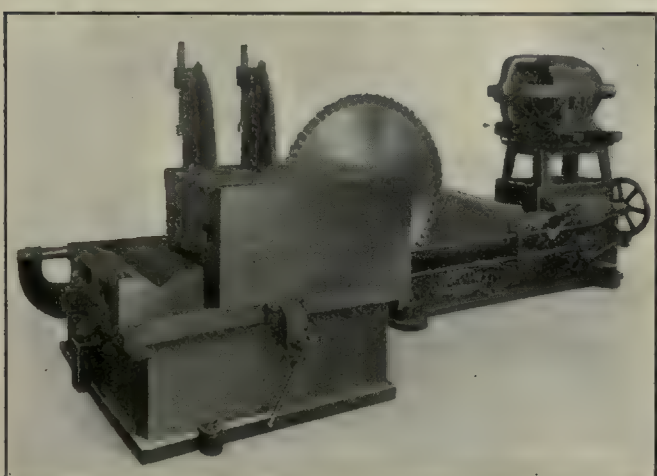
We have a shining example of this method in the construction of the Panama Canal, and the man who carried that on so successfully is now back in Government service in charge of the building of the huge fleet of cargo carriers with which to neutralize the effect of the U-boat campaign. In peace times it is doubtless better to be less efficient and preserve our individuality to the full, but this must now be sunk to the extent of working under the direction of a central board that has the advantage of being able to see the relations of one industry to another.

Now is the time for us to realize that the Government is not a thing apart from ourselves, but that we are part and parcel of it, just as we are a part of the business in which we are employed. Realizing that we are all shareholders in the greatest corporation that the world has ever seen, it is up to us to get behind the directors with a vote of confidence and endeavor to carry out their orders to the best of our ability, whether we see the reason for all of them or not. If the dividends in the shape of results are not satisfactory, we can elect a new board at the proper time. But while the present board is on the job, let us give it all the coöperation we can; let us submit to regulation as gracefully as possible, as only in that way can we judge honestly and fairly as to the board's capacity.

Shop Equipment News

Cold-Metal Saw

The cold-metal saw illustrated has been placed on the market with the intention of providing a machine that will readily handle large, heavy structural-steel sections. A 56-in. saw blade is used, but this size may be increased to 62 in. if necessary. With the smaller blade the machines will take rounds up to $16\frac{3}{4}$ in. in diameter, squares up to $15\frac{1}{2}$ in. and oblong sections up to 17 x 58 in. Provision is made for a saw traverse of 90 in. and also for using a cutter head in place of the saw, thus transforming the machine into a rotary planer for machining the ends of sections. A 25-hp. variable-speed motor is used for driving purposes.

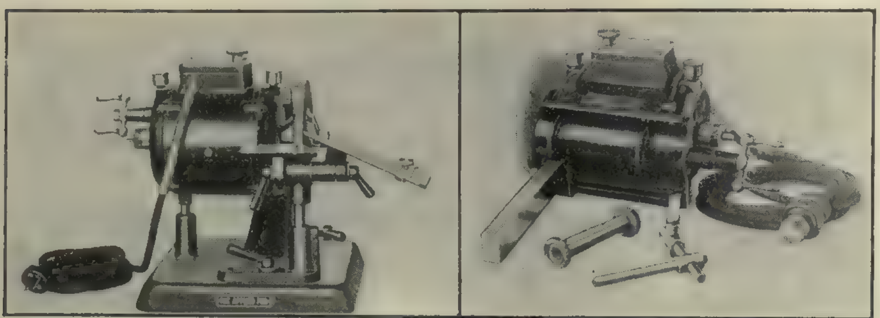


COLD-METAL SAW FOR STRUCTURAL-STEEL SECTIONS

The design includes herringbone gear drive for the spindle, spindle gear and pinion inclosed for continual lubrication, bushed bearings, triple-shear narrow-guide alignment control for the saddle, reversible fast power traverse, gear feed, and sectional table top to permit the work being so located as to require a minimum saw travel to complete the cut. Control levers are so made that conflicting motions cannot be engaged at the same time. The machine is the product of the Newton Machine Tool Works, Inc., Philadelphia, Pennsylvania.

Drill, Tool and Toolpost Grinder

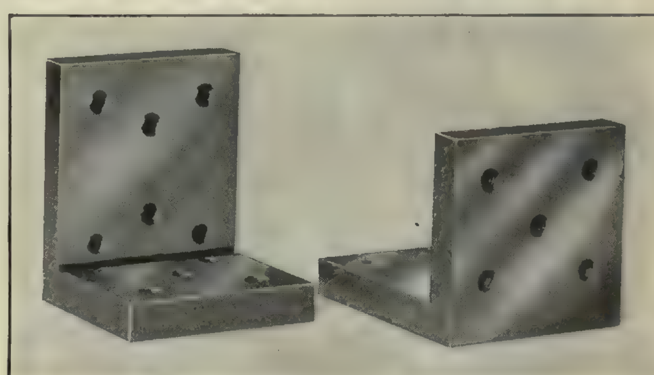
The universal drill, tool and toolpost grinder illustrated is being manufactured by the Universal Electric Co., Inc., 5 Oliver St., Newark, N. J. As illustrated, the machine consists of $\frac{1}{4}$-hp. electric motor, Fig. 2, arranged to be used as an ordinary toolpost grinder for a lathe. A spindle provided for internal-grinding operations may be seen just in front of the motor. When not in use as a toolpost grinder, the machine may be slipped into the stand, as shown in Fig. 1, being held in place by two thumb-screws. The stand is equipped with both a table rest for grinding tools and a V-rest for sharpening drills. The motor is supplied for either direct or alternating current and has a speed of 3550 to 3575 r.p.m. A fan is used to provide a draft for cooling, and the brushes are interchangeable and removable. The cooling is claimed to be such that the motor will not overheat on long runs under heavy loads.



FIGS. 1 AND 2. UNIVERSAL GRINDER
Fig. 1—Used as a tool grinder. Fig. 2—Used as a toolpost grinder

Angle Plates

The Simplex Tool Co., Woonsocket, R. I., has placed on the market an angle plate, shown in the illustration, which has been made to meet the demand of toolmakers. It can be used on a bench-lathe faceplate, grinder, on the bench or in other ways. Both the inside and the outside faces of the plate are ground. Tapped holes are provided in the long side and plain holes in the short side, for securing the work. The plates are made of hardened steel and are ground all over.



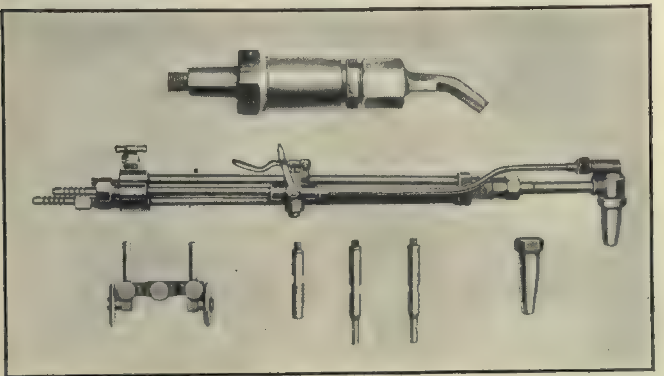
SIMPLEX ANGLE PLATES

Toolpost Collar and Shoe

The address of the Du Bois Machine Shop, Inc., was inadvertently left out of the article on page 920, describing the new toolpost collar and shoe. The address is 118 Hudson Ave., Albany, N. Y.

Cutting Torch for Rivets and Stay-Bolts

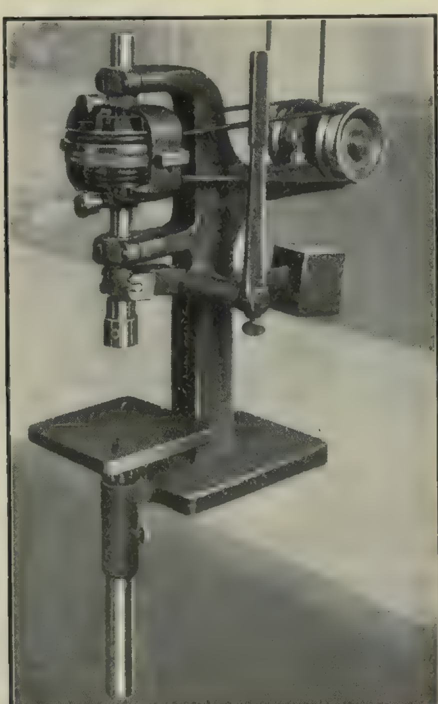
In cutting off rivet heads and stay-bolts with oxyacetylene apparatus it is often convenient to have a cutting tip so made as to permit the flame being parallel to the surface of the work. To meet this need, the Prest-O-Lite Co., Inc., Indianapolis, Ind., is now marketing a special attachment. It is used in connection with the company's type K cutting blowpipe, being screwed into the head in place of the regular nozzles. The tip is adjustable and may be worked in close quarters. Much closer cutting is possible than with the standard line of tips.



TORCH FOR CUTTING WORK ON RIVETS AND STAY-BOLTS

Drilling and Tapping Machine

The Fulton Foundry and Machine Co., 25 Furman St., Brooklyn, N. Y., has added a new type of tapping and drilling machine to its existing line. The new machine is of the vertical type with an adjustable work table and a movable head, the tap or drill being fed either by foot or by hand. A weight serves to counterbalance the head. Ball bearings taking both the thrust and the radial loads are used on the friction pulleys, which have flat friction surfaces. There are no gears, positive clutches or tension adjusting devices.

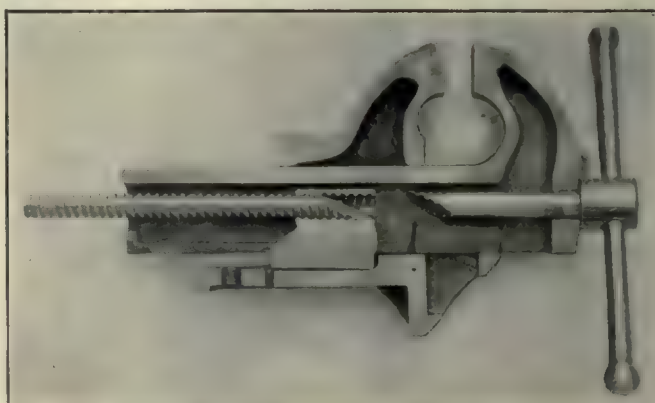


BENCH-TYPE DRILLING AND TAPPING MACHINE

The machine will handle taps or drills up to $\frac{3}{8}$ in., it being possible to change from one operation to the other in a few moments. Two speeds are provided for both tapping and drilling, the maximum drilling speed being 2000 r.p.m., while the maximum for tapping is 1000 r.p.m. Drilling and tapping operations to a fixed depth are secured by means of a stop. A self-oiling countershaft with belt shifter is provided with the bench-type machine, while on the pedestal type the belt shifter is carried on the jackshaft on the base.

Malleable-Iron Vise

The illustration gives a sectional view of a new malleable-iron vise that has recently been placed on the market by the Columbian Hardware Co., Cleveland, Ohio. The vise has been sawed in two in order to show the construction. It will be noticed that the jaws are hollow, thus lightening the vise considerably.



MALLEABLE-IRON VISE

The jaws are faced with tool-steel plates fastened in place by means of screws. The screw is machined from a drop-forging. It is claimed that this type of vise is much stronger than those made of cast iron or semi-steel and that it is impossible to break it by pounding.

Pipe Wrench

The chain pipe wrench illustrated is one that has recently made its appearance on the market. The important advantage claimed for this tool is its double action, or reversibility, which provides for turning pipe in either direction without the necessity of removing and turning the wrench. This feature is due to the angular

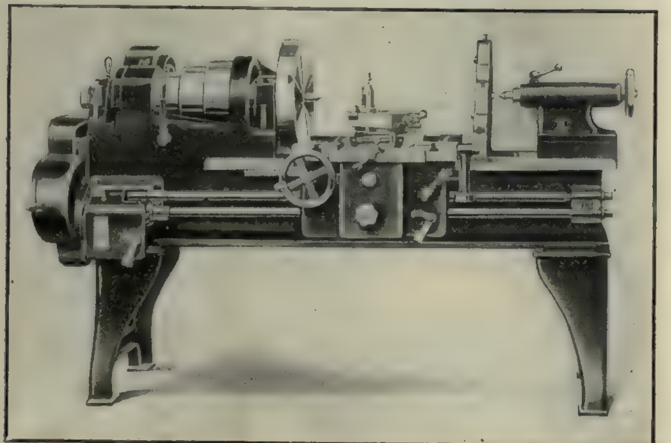
FIGS. 1 AND 2. ACTION OF ANGULAR JAWS OF PIPE WRENCH

position of the elliptical-shaped jaws, permitting the engagement of either the inner or the outer teeth.

The jaws are bolted to the body of the wrench; and as they are serrated all around, they may be turned end for end when the first set of teeth becomes worn. By removing the jaws a narrow jaw on the under part of the handle is brought into use, thus converting the tool into a narrow wrench for narrow or irregular work, pipe fittings, bolts, nuts, etc. The handle is a drop-forging, and the jaws are of hardened steel, all parts being interchangeable. Either flat-link or cable chain is supplied, as desired. The Billings & Spencer Co., Hartford, Conn., is the manufacturer.

Eighteen-Inch Lathe

The illustration shows an 18-in. lathe recently brought out by the Giddings & Lewis Manufacturing Co., Fond Du Lac, Wis. The bed has a large V in front and a flat surface at the rear for the carriage and a second smaller V for lining up the headstock and tailstock. The pads for the gear box and lead-screw bracket are shouldered



EIGHTEEN-INCH LATHE

Swing over bed, $18\frac{3}{8}$ in.; swing over rest, 11 in.; distance between centers with 6-ft. bed, 28 in.; front spindle bearing, $3\frac{1}{16}$ x $5\frac{3}{4}$ in.; rear spindle bearing, $2\frac{5}{16}$ x $3\frac{3}{4}$ in.; hole through spindle, $1\frac{1}{2}$ in.; diameter of spindle nose, $2\frac{11}{16}$ in.; width of belt, $3\frac{1}{2}$ in.; diameter of tail spindle, $2\frac{1}{16}$ in.; length of carriage bearing on shears, 27 in.; size of tools, $\frac{5}{8}$ x $1\frac{1}{4}$ in.; diameter of work handled by steadyrest, up to 5 in.; weight with 6-ft. bed, 2350 pounds

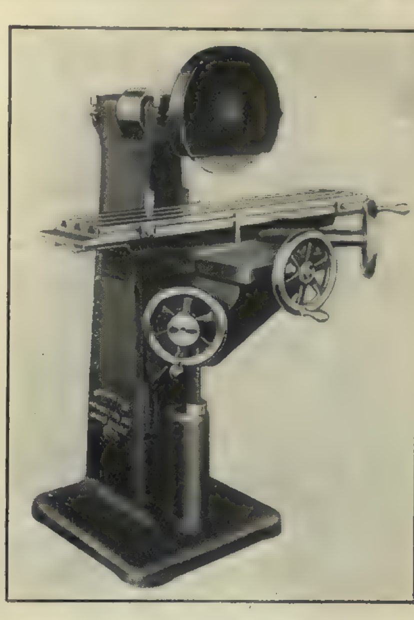
to insure a correct line-up. The headstock is double back geared, giving gear ratios of 9 and 3 to 1.

A crucible-steel forging is used for the spindle, which is ground to size and runs in self-oiling phosphor-bronze bearings. A curved front on the tailstock allows the compound rest to be used at right angles to the cross-slide. The carriage is planed flat on top and has T-slots for attaching work for boring. Power longitudinal and cross feeds are provided, and the feed screws are equipped with micrometer dials. A chasing dial indicates the rotation of the lead screw and allows the half-nut to be engaged at the proper moment.

The lead screw is of carbon steel with a four-pitch Acme thread. Eight changes of feed are given by the standard gear box, while the quick-change box, which is interchangeable with the standard box, gives 40 changes. Metric pitches are obtained by means of a pair of gears running as idlers on the quadrant stand. Equipment includes double friction countershaft, change gears, large and small faceplates, blank chuck mount and steady and follow rests.

Surface Grinder

The surface grinder illustrated is one that has just made its appearance on the market, being the product of the Manhattan Machine and Tool Works, Grand Rapids, Mich. The spindle runs in split brass boxes, oiled from a reservoir, and carries a wheel up to 12 x 1 in. in



SURFACE GRINDER

Diameter of spindle bearings, $1\frac{1}{2}$ in.; wheel carried, up to 12 x 1 in. with $1\frac{3}{8}$-in. arbor; spindle pulley, 5 x $3\frac{1}{2}$ in.; length of bed over all, 48 in.; working face of table, 36 x $7\frac{1}{2}$ in.; maximum distance, wheel to bed, $13\frac{1}{2}$ in.; weight, 860 pounds

size. The working face of the bed is 36 in. long and is provided with $\frac{5}{8}$-in. T-slots for clamping work or fixtures.

It is possible to surface the entire bed of the machine with its own wheel, which has an 8-in. overhang from the column. All bearings are covered to afford protection from dust. The knee is raised or lowered by means of a screw. Handwheels are provided with micrometer dials, and the one for the vertical table movement is equipped with a locking arrangement. The bed is operated by a spiral rack and pinion and has two adjustable stops.

Decalescence-Point Finder for Hardening Steel

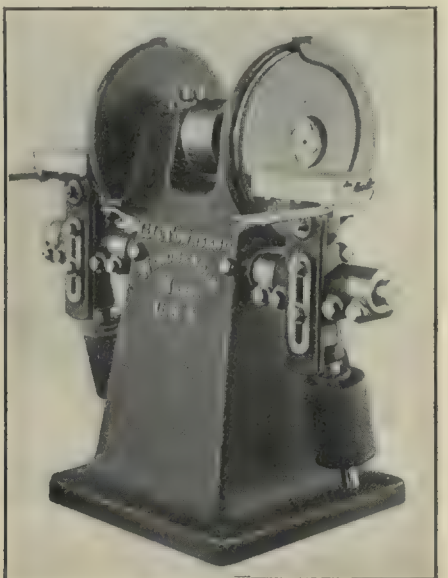
The Slocum, Avram & Slocum Laboratories, Inc., 532 West 21st St., New York City, are now manufacturing a decalescence-point finder for use in hardening steels. The instrument consists of a magnet of compact form, balanced in a brass arm to allow the attraction due to the magnetic force to be shown, up to the time the decalescence point is reached. When this happens, the steel being heated loses its power of magnetic attraction, but regains it again when a temperature of from 75 to 100 deg. F. above this point is reached. The steel being hardened should be quenched at the point where it becomes nonmagnetic.

The instrument is provided with interchangeable extensions for the arm, adapting it for use with the various types of furnaces. It is expected to be particularly valuable in shops where the amount of work is not sufficient to warrant the installation of a set of pyrometers.

Heavy-Duty Disk Grinder

The illustration shows one of a new line of heavy-duty disk grinders recently placed on the market by Guy G. Townsend, Winchendon, Mass., to take the place of the lighter line of grinders formerly manufactured by him.

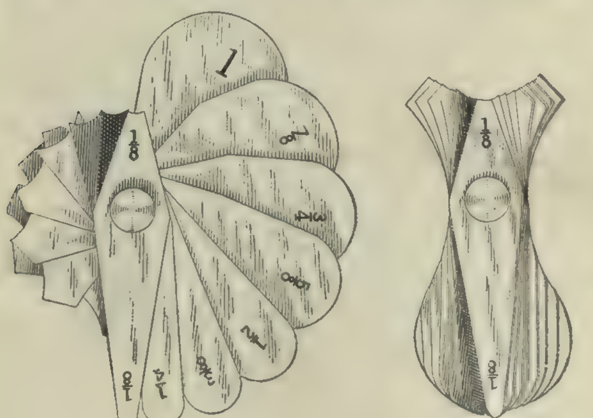
The tables are constructed with adjustable gibs, and the head swing-shaft bearings are adjustable. The abrasive wheels are mounted in steel disks. The hoods serve both for safety and for the purpose of carrying away the grinding dust, which passes through the cabinet-type base to an exhaust fan mounted on the back. The exhaust fan is fitted with removable bearings. The main grinding spindle is made from a forging and runs in bearings adjustable for both lateral and longitudinal wear.



HEAVY-DUTY 18-IN. DISK GRINDER

Radius Gages

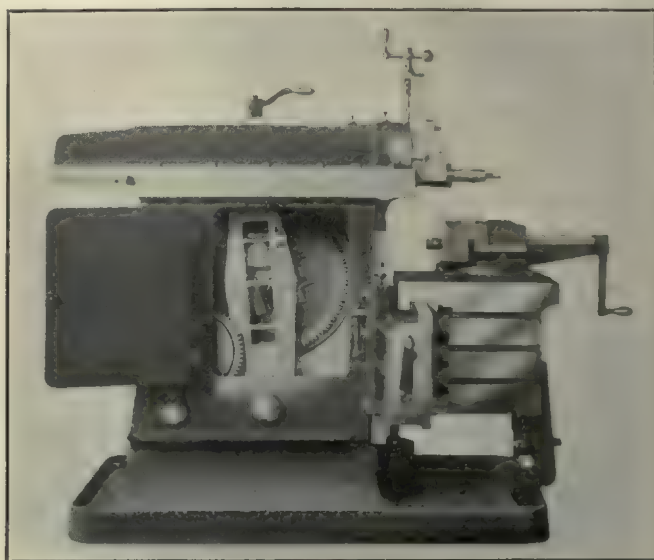
The radius gages illustrated have been recently placed on the market by the Moss-Ochs Co., 3387 East 116th St., Cleveland, Ohio. They are made up in sets for determining concave and convex surfaces with radii from $\frac{1}{8}$ to 1 in. in steps of $\frac{1}{8}$ in. The gage has eight blades hinged at the middle, each blade having a convex gage on one end and a concave gage, of the same radius, upon the other.



RADIUS GAGES FOR CONCAVE AND CONVEX PARTS

Twenty-Inch Shaper

The Leisy-Patton Co., Cleveland, Ohio, is now marketing the 20-in. shaper illustrated. Ribs are cast on the inside of the base and body of the machine in order to insure rigidity. The table support is quickly adjustable to any table elevation, and taper gibs are provided for adjustment of all sliding parts. The bull gear is of semi-steel and meshes with a bronze pinion.



TWENTY-INCH SHAPER

Specifications: Maximum stroke, $20\frac{1}{2}$ in.; horizontal table travel, $26\frac{3}{4}$ in.; minimum distance of table to bottom of ram, $14\frac{1}{2}$ in.; size of vise jaws, $12 \times 2\frac{1}{2}$ in.; opening between jaws, 10 in.; width of ram, 10 in.; length of ram, $38\frac{1}{2}$ in.; ram bearing in column, $31\frac{1}{4}$ in.; minimum speed, 8 r.p.m.; maximum speed, 98 r.p.m.; maximum feed, $\frac{3}{16}$ in.; size of table, $18\frac{5}{8} \times 14$ in.; length of rocker-arm, $30\frac{1}{4}$ in.; width of belt, 4 in.; number of feed changes, 8; keyseating capacity, 3 in.; countershaft, tight and loose pulleys, 13 and 14×4 in.; cone (3 in.), four steps $7\frac{3}{4}$ to 13 in.; countershaft speed, 215 revolutions per minute

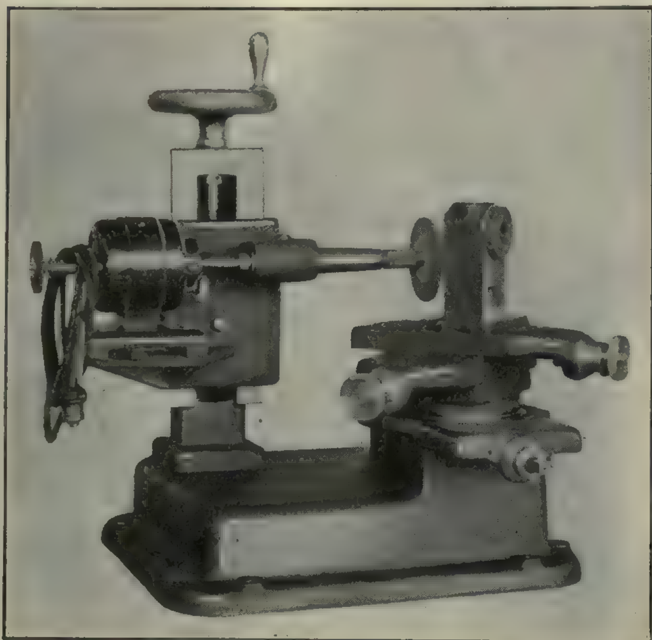
Profile Grinder for Work on Milling Cutters

In response to the demand for a machine to grind the profile of milling cutters, the Cleveland Milling Machine Co. has placed on the market the profile grinder illustrated. The spindle is direct connected to the motor shaft, has adjustable bronze bearings and carries a wheel up to 4 in. in diameter with a $\frac{1}{4}$-in. face and a 3-in. hole.

The bracket carrying the motor and wheel spindle is mounted on a vertical housing and is adjusted by a screw equipped with a micrometer dial. The work-holding arbors are held in a sleeve that revolves freely in the work-holding posts. Four posts are furnished, with No. 9 and No. 7 Brown & Sharpe tapers, a $\frac{1}{2}$-in. straight hole, and a flat block for holding flat tools. These posts are fastened to three T-slots in the upper compound slide. The two upper slides are used to bring the work to the proper sweep across the face of the wheel and are in turn mounted on a swivel block that is pivoted on the bottom slide. The maximum radius that can be ground is 3

in. on either concave or convex cutters up to 12 in. in diameter.

A gage is furnished to set the work in the proper relation to the wheel; and after the slide is once set for a given radius, the machine will grind that radius regardless of the adjustment of the two other slides. All



PROFILE GRINDER

screws are provided with micrometer dials. The machine may be used to grind concave and convex cutters, cutters for drill fluting for rounding the corners on side and face mills, for formed tools for screw machines, for corner-rounding tools, for use on the lathe planer, shaper, etc., or for any irregular work having true curves. The floor space of the machine is 24 x 30 in., and the weight is 217 pounds.

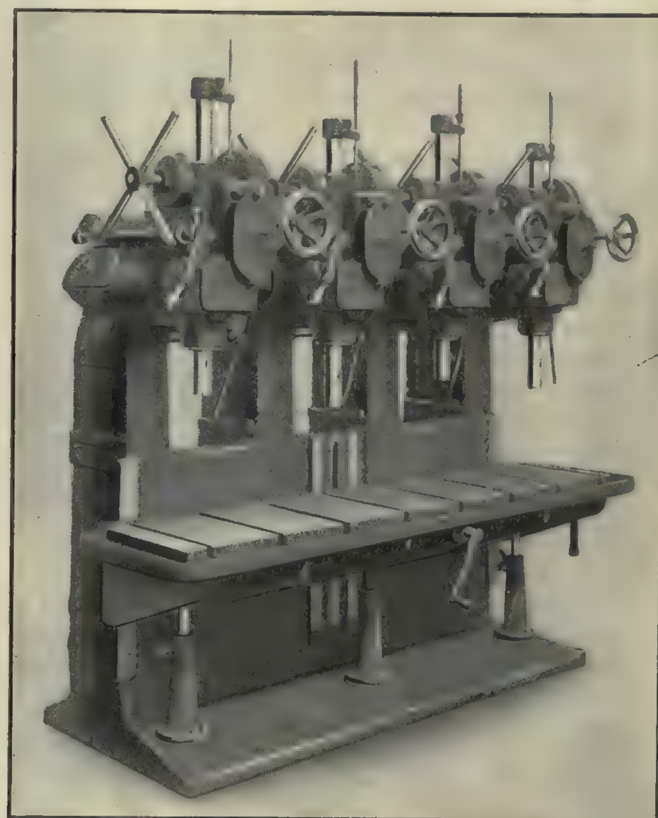
Drilling Machine

To meet the demand for a heavy-duty drilling machine, the Colburn Machine Tool Co., Franklin, Penn., has placed a drill of this type on the market, the illustration showing the four-spindle gang type. A unit construction is used, and the machines may be had with one, two, three or four spindles. The drive is through a constant-speed belt to the main driving shaft.

Two mechanical speed changes are provided, which in conjunction with an arrangement for changing gears make it possible to obtain 40 different speeds ranging from 74 to 508 r.p.m. The mechanical changes are made by means of sliding gears located inside the column in an oil-type speed box, all gears running in a bath of oil. There are 36 feed changes ranging from 0.005 to 0.153 in. per spindle revolution. These changes are effected by means of a worm-feed handwheel. An automatic tripping mechanism is furnished to disengage the feed at any desired point.

The spindle is double splined and is driven by means of bevel gears, the spindle gear being mounted on a sleeve revolving in the lower bearing of the head. The advantage claimed for this type of drive is that the spindle is driven at its lower, or larger, end. The sleeve is made of steel with bronze bushings, the thrust being taken by self-aligning ball bearings. The mechanical gear change consists of a set of two removable gears, which may be either transposed or replaced by gears having a different ratio to each other. For ordinary operations two changes are provided for, but more can be supplied if so desired. A similar arrangement is used on the feed gears. All gears run in a bath of oil in an oil-tight case.

A geared tapping attachment, furnished if desired, is mounted on the driving shaft and driven by a single pulley that replaces the regular tight and loose pulleys. A positive feed for the spindle corresponding to the thread to be tapped can also be supplied. Gears for this



HEAVY-DUTY DRILLING MACHINE

Capacity, up to 1¼ in.; distance from spindle to face of column, 10 in.; maximum distance spindle to table, 28 in.; length of power feed, 12 in.; diameter of driving end of spindle, 2⅜ in.; diameter spindle sleeve, 2½ in.; taper in spindle nose, Morse No. 4; working surface of table, 16 x 16 in.; vertical adjustment of table, 13 in.; height with spindle down, 73½ inches

purpose take the place of the standard feed gears and are furnished for 8, 9, 10, 11, 11½, 12, 13, 14, 15 and 16 threads per inch. The table is of the bracket type and has an oil groove around the edge. The vertical adjustment is by means of a crank-operated screw that is set off center to permit a hole being bored in the table to accommodate boring bars.

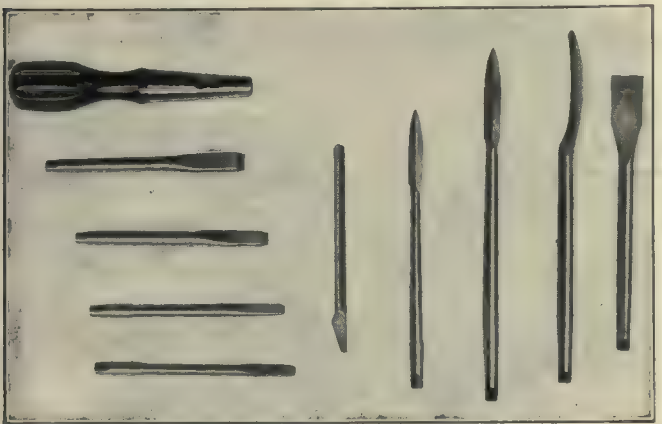
Constant-speed motor drive can be furnished, the motor being mounted on the lower part of the column on the rear.

Standard Surface Plates

The T. P. Walls Tool and Supply Co., 75 Walker St., New York City, is now marketing a line of standard surface plates in sizes from 4 x 4 to 24 x 48 in. These plates are made of hard cast iron with the standard ribbed construction and are hand scraped to a surface.

Combination Screwdriver and Scraper Set

The Hultberg-Johanson Tool Co., Inc., 212 Prendergast Ave., Jamestown, N. Y., has placed on the market a combination screwdriver and scraper set. The set



COMBINATION SCREWDRIVER AND SCRAPER SET

consists of a handle, a drift and a number of interchangeable screwdriver and scraper blades.

Kiln-dried maple is used for the handle, which has deep flutes to insure a firm grip. The taper socket for holding the tools in the handle is of casehardened cold-rolled steel. The handle and drift for removing the blades may be purchased with any combination of blades desired.

Back-Geared Shaper

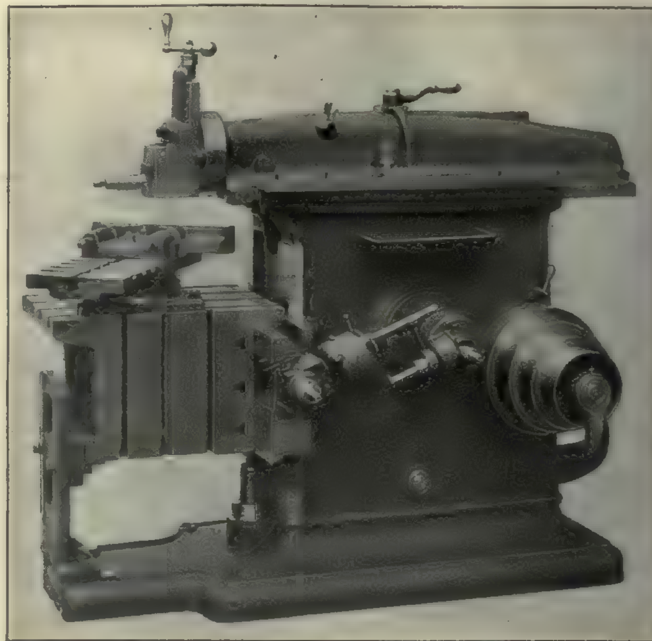
The accompanying illustration shows one of a line of 16-, 20-, 24- and 28-in. back-geared crank shapers manufactured by the Queen City Machine Tool Co., Cincinnati, Ohio. On this new line of machines helical gearing is used throughout. The helix angle is 14 deg. 55 min., at least three teeth being in mesh at all times. The advantages claimed for this construction are smoother finish on the work, increased strength and wearing qualities and the reduction of vibration. All journals are hardened and ground to size and are oiled by means of oil reservoirs and ring oilers, the reservoirs being so arranged that they may be cleaned. Sight-feed oilers are used on the ramways, which are so made as to be adjustable for wear. All feed screws have micrometer dials, and the length of stroke may be adjusted while the machine is in motion. Back-gear changes are made by means of a lever located on the side of the column.

The body of the crankpin is of crucible steel; vise jaws are steel faced; tool-backing plate, feed pawl, ratchet and other small parts are heat-treated; and all castings are of steel or semi-steel. The crank-block bearing in the rocker-arm is so made that adjustment may be made for wear.

There are eight cutting speeds arranged in geometrical progression as follows: 6.4, 9.3, 13.5, 20, 30, 44, 63 and 92 strokes per minute at 290 r.p.m. Higher speeds may be used if necessary.

The table support moves up and down automatically with the rail and is self-aligning with the table. It is gibbed to the table in order to eliminate spring due to the thrust and lift of the tool. The elevating screw works in a telescoping sleeve. The cone-pulley shaft has three bearings.

Any of the shapers may be had with either a variable-speed motor or a constant-speed motor and gear box. They may also be had equipped with gear box for driving from the lineshaft by a single pulley instead of by the customary cone pulley. The makers can also furnish power down-feed, revolving table, tilting top or side table, concaving-convexing attachments, special keyseating device for gears, and will design attachments for any special work.



BACK-GEARED 24-IN. CRANK SHAPER

Automatic cross-travel, 27 in.; vertical adjustment of table, 15 in.; minimum distance ram to table, 2 in.; maximum, 17 in.; head feed, 8 in.; size of tool, 1¾ x ¾ in.; table and saddle, length 24½ in., width 17½ in., height 15 in.; keyseating, up to 3½ in.; vise jaws, 15½ x 2¾ in.; vise jaws for moldmakers, 15½ x 4½ in.; vise opens, 14 in.; speeds, 8 in geometrical progression from 6.4 to 92 strokes per minute; cone ratio, 3.1 to 1; single-gear ratio, 5½ to 1; back-gear ratio, 26 to 1; cone-shaft speed for general work, 290 revolutions per minute.

What To Use in Place of Tin Cans?

Certain types of containers as substitutes for tin cans are now being tested to determine to what extent the claims of their manufacturers as to their general qualities can be substantiated. Manufacturers of substitute containers who wish their products tested should send samples to the Bureau of Standards, Department of Commerce, with full information regarding commodities for which the containers are specially designed, prices, and ability to contract for early deliveries. Names and addresses of firms prepared to supply fiber and other containers may be obtained from the Bureau of Foreign and Domestic Commerce or its district or coöperative offices. Coöperation is required between the Government departments, the manufacturers of tin plate and of substitute containers, the packers of foodstuffs and of other articles commonly put up in tin, and the general public, if the available supply of tin plate is to be limited to strictly necessary uses and if, at the same time, the largest possible quantity of food is to be preserved against the special needs of the coming months.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., June 9, 1917—While there is nothing more futile than crying over spilled milk, it is difficult to refrain from wishing most heartily that we had given far more encouragement to the building of airplanes, so that we might now be able to turn out standardized machines at a rapid rate. We could probably do our allies no greater service than to supply them with airplanes manufactured in the same systematic manner that has made our reputation for automobiles of all grades and prices.

Few seem to realize the great difference between the requirements of airplane and other engines. Not only must airplane engines be as light as possible per horsepower, but they must be capable of developing their maximum power continuously over long periods as well as operating at greatly varying altitudes, which affect their performance to a marked degree. In order to secure high power at minimum weight, a high compression is used; but when this is calculated only from the motor on the ground, it is apt to be misleading, as the conditions at high altitudes affect the motor very seriously. In fact, it is sometimes stated that a motor at 15,000 ft. altitude develops about half the horsepower it will deliver on the ground. Fortunately, the air resistance is also less than at lower altitudes, so that the total loss is considerably less than this.

Experiments are now under way with a motor that overcomes a goodly proportion of this difficulty by ingeniously maintaining a fairly approximate uniform compression at the different altitudes. This provision, if successful, should add greatly to the efficiency of the airplane motor and be of tremendous service in this important field of work.

How the "Eyes" of the Army Work

We read of the airplane being the eyes of the army, but few of us realize what this really means. The old methods of observation from some high point or even from a captive balloon are next to impossible in this greatest of all wars, as the balloon stands very little chance against the swift airplane, either in direct attack or in giving the range to the gunners by wireless. Consequently it is extremely interesting to know how these modern eyes do their work.

Everything is timed, and timed accurately, from a predetermined hour, which is known as the "zero of the day." This zero may be at any hour or fraction of an hour set by the commander. This plan renders it extremely difficult for any spy to get information to the enemy, even if he knows the orders; for unless he also knows the zero from which the operations are all timed, the information would be of little value.

When a battery commander desires accurate information as to any object he wishes to shell, he communicates with his air base. Then a spotting plane, carrying an observer, goes up at the proper time to a height of 15,000 ft., this being the usual observation height at present. The climb may take 30 min., for these spotting planes are not of the fastest and are not fighting machines in many cases. Having reached the 15,000-ft. level, the pilot guides his machine in long ovals, or elongated letter O's, over the place the gunners want to reach. He arranges his ovals so that the long side of the letter O is in the direction of the wind. This procedure enables the observer to make his observation while the plane is at its slow speed in going against the wind and to utilize the other part of the oval for sending his wireless messages to the gun commander. In this way the gunner is kept constantly informed as to each shot, if it be long-range work, and the spotting plane often stays in the air for two or three hours while a certain position is being demolished, to be called down at the discretion of the commander, if it is not forced down.

Using Cameras To Locate Hidden Batteries

But this work of observation is not as easy as the description may sound. With carefully concealed batteries, it is very difficult to locate them accurately from such a height, which is nearly three miles. The observer is furnished with maps of the country, which are made in most cases from previous photographs taken by other observers. With these as a guide, the observer takes many photographs with a special camera, either through the bottom of the plane or over the side. These cameras have lenses of three different focal lengths, 20, 50 and 120 cm., to be used in accordance with the work in hand. The shorter-focus camera naturally takes a very wide angle with a correspondingly small object and may not discover the thing desired, which is the hidden battery that is keeping quiet to avoid revealing its position. Then the second lens is tried, giving a field of about 800 sq.ft. at the height of 15,000 ft. It is the lens most used for this plotting work. By taking photographs that lap over each other, a very complete topography may be worked out. If the hidden battery is not shown, the longest lens is used, which greatly enlarges the size of the object and usually allows the enemy's guns to be picked out.

Should this fail, however, as happened at Ypres, where a battery of big guns were screened with wonderful

care and could not be discovered even with the long-focus lens, the most dangerous work of the aviator becomes necessary. This task consists in flying low enough to allow the observer to pick out the battery with powerful field glasses. When we realize that anti-aircraft guns sometimes bother a man at 12,000 ft. and even higher, the hazard entailed in flying as low as 2000 ft., or even lower at times, can be understood. Yet this feat sometimes becomes necessary, even at the loss of one or more machines; for if the guns are not discovered and silenced, it may entail the loss of hundreds of troops and may mean the failure to capture a certain position.

So carefully is this work of plotting done and so many are the photographs taken in important sections of the front that the observer becomes so familiar with the country and its inhabitants that he can pick out certain dots that he knows are men; and he can tell what the person is doing and where he is going, assuming of course that he is pursuing his regular tasks.

Just as the presence of our "spotter" over the enemy is of great value to our side, so is it correspondingly injurious to the other; and the fast fighting planes of the enemy try to drive him down in order that the artillery may not have this deadly and accurate eye over their positions. To protect the aviator at his post, the fast fighting machines of his own army often fly high above the spotting plane, so as to be able to swoop down on an enemy before he can disturb the spotter. It is these encounters, protecting one's own spotters and driving down the spotters of the enemy, which give the real air battles and which outrival the wildest fancies of the great dreamer of years ago, Jules Verne. Some of these battles are almost unbelievable and will form some of the most thrilling anecdotes of the war.

But the maintaining of these spotters and fighters is a tremendous problem, as the life of the airplane in active service is very short, owing to the many hazards to which it is subjected. Consequently, it requires a huge manufacturing organization to maintain this all-important branch of the service. At the present time, France alone has between two and three thousand fighting planes, the same number of planes in reserve, another similar force in the secondary or spotting service and approximately as many in the schools where pilots are constantly being trained. England presumably has about the same equipment. These numbers are being increased as rapidly as possible, and it is confidently expected that there will be twice as many machines in each division by January first. The French count 25 machines to a squadron. This provides something over 400 squadrons in all. These figures give some idea of the immense task of keeping up the air supremacy that our allies have secured.

Training Pilots in the United States

For the present, our part in the aviation work will be the training of pilots and observers, and several hundred planes have already been ordered for this purpose. Each plane will have an extra engine and also have three propellers, so as to make it possible to keep the machines in practically constant use and train men in the shortest possible time, or at least with as little delay as possible. We are particularly fitted for this work, because we have such a variety of climate that we can utilize almost every minute of the year, whereas in England, for example, the climate and weather conditions make a large amount of waste time inevitable. But in our South and Southwest, flying weather is almost continuous; and we may expect to see huge flying schools established in the very near future, where not only our own men, but men from England, France and perhaps Italy will be taught the preliminary points of the birdman's profession. The secondary and final touches of the art must be obtained immediately behind the battle lines, where actual military conditions prevail and where observation of those seriously engaged in the work of spotting, or warding off attack and of driving off enemy observers, gives practical demonstrations of how the work is done.

How Airplanes Are Being Standardized

It may be of general interest to know how the ordering of airplanes is now being carried on, although with the greatly increased demand this method may be modified at any time to facilitate the work in hand. A joint board, containing representatives of both the army and the navy, sits and designs, or approves designs and specifications of the various types of land and sea planes required, in accordance with the result of experience in the field and at the naval stations. Requisitions are then made for the planes that have been approved; the probable cost is given and the delivery desired. These data go to the supply officer of the Signal Corps. He consults with the new Aircraft Production Board as to where he can get the best machines and the quickest delivery, this information being obtainable from the board's files. Orders are then placed, and the responsibility for quality of work and the deliveries passes to the Aircraft Engineering Division of the Signal Corps, whose inspectors keep everlastingly on the job until the work is delivered.

It is needless to say that the manufacture of good airplane motors is one of the important problems at the present time and that any shop with the necessary equipment and experience for work of this kind should get in touch with the Aircraft Production Board, Munsey Building, Washington, D. C., if it has not already done so. On this board are Howard E. Coffin, chairman; S. D. Waldon; E. A. Deeds; R. L. Montgomery; General Squier; Admiral Taylor and A. G. Cable.

Standardization has proceeded to the point where some of the engines are practically interchangeable on the bedplate of the airplane so that one engine can be substituted for the other to some extent, when the weight of motors and the power required are considered. This provision is of great importance, both in the school and in the field, for the mortality of airplanes is very high, much higher than that of the aviators themselves, according to statistics from the battle front in France. These figures go to show that aviators are *fourth* in the percentages of fatalities, doctors and the medical corps generally coming first, infantry second and artillery third. This record is encouraging, particularly when we consider that the requirements which students of aviation must pass are more strict than those in any other branch of the service. We must train thousands of aviators, and it is fair to assume that the supplying of airplanes and the establishment of training camps will be one of the busiest industries.—Fred H. Colvin.

Machining a Circular Dovetail on a Drilling Machine

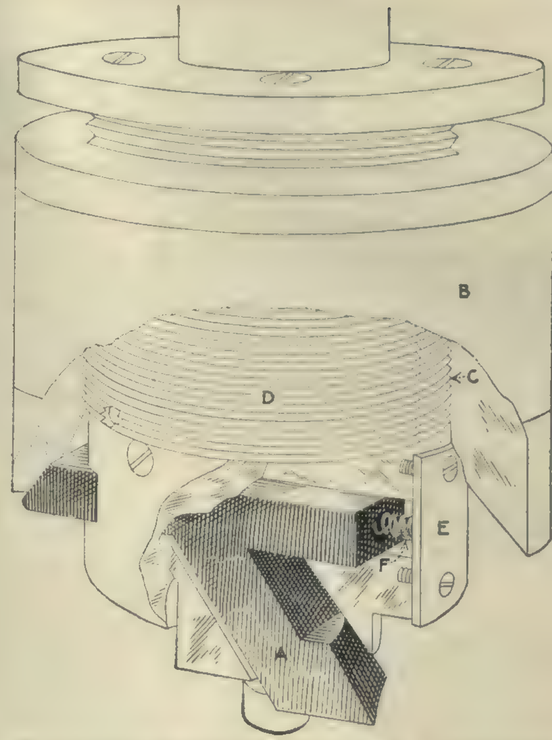
BY WALTER GABRIEL

To machine two circular dovetails in a quantity of brass pump bodies that required other drilling-machine operations, such as drilling, tapping and counterboring, a special tool was made, which is shown in the illustration.

The cutting tool *A* is fed into the work by the wedging action of the tapered face on the inside of the threaded and knurled bushing *B*. The lower half of the tool body is made in two parts *C* and *D*, each part being milled out to receive the cutting tool *A*.

The threads on the parts *B* and *C* are left-handed and the motion of the machine spindle is right-handed. Consequently, when the turning motion of the knurled bushing is stopped by the operator's hand, this bushing moves downward and in turn imparts its motion to the cutting tool, until its end comes to a dead stop against the plate *E*. By reversing the power and again arresting the turning motion of the bushing, the tool, owing to the pressure of the spring *F*, is withdrawn from the work.

These dovetails were made to receive a rubber washer of the same shape, so as to form a tight joint with another part against liquid pressure.



TOOL FOR MACHINING CIRCULAR DOVETAILS

New Publications

Typographical Printing Surfaces—By Legros and Grant. Seven hundred and thirty-two 6 x 9½-in. pages; illustrated; cloth bound. Published by Longmans, Green & Co., Fourth Ave. at 30th St., New York City. Price, $12.50 net.

This book is intended for those who have to do with printing in any form. The author treats of the creating of printing surfaces rather than of the impression produced, and he covers in concise form every subject of typography, engraving, electrotyping, die cutting, type design, casting and composing machines, typefounding, type and its legibility, keyboard and type-case arrangement, tables of proportion, weights, proportions, etc.

In this book there is nothing left unsaid that would enlighten the layman or practical man in the fundamentals of the many subjects of the allied trades.

Personals

H. Thomée, of the firm of A. Bonthron, Stockholm, Sweden, is in the United States on business.

J. B. Ennis has been appointed vice president of the American Locomotive Co., in charge of engineering.

W. F. Herst, formerly with the Brown-Lipe Co., Syracuse, N. Y., has taken a position as manager of the M. & S. Corporation, Detroit.

R. F. Anderson, formerly with the Packard Motor Car Co., Detroit, has resigned to become body engineer of the Grand Rapids-Hayes-Iona Plant.

Henry F. Russell, formerly with the Lumen Bearing Co., has been appointed sales manager of the gray-iron foundry department of Farrar & Trefts, Inc., Buffalo, New York.

W. F. Sheehan has been made general manager of the Globe Motor Truck Co., St. Louis. **C. T. Schaefer**, formerly with the Mogul Truck Co., has been made head of the engineering department.

F. C. Shenehon, formerly dean of the College of Engineering of the University of Minnesota, Minneapolis, Minn., has opened offices in the new Metropolitan Bank Building and will give his entire attention to his practice as a consulting hydraulic engineer.

C. S. Butler, formerly with the Hess-Bright Manufacturing Co., has taken a position as sales manager with the Carison-Wenstrom Co., Philadelphia, Penn. This firm is to introduce a new line of double-row ball bearings and also a line of thrust bearings.

George W. Goethals announces his association with Charles C. Jamieson, George H. Houston, Robert Graham, John C. Jay, Jr., and George M. Wells. The firm will be known as Goethals, Jamieson, Houston & Jay, Inc., and will do business as consulting engineers with offices at 40 Wall St., New York City.

Obituary

Gustaf J. Johnson, of the firm of Johnson & Miller, died on May 21, 1917.

Alfred Ruggles Williams, president of the A. R. Williams Machinery Co., Ltd., died in Toronto on May 18, 1917.

John C. Simm, president and treasurer of the Machinists Supply Co., Pittsburgh, Penn., died on May 8, 1917.

Business Items

Gaston Williams & Wigmore, Inc., have removed their offices from the Guaranty Trust Co. Building to the Equitable Building, New York City.

Charles A. Schieren Co., New York City, has recently opened branch offices at 72 Congress St. West, Detroit, Mich.; 18 South Broadway, St. Louis, Mo.; 475 South Main St., Memphis, Tenn.; 272 Marietta St., Atlanta, Georgia.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeting at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineer's Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, except July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The American and Canadian engineers and architects of Norwegian birth and descent will hold an informal congress and reunion at the Chicago Norske Klub, Logan Square, Chicago, Ill., Sept. 27 to 29, 1917.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Quotations were current as follows at the points and dates indicated:

	June 8, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham..	$40.00	$38.00	$15.00
No. 2X Northern Foundry, New York..	46.00	43.00	20.75
No. 2 Northern Foundry, Chicago.....	47.00	42.00	19.00
Bessemer, Pittsburgh	50.95	44.95	21.95
Basic, Pittsburgh	45.00	42.00	18.95
No. 2X, Philadelphia.............	45.50	42.50	20.50
No. 2, Valley....................	45.00	42.00	18.50
No. 2, Southern Cincinnati...........	42.90	40.90	17.90
Basic, Eastern Pennsylvania.........	42.50	38.00	20.50
Gray forge, Pittsburgh..............	43.95	40.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	June 8, 1917	One Month Ago	One Year Ago	June 8, 1917	One Year Ago	June 8, 1917	One Year Ago
Structural shapes ...	5.00	5.00	3.50	5.00	3.25	5.00	3.10
Soft steel bars.....	4.75	4.75	3.55	4.50	3.25	4.50	3.10
Soft steel bar shapes	4.75	4.75	3.50	4.50	3.25	4.50	3.10
Plates	8.00	7.00	4.25	7.00	3.65	7.00	3.50

BAR IRON—Prices in cents per pound at the places named are as follows:

	June 8, 1917	One Year Ago
Pittsburgh, mill	4.25	2.60
Warehouse, New York..................	4.60	3.25
Warehouse, Cleveland	4.45	3.25
Warehouse, Chicago	4.50	3.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York June 8, 1917	New York One Month Ago	New York One Year Ago	Cleveland June 8, 1917	Cleveland One Year Ago	Chicago June 8, 1917	Chicago One Year Ago
*No. 28 black......	7.25	9.50	9.00	3.65	8.25	3.20	8.00	3.20
*No. 26 black......	7.15	9.40	8.90	3.55	8.15	3.10	7.90	3.10
*Nos. 22 and 24 black	7.10	9.35	8.85	3.50	8.10	3.05	7.85	3.05
Nos. 18 and 20 black	7.05	9.30	8.80	3.45	8.05	3.00	7.80	3.00
No. 16 blue annealed	7.85	9.20	8.50	4.70	7.95	3.70	8.20	3.60
No. 14 blue annealed	7.60	9.10	8.40	4.60	7.85	3.60	8.10	3.50
No. 12 blue annealed	7.35	9.05	8.35	4.50	7.80	3.50	8.05	3.45
No. 10 blue annealed	7.10	9.00	8.30	4.55	7.75	3.55	8.00	3.40
*No. 28 galvanized..	9.25	12.00	10.25	5.65	10.00	5.50	10.00	5.50
*No. 26 galvanized..	8.95	11.70	9.95	5.35	9.70	5.20	9.70	5.20
*No. 24 galvanized..	8.80	11.55	9.80	5.20	9.55	5.05	9.55	5.05

*For corrugated sheets add 25c. per 100 lb.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	June 8, 1917	One Year Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 20%
Chicago	List plus 10%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	45%
Cleveland	45%	50%
Chicago	45%	50%

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	June 8, 1917	One Year Ago
New York	$13.00@19.00	$6.00
Cleveland	12.30	6.30
Chicago	12.00	5.25

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*

⅜, 11/32, 5/16, ¼, 7/32, 3/16	19.00
No. 8, 5/32 and No. 10	20.00@30.00
⅛	
No. 12	
3/32, No. 14 and 1/16 ..	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods

3/16 by 12 in. long.........	16.00
¼ by 19 in. long.........	14.00
⅜ by 19 in long.........	12.00
½ by 21 in. long.........	12.00

*Special Welding Wire

⅛	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York June 8, 1917	Cleveland June 8, 1917	Chicago June 8, 1917
Tire	4.80	4.50	4.50
Toe calk	4.75	5.00	4.75
Openhearth spring steel...	6.50@7.00	8.25	7.50@8.50
Spring steel (crucible analysis)	8.00	11.25	12.00
Carbon tool steel, base price	14.00	13.00	....
Special best cast steel....	14.00@18.00	20.00	....

*In bars.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh basing card in effect May 1, 1917:

BUTT WELD

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
⅛, ¼ and ⅜..	42%	15½%	¾ to 1½.....	38%	22%
½	46%	31½%			

LAP WELD

2	42%	27½%	1¼	23%	8%
2½ to 6......	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4......	33%	20%
			4½ to 6......	33%	20%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜..	38%	20½%	¾ to 1½.....	38%	23%
½	43%	30½%			
¾ to 1½.....	47%	34½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	40%	28½%	1¼	24%	8%
2½ to 4......	43%	31½%	1½	30%	16%
4½ to 6......	42%	30½%	2	32%	19%
			2¼ to 4......	34%	22%
			4½ to 6......	33%	21%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanized
¾ to 3 in. steel butt welded	44%	28%	43%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	June 8, 1917	One Month Ago	One Year Ago
Copper, electrolytic (carload lots)*....	31.00	33.00	29.00
Tin	61.00	65.00	45.00
Lead	12.00	10.50	7.00
Spelter	9.50	9.75	13.75

*Third-quarter copper; for spot copper the market price is 33c.

ST. LOUIS

Lead	12.00	10.50	7.00
Spelter	9.50	9.50	13.62½

At the places named, the following prices in cents per pound prevail:

	New York June 8, 1917	New York One Month Ago	New York One Year Ago	Cleveland June 8, 1917	Cleveland One Year Ago	Chicago June 8, 1917	Chicago One Year Ago
Copper sheets, base.	42.00	44.00	37.50	42.00	38.50	42.50	37.00
Copper wire (carload lots)	39.50	39.50	37.50	39.00	33.00	40.00	37.50
Brass pipe, base...	47.50	47.50	46.50	48.00	45.00	47.50	38.50
Brass sheets	45.00	45.00	44.50	41.00	42.00	43.50	46.00
Solder ½ and ½ (case lots)	39.75	39.50	28.00	39.50	32.50	39.50	38.50

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	June 8, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	....
New York	45.50	45.50	$44.50
Cleveland	38.00	42.00	38.00
Chicago	42.50	42.50	40.00

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill.............. 19.00

	In Casks June 8, 1917	In Casks One Year Ago	Broken Lots June 8, 1917	Broken Lots One Year Ago
New York	22.00	24.00	23.00	24.50
Cleveland	23.00	26.00	23.25	26.50
Chicago	22.50	26.00	23.50	26.50

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	June 8, 1917	One Year Ago
New York	21.00	23.00
Cleveland	28.00	52.50
Chicago	29.00	46.00

Naval and Military Searchlights

By Charles Osmond Knowlton

SYNOPSIS — The three types of searchlight control are described and examples shown. Other details of the mechanism used on various sizes of naval and military searchlights are presented in such a way as to give a good general idea of the subjects. The Venetian blind and iris type of signaling shutter are also clearly shown and their uses described.

The electric searchlight, or searchlight projector, is indispensable in all phases of warfare. With powerful projectors to nullify the darkness, there is no time during which an army or a fleet cannot defend itself against surprise. An army well equipped with searchlights is in a position to defend itself against night surprise from the air or the surrounding country or to attack others effectively. Fleets cannot navigate safely at any time without the aid of searchlights, and in war, searchlights offer the only safeguard against night submarine or airplane attacks and make blockades possible. Powerful projectors are an important factor in sea forts and coast defense and are also very extensively used in signaling in all the branches of the army and navy.

A large proportion of the searchlight projectors that the United States and several foreign countries have purchased in the last 15 years have been made by the Carlisle & Finch Co., of Cincinnati, Ohio. This company has been in the business for 22 years and is one of the few manufacturers of searchlights in the United States, or even in the world. In addition to its regular commercial line the Carlisle & Finch Co. makes a specialty of navy and military searchlights. These lights range in size from 9 to 60 in. in diameter, with approximate ranges of from one to two miles to five or six miles. The electric current required for the different sizes ranges from 10 to 200 amp.

The construction is virtually the same for all sizes of projectors. Each size is divided into three distinct classes, or types, of control. In the local hand-control type the operator stands at the searchlight and directs it by hand. In the distant mechanical-control type the operator controls the light from below, one side or the rear, by means of handwheels, gears and shafting. This control consists of a metal box supporting three horizontal shafts with handwheels at one end, Fig. 1.

Bevel gears, which are attached to the other end of the shafts, mesh with bevel gears on two vertical shafts. Two of the horizontal shafts mesh with one vertical shaft and perform the same operation, and the third meshes with the second vertical shaft. The vertical shafts consist of one central shaft and a tube, and both move independently of one another. Motion is imparted to the inside vertical shaft by one of the two handwheels on the horizontal shafts and then to the light, causing it to move in a vertical plane. The outer shaft is connected to the turntable and causes the light to turn in a horizontal plane. A gear at the top of the inside vertical shaft meshes with the teeth on a sextant on the bottom of the searchlight case and gives the vertical motion.

The distant electric control on the light shown in Fig. 2 can be used with the operator at a convenient distance, by moving a small lever on the electric controller up and down for imparting vertical motion, and left and right to impart horizontal motion. The controller consists of a light metal box containing sliding contacts and motor resistance. The handle controls the searchlight movement in either of two planes, or in both, at the same time. The controller is connected to the searchlight by means of a six-conductor cable with plug connectors at each end. The main circuit to the searchlight is conducted through another plug connector and a water-tight stuffing-box.

The cables are usually wound on metal reels attachable to the searchlight base or to the trucks of the movable

lights. Two electric motors in the base of the searchlight operate the light vertically and horizontally. The motors are geared down to give a very slow motion, in order to throw the light on a distant object accurately.

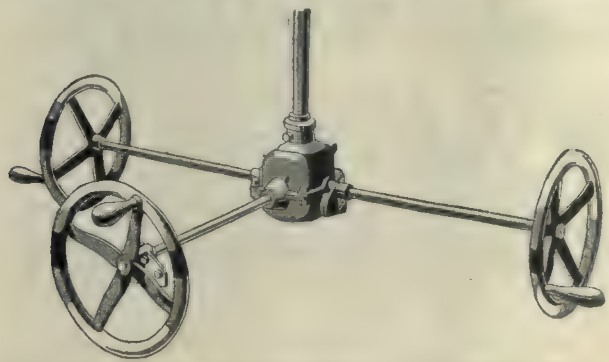


FIG. 1. DISTANT MECHANICAL CONTROL

The motors have three speeds each in either direction. On the very large projectors, a separate motor is used to operate the iris shutter. A small switch on the controller operates this motor.

The stands of the searchlights are usually constructed of cast iron, though brass is preferable, but more expensive. The base is hollow and contains the contact rings, the

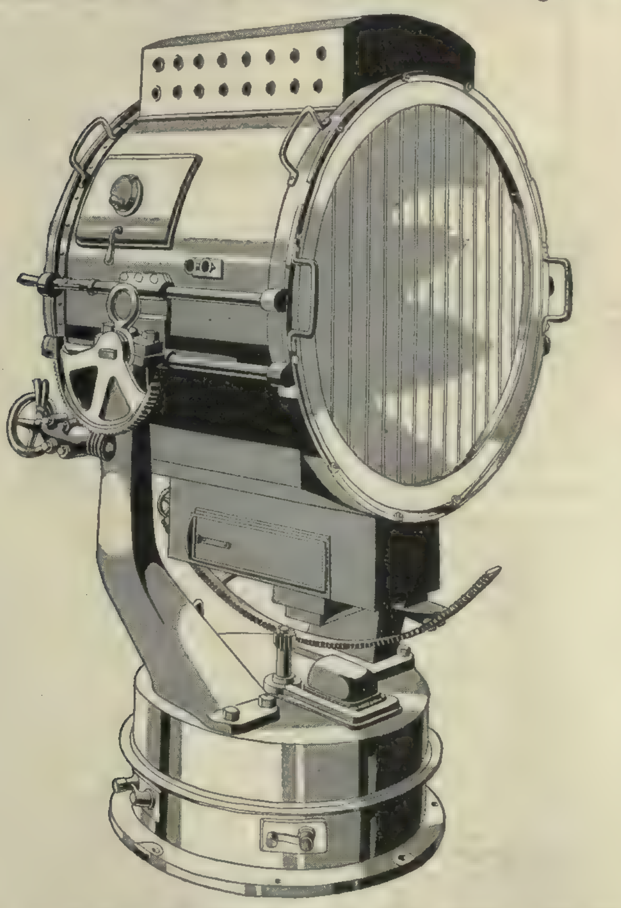


FIG. 2. NAVAL PROJECTOR, 30-IN. SIZE, WITH DISTANT MECHANICAL CONTROL

motors for electrical control and the necessary bearings on which the turntable revolves. A ball race, with bronze balls, is placed on the top of the base for supporting the turntable. The sides of the base have openings for plug connectors and handholes closed by heavy steel plates clamped in position. These openings are provided for easy access to the electrical connections, gears and motors. The turntable revolves on the base and has an overhanging edge for protection against rain and water getting into the base. The insulated brushes or sliding contacts for conducting the current from the base contact rings to the lamp are placed in the turntable. The steel or cast-iron supporting arms are bolted to the turntable. These arms have the bearings at their upper ends for the trunnions on the searchlight case.

The case, which consists of a heavy sheet-steel or brass cylinder, with the ends held by brass rings riveted on, is supported on trunnions, swiveling on the two steel supporting arms of the stand. The trunnions are mounted on two parallel steel rods, two on each side of the cylinder, which are fastened in sockets on the end rings. One of the rods is threaded, and the case is moved by means of this screw, for balancing. The right-hand trunnion has a quadrant attached to it for locking the cylinder at any elevation. The front end of the cylinder is closed with strips of plate glass, set in a brass ring that fits over the

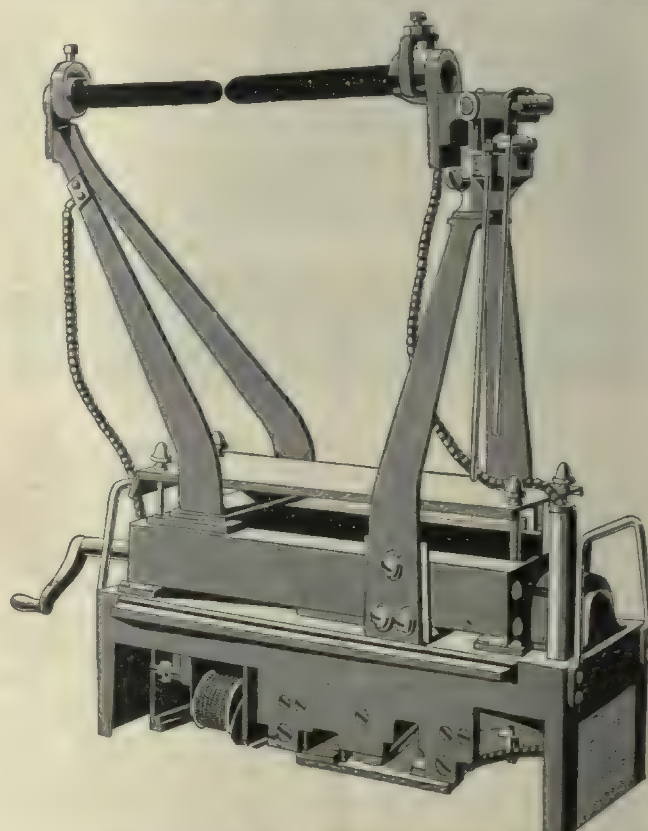


FIG. 3. CARBON-FEEDING MECHANISM

end ring of the case. This ring is hinged and provided with wing clamps for closing. The rear end of the case is closed by a bowl-shaped receptacle for the mirror. This is riveted to another brass ring. These rings at either end are flexibly mounted to allow for expansion and vibration and are easily removed.

A rectangular box is attached to the bottom of the cylinder to hold the arc lamp. This box is fitted with supporting brackets, contact clips, focusing screws and electrical connections, and all necessary electric contacts are automatically made by placing the lamp in the box. Two ventilators along each side of the box let in cool air. A large ventilator is placed on the top of the case and is so constructed that, by the use of baffle plates, light is prevented from escaping and water from entering the case. A peep sight and photographic finder are placed

on the right side of the case, so the arc can be examined. A light and water-tight hand opening and handles are also on the right side. Two small insulated buttons on the outside of the cylinder control the positive carbon by means of universal joints and thin brass rods.

The mirrors used in the searchlights are made of the highest-standard white optical glass. They are ground to a parabolic curve, polished on both sides and silvered on the convex side. The mirror is contained in a spun-copper receptacle, riveted into a cast-brass ring. This receptacle forms the back of the case and is easily removed. The mirror is flexibly mounted in the receptacle to allow for expansion and for shocks from gunfire. The lamp mechanism, Fig. 3, for feeding of the carbons is contained in the box on the bottom of the searchlight case. The slender carbon holders extend up into the case and hold the carbons with the arc in the focus of the mirror. The negative carbon is slightly smaller in diameter than the positive carbon and is placed nearer the mirror. The hottest part of the arc between the carbons when a current is flowing is the crater in the end of the positive carbon. By placing the positive carbon in front and making the rear negative carbon smaller in diameter, the full concentration of intense light is projected on the mirror and then out in a solid beam, the slender carbon holders offering no obstruction to the beam.

The carbon carriers slide on parallel rods and are moved by right- and left-hand screws. A two-field electric motor actuates these screws and feeds the carbons together or away automatically, to maintain a uniform voltage across the arc. The carbon carriers can be moved by hand or motor feed, independently. The positive carbon can be moved in two planes by means of two small brass rods, controlled by buttons on the outside of the case. The principle of the mechanism is shown in Fig. 4.

A 110-volt current flows from the outside circuit. By means of the rheostat the voltage across the arc is maintained at 55 volts. When the current is thrown on, the solenoid C draws D to it and completes the circuit passing through one field of the two-field motor A, causing the motor to feed the carbons together by turning the feed screw. As soon as the carbons touch together, the solenoid controller will be short-circuited. The armature will be pulled away by means of the spring until it touches the outer contact. This will reverse the field of the feeding motor, the armature will be reversed, and the carbons will be separated until the voltage across the arc reaches the amount for which the controller has been set (usually 55 volts).

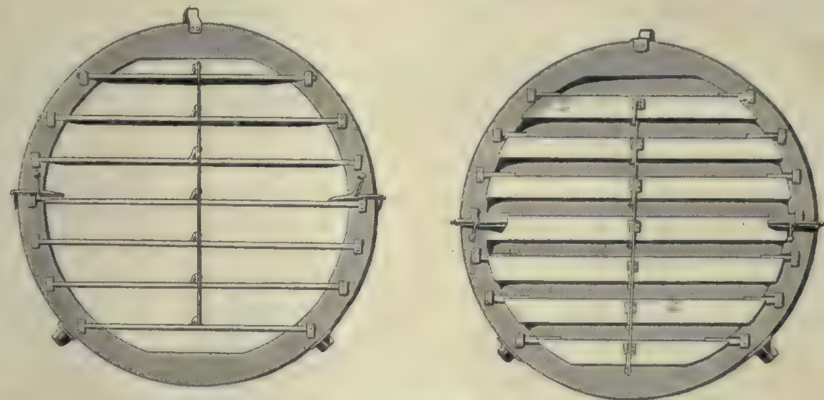
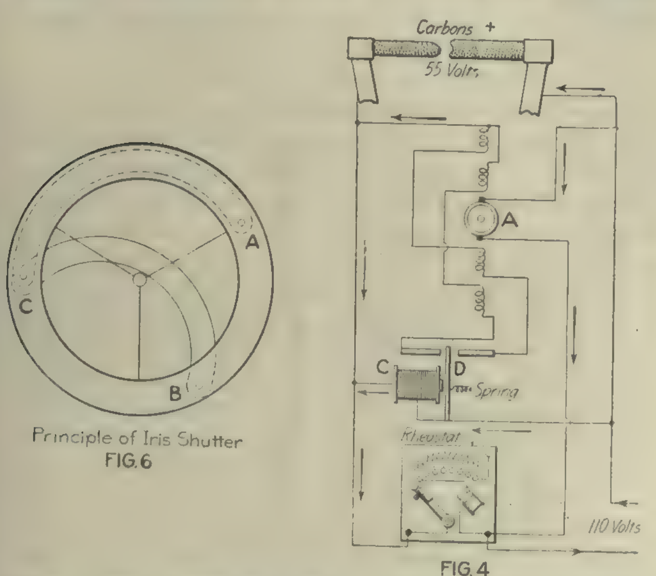


FIG. 5. SIGNALING SHUTTER OPEN AND CLOSED

When this point is reached, the pull of the solenoid will balance the pull of the spring, and the controller armature will "float" between the two contacts, causing the motor armature to come to rest. This condition will exist until the carbons burn off sufficiently to raise the voltage, at which time the solenoid will overcome the tension of the spring and draw in the controller arma-



FIGS. 4 AND 6. FEEDING MECHANISM AND IRIS SHUTTER
Fig. 4—Principle of the feeding mechanism. Fig. 6—Principle of the Iris shutter

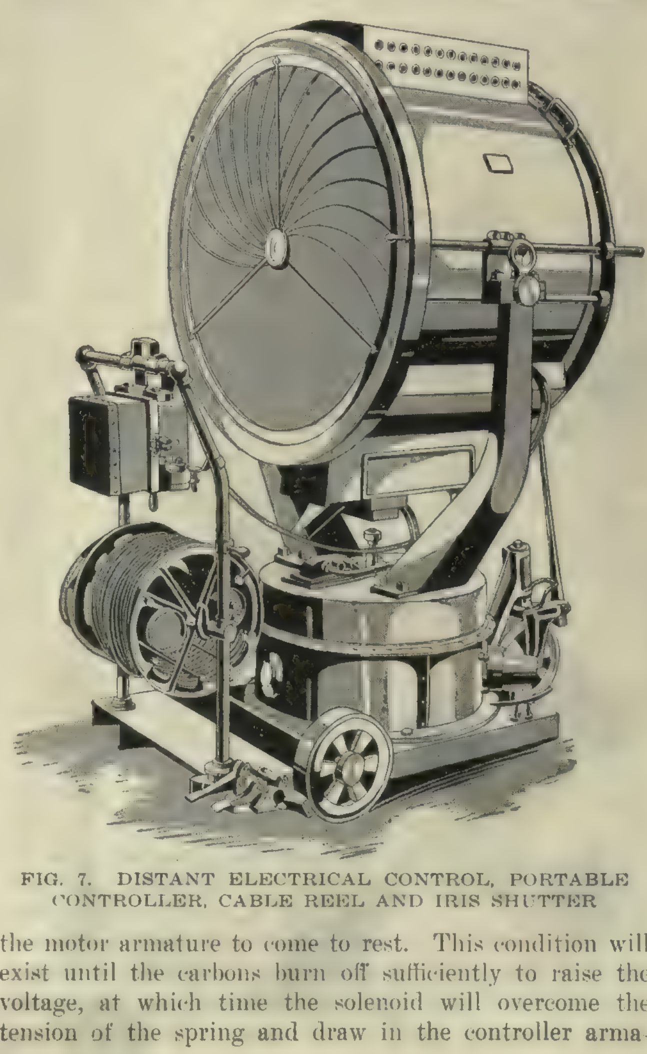


FIG. 7. DISTANT ELECTRICAL CONTROL, PORTABLE CONTROLLER, CABLE REEL AND IRIS SHUTTER

ture D, thus energizing the field of the feeding motor and causing the motor armature to feed the carbons together. As soon as the arc voltage is lowered to 55 volts, the motor will stop. This gives a constant voltage across the arc.

A balancing resistance is required in connection with any arc lamp burning on a constant-voltage circuit. In order to secure this, a rheostat is made use of. The rheostat is built up of sheet-metal grids securely clamped together and contained in a steel case. A series of contacts and an adjustable arm give a range of voltage of 5 above and 5 below normal voltage of the supply current. The grids are made of special metal with large spaces between for ventilation. Asbestos and mica are used for insulation purposes.

Signaling Methods

Searchlights are extensively adopted for signaling by the use of long and short flashes. A special shutter of the Venetian-blind type, Fig. 5, is made for signaling. The shutter consists of flat blades, pivoted at the middle and all hinged to one center rod that turns them all at a time. By moving the handle on the center blade the shutter can be opened and closed rapidly. The shutter can be slipped on or off the front, and the blades can be set vertical or horizontal.

Another type of shutter is the iris shutter, Fig. 6. This is used to prevent any light emerging from the searchlight, in place of turning the current off. It consists of a brass ring clamped to the front of the cylinder and another brass ring fitting into the first and supported on a train of bronze balls. A series of sickle-shaped steel blades are pivoted at one end to points around the circumference of the retaining ring, and at the other end to the revolving ring. When the outer ring is revolved, the blades are drawn from a sheaf around the edge of the shutter, across the middle, and form a solid sheet-metal shutter, shutting off the light entirely. On revolving the outer ring back, the sickle-shaped blades are again sheathed around the sides of the shutter. A metal spool in the center receives the blades and makes the closing complete.

As the outer ring is revolved, each blade remains stationary at its pivot on the retaining ring at C, but its pivot at the other end moves with the outer ring from A to B. The appearance of a shutter with the blades closed can be seen in the illustration of the 36-in. projector, Fig. 7, and with the blades open in the 30-in. projector, Fig. 2. A motor, geared to a rack on the outer ring and mounted at the bottom of the retaining ring, is sometimes used to open and close the shutter from the controller.

Portable Outfits

Projectors are sometimes mounted on trucks, as shown in Fig. 7. The trucks are made of steel throughout and roll on three rubber-tired wheels. A rod on the front pivoting wheel is used to steer the truck. The wheels are also provided with brakes. For the distant electrical control a frame on the truck holds the cable and reel for the controller and also a bracket for holding the controller. The controller is lifted from the bracket and carried any convenient distance away. Both the distant mechanical and distant electrical controls can, by merely turning two small levers, be converted into the usual hand control.

Meeting of Mechanical Engineers and Machine-Tool Builders

The meetings of the American Society of Mechanical Engineers and the National Machine Tool Builders Association, held in Cincinnati, May 21 to 24, proved a huge success, all registration records being broken for both societies.

Headquarters for both societies were at the Hotel Sinton. For the mechanical engineers, Monday morning was chiefly devoted to registration and the business of getting under way. The afternoon was taken up with a council meeting, trips to various shops by members and guests, while the ladies were taken to the city hospital and to tea at the Woman's Club. The National Machine Tool Builders Association members and guests registered early and at 9:45 opened their first session. Several committees reported, and a number of addresses were given. In the afternoon, William Hard gave an interesting address on "Lessons and Opportunities of the World War for American Manufacturers." At the conclusion of his talk, it was decided to have his remarks printed in pamphlet form and given as wide circulation as possible. Other shorter addresses followed this one. The evening was enjoyed by members of both societies at an informal reception in the hotel ballroom. An address of welcome was delivered by the mayor, and responses were made by the presidents of both societies. Stereopticon views of Cincinnati and the vicinity were then shown, followed by dancing.

Tuesday morning was devoted to a business meeting and the reading of a number of papers for the American Society of Mechanical Engineers, and to committee meetings and an executive session for the machine-tool builders. Tuesday afternoon, a joint session was held, addresses being given by Dean Schneider and Mr. Geier. In the evening there was a smoker at the Business Men's Club for the men and an entertainment at the hotel for the ladies. The smoker entertainment was unique and will be long and pleasantly remembered by those who attended.

Wednesday morning, a joint munition session was participated in by both societies. In the afternoon a boat ride to Fernbank dam constituted the major attraction. The boat ride was one of the bright spots of the entertainment program, as it included the ladies. The views along the river to the great dam are ranked with the best of the country's river scenery. Refreshments were served on the way and the younger guests enjoyed the dancing and special music. Only about three hours were taken for the round trip which was not long enough to tire anyone. In the evening there was dancing in the hotel ballroom.

Thursday morning, simultaneously, munition sessions were in order. There were also gas-power and industrial-safety sessions. In the afternoon a number of automobile trips were made to the Zoo and other points of interest.

All through the meetings, automobiles were at the service of the visitors to take those who desired to see various shops. Ample entertainment was provided for the ladies at all times, and time was not allowed to drag for anyone. It has been possible here to give only the barest outline of the sessions, but extracts from a number of the more interesting papers will be given later.

Time Studies for Delay Allowances in Rate Setting*

By Dwight V. Merrick†

SYNOPSIS—The conditions that influence the fatigue induced by work are discussed, and an experiment to determine the effect of fatigue on output is outlined. The use of production studies as the basis for curves by which the delays due to fatigue and other causes can be determined is described in detail.

Mention has been made in a previous article of the use of curves for determining the percentage by which the minimum selected handling time should be increased in the fixing of tasks to cover fatigue and unavoidable delays. The minimum selected time represents an exceedingly high standard of performance, well beyond the ability of the average operator. It is simply to be regarded as a standard, and a factor that varies with the nature of the work and the conditions under which it is done is applied to it to determine a fair task for the average skilled worker. The measure of the fairness of a task is the ability of the operators to complete it consistently in slightly less than the task time—that is, in the minimum selected time increased by the allowance factor.

The best operators will complete their tasks in a time approaching the minimum selected time, while the poorer operators will exceed it by a considerable margin. All, however, should, at the worst, equal it.

Factors Influencing Fatigue

The determination of the allowance factor was at first somewhat crude, an arbitrary figure being set to cover all the operations within certain classes of work. As knowledge of time study increased, however, it became evident that factors had to be considered other than the particular class of work involved. For instance, the length of the cycle of operations was found to be a considerable factor. Likewise, a job that involves only machine work requires a very different allowance than a job that is made up wholly or partly of hand operations. The character of the surroundings also has a great influence on the allowance. Work done in a clean, cool and light place will require a smaller allowance than work carried out in a smoky, hot, moist or poorly lighted shop.

The allowance was originally called a "fatigue allowance," but this term is a misnomer. While in some classes of work, fatigue does play an important part in diminishing the output, in others it has comparatively little influence. Thus, in machine work, where the jobs are long and the operator has little to do but watch his machine, the influence of fatigue is negligible, while variations in lineshaft speed, quality of tool steel, hardness of material and half a dozen other factors will prove of great importance in the correct formulation of the allowance. On the other hand, in the case of a man doing a great deal of chipping, fatigue is probably of far more importance in diminishing the output than any other one factor.

The continuity of the work also has its effect on the allowance that must be made. By this is meant that, if a job be made up of a series of related operations that recur in a regular sequence at regular intervals, the operator will tend to establish a rhythm in his work which will materially cut down the amount of allowance required. The more nearly he approaches a perfect rhythm the less will be the allowance. On work on which there is more or less interruption, such as jobs involving several machine cuts, requiring starting and stopping between cuts, the allowance should be greater than on work having no such interruption. These interruptions apparently destroy the rhythm of the work instead of providing a rest period, as is the common idea of their effect.

A Study of Fatigue

Studies on the effect of fatigue were made by Dr. Taylor soon after he had begun his management work. These studies originally were made to determine the point at which fatigue began to affect the output of the operator. They were similar to that shown in Fig. 1, which represents a study made recently to demonstrate the value of fatigue allowances to an operator who was skeptical as to the effect of fatigue on his work. While this study indicates the value of rest periods in certain classes of work, in the opinion of the writer it is not of sufficient scope to give information for making allowances on a broad line of work. The study illustrated extended over but two days and was on a single operation. To be possible of general use, it should have covered a wide range of work with different operators and extended over many days and under varying conditions.

The method followed in this experiment consists in having the operator work straight through from starting time in the morning until noon, without any stops for rest. The fatigue incident to the work was compensated for by allowing him to set his own pace as he became tired and taking longer for each operation as he desired and as the amount of fatigue increased. The length of time required for each complete production operation was noted and recorded as the work progressed, and later plotted as in Fig. 1. After a rest of one hour at noon the experiment was continued and carried forward to quitting time at night. The observation of the work is in reality a production study such as has already been described.

It should firmly be borne in mind that a procedure of this character—that is, working the operator through the day without any rest except that at noon—is not recommended except as an experiment made to learn facts. In the experiments conducted under the direction of Dr. Taylor it was early discovered that an adequate provision for rest to overcome the fatigue incident to labor was the governing factor in promoting the efficiency of the workman. It was found that, if proper provision was not made to overcome fatigue, the output of the worker would drop and at the end of the day would be seriously reduced.

 This article is one of several by the same author dealing with the general subject of time study. Previous articles appeared in "American Machinist" on pages 177, 221, 269, 407 and 628.

†Consulting Engineer, New York.

On the other hand, it was found that, when an adequate number of rest periods of the proper length were introduced, the workman maintained his efficiency and output at the desired high point throughout the day. No greater misstatement has ever been published than that the work of Taylor aimed at speeding a workman to the point where his ability was sapped and his health ruined. The conservation of the health and therefore of the efficiency of the workman was one of the prime objects of Dr. Taylor's investigations.

The method of making the fatigue study of Fig. 1 was as follows: A job comprising all handling time was selected, for which a minimum selected time of slightly under 0.50 min. was fixed by time study. A machine was used; but as it was hand operated, the work falls in the classification of all handling time. Since, as has been stated elsewhere, the minimum selected time is an especially severe task and one not expected to be reached by the average operator, the minimum selected time was slightly modified: and a task of 0.5 min. was set as the standard which was desired and on which the fatigue allowance should be based.

The dotted lines represent the performance of the operator working steadily without any artificial rest periods. The full line represents the performance of the worker on the same kind of work (but possibly of slightly more difficult character) on the following day, with a rest period of $2\frac{1}{2}$ min. every half-hour. The curves were obtained by dividing the number of pieces produced every half-hour into 30 min., thus getting the average time required per piece during the period. The points plotted represent the performance of the half-hour preceding the time given; that is, the record at 8:30 shows the average time of production per piece for the half-hour between 8 and 8:30.

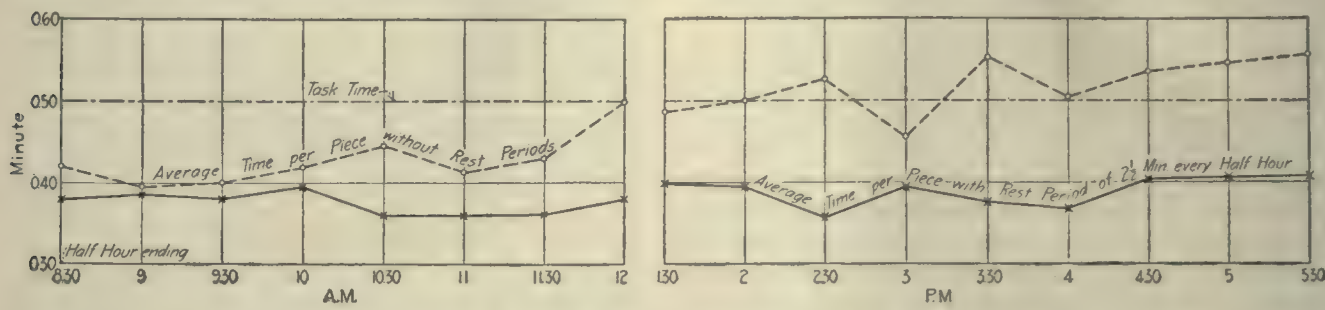
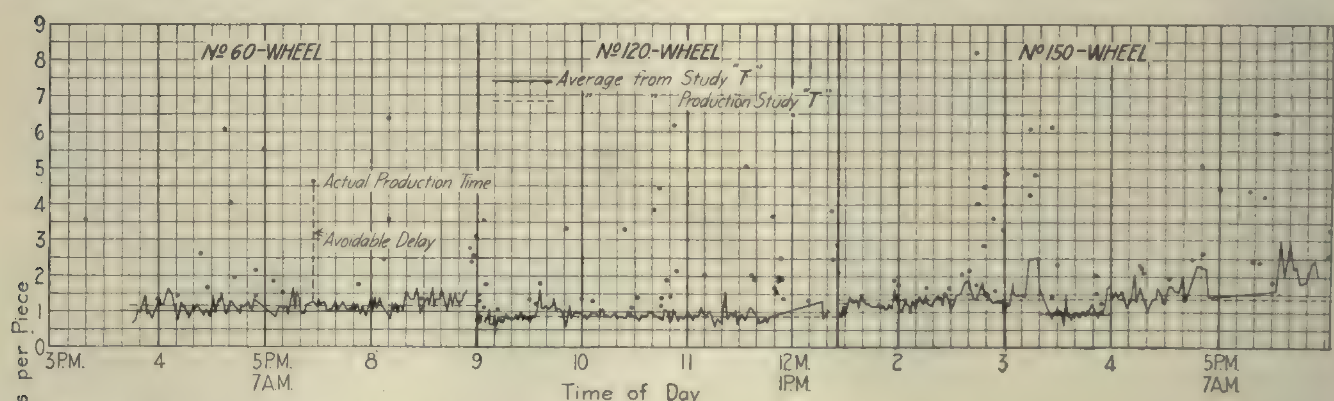


FIG. 1. EFFECT OF A REST PERIOD ON THE TIME OF PRODUCTION

A study of the curve of performance without rest periods reveals several interesting facts, and it is particularly interesting to note that any extra exertion after fatigue has begun to make itself apparent is always accompanied by still greater fatigue and coincident falling off in efficiency. This is clearly shown by the record between 3 o'clock and 4:30 in the afternoon.



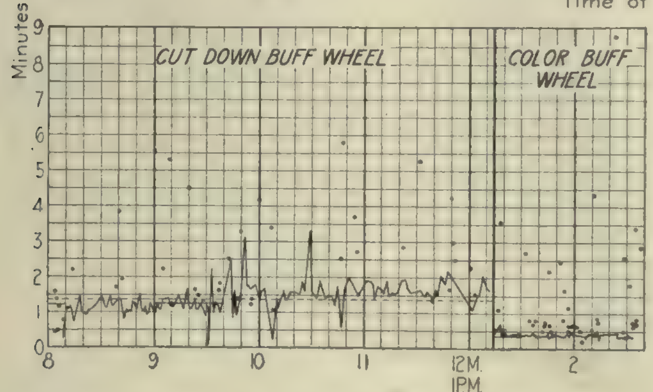


FIG. 2. GRAPHIC RECORD OF FATIGUE STUDY EXTENDING OVER SEVERAL DAYS

The effect of the $2\frac{1}{2}$-min. rest period every half-hour, as shown by the full line, is so obvious as hardly to require comment. Not only did the time per piece remain below the standard throughout the day, but it was maintained at a steady rate, even improving as the day wore on. While the operator was thoroughly tired out at the end of the first day, the effects of fatigue were hardly apparent at all on the second day. Despite the fact that 40 min. was taken for rest and that nearly 30 min. additional was lost, due to machine breakdown on the second day, the actual number of pieces produced by the operator was over 10 per cent. greater than the number produced the previous day, when there were no interruptions for rest or machine trouble.

From a casual study of the curves of Fig. 1 it would seem that all the information needed regarding fatigue allowances could be obtained by a set of studies of the

character described. This, however, is not the case; and another method is used by the writer, as will be shown later. The method just described does give information as to the maximum rate of speed of the worker and the length of time he could maintain this speed; it also indicates the point at which the first rest period should be applied. In addition, it shows the diminution in output that may be expected if rest periods are not provided. What the method does not show, however, is how long the rest periods should be, how often they should be applied and what relation they should bear to the character of the work. If these facts are known, allowances can be predetermined even for jobs that have never before been performed, and they will work out in practice in very close accordance with the underlying theory. It is quite evident that the determination of the proper interval between, and the length of, the rest periods can only be determined by trial and error with the methods illustrated in Fig. 1, repeating the study over and over again with rest periods of varying lengths and at different intervals. This is at best a cumbrous, expensive and time-consuming proposition.

A Substitute for Rest Periods

Instead of providing rest periods, a change in the monotony of the job may effect the same result. In actual practice it may prove unwise from the standpoint of discipline actually to stop production for the purpose of providing forced rest periods. The same object may be accomplished by introducing a rest period under the guise of a nonproductive operation. Thus, an operator on a high-speed machine may be required at certain intervals to move his finished product to a different location or to go some little distance for his supply of raw material. The change in the nature of the work involved in this procedure provides for the muscles employed in the productive operations the necessary relaxation to overcome the fatigue produced by the work. The introduction of rest periods in this manner is a matter for the man who prepares the instruction cards, and considerable ingenuity may be exercised by him in this respect.

In certain classes of work, as the operation of automatic machinery, it is often desirable to provide an additional operator to each group of six to twelve workers. This operator takes the place of each of the workers successively, thus providing an opportunity for rest or for attending to their personal needs without stopping production. This additional operator may be the instructor or supervisor for the group.

Another method of producing the necessary change in monotony is interchanging operators every hour or two on two machines doing different jobs of the same general character of work.

Studies for Fatigue Allowances

In the method now used by the writer all the necessary information for fatigue and delay allowances can be obtained from the production studies that should be carried on as a part of the time-study routine.

Fig. 2 is a plotted record of a production study of several different jobs of the same character, extending over several days. The ordinates represent the time of production per piece, while the abscissas are the time of day at which the successive pieces were completed. In plotting the time of production, only the net time is used, avoidable delays being subtracted. It will be observed that above the curve of production there are a number of points plotted. These represent the actual time of production, and the distance between them and the corresponding point on the curve represents the avoidable delay that has been deducted. It will be observed also that the time of production per piece has a tendency to increase somewhat as time passes and the end of the day approaches.

One of the earliest attempts to establish a scientific basis for fatigue allowance was the making of a formula to govern this feature. In one of the first shops to use time study, data were gathered as to the percentage by which the actual time of performing jobs on the heavier

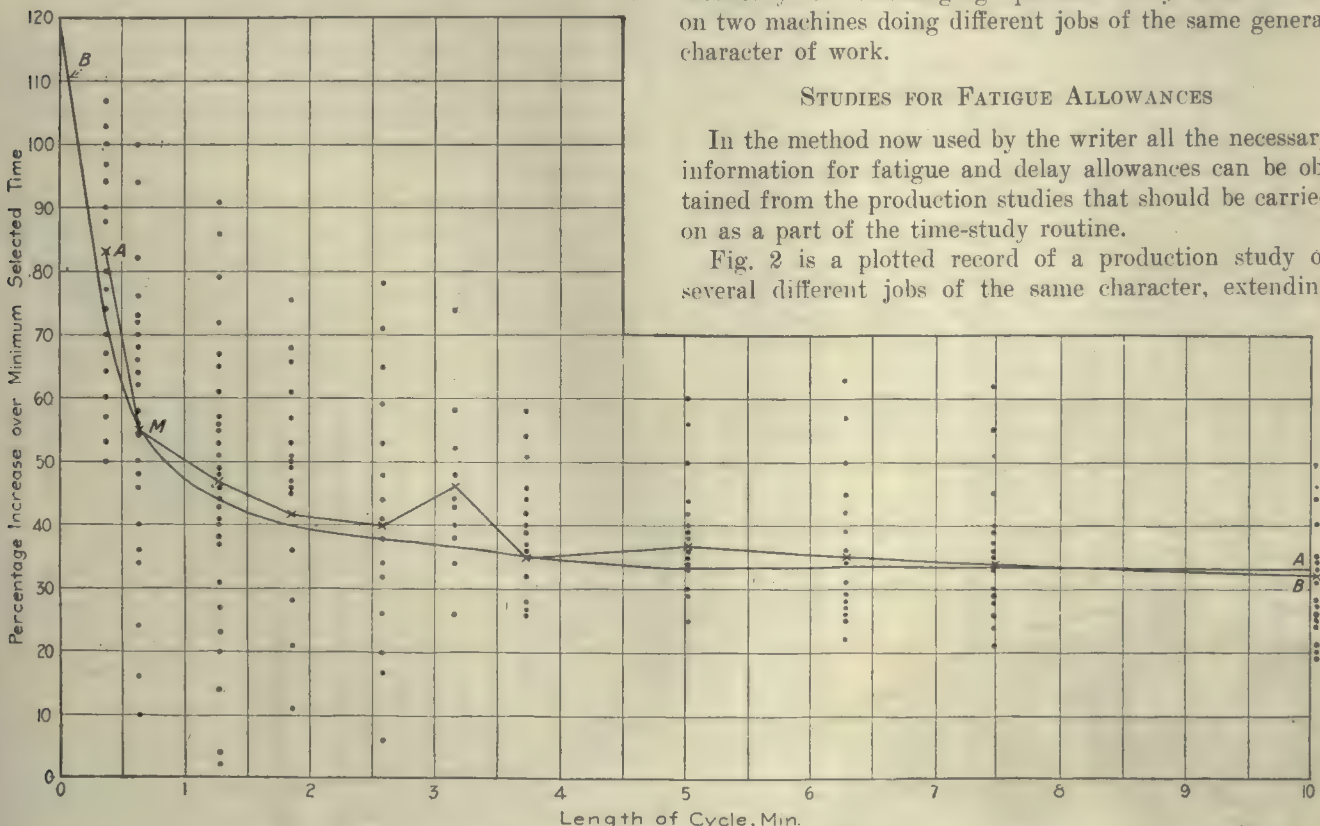


FIG. 3. METHOD OF MAKING FATIGUE CURVE FROM PRODUCTION STUDY

tools exceeded the minimum selected time, and the following allowances were deduced:

Type of Machine	Size	Percentage To Be Added to Minimum Time	Remarks
Lodge and Shipley lathes...	24 to 30 in.	35 to 50	On 24- to 30-in. lathes, the allowance is 35 per cent. when handling time is more than 8 min. and machine time double handling time; 50 per cent. when handling time is less than 8 min. and machine time about equal to it.
Lodge and Shipley lathes...	48 in.	30	
Vertical boring mills.......	120 in.	25	
Vertical boring mills.......	36 in.	35	
Vertical boring mills.......	30 in.	40	
Horizontal boring mills.....	No. 74 Bennse	40	
Planer..................	36 in.	40	

Similar data on light tools, such as vertical drilling machines, etc., were incorporated into a formula by Carl G. Barth, as follows:

$$P = \frac{125}{1.20 + \sqrt{T}} + 20$$

in which P is the percentage by which the minimum selected time is to be increased and T is the minimum selected time.

The allowances, as given by the table and formula above, while fairly satisfactory for the particular shop in which they were made at the time, proved to be inaccurate when applied to shops in different lines of work. It was evident that a broader method of ascertaining allowances was necessary, which could be applied along more general lines.

A hypothetical case will be presented to illustrate the method now used. Production studies are made of a series of jobs requiring various lengths of time for their completion, but in which the percentage that the handling time bears to the total time of the job is the same. In these studies the handling time is carefully noted and separated from the machine time, and the total of the handling time in each cycle is expressed as a percentage of the minimum selected time of that cycle. For example, if the total minimum selected time for a job was 1.06 min., made up of a machine time of 0.54 min. and a handling time of 0.52 min., we might obtain the following figures for handling time in several successive cycles: 0.56, 0.64, 0.67, 0.63, 0.65, 0.68 min. These would then be expressed as percentages of increase over the minimum selected handling time of 0.52 min., as 26.9, 23.1, 28.8, 21.1, 25.0, 30.7 per cent.

The percentage increases of the actual handling time over the minimum selected handling time are plotted with percentages as ordinates and the length of cycles in minutes as abscissas. A curve that will represent the mean of all the points is then drawn through the field, and from it values may be taken which will be a fair allowance for all work with the same percentage of handling time as the jobs on which the curve was based.

The method of laying out the curve is shown in detail in Fig. 3, which is a hypothetical case representing the results of production studies on jobs in which the handling time is 50 per cent. of the total time of the cycle. The jobs have cycles varying from 0.30 min. up to 8 min. in length, and the percentage excess of the actual handling time over the minimum selected handling time for the several cycles in each of the jobs is shown as the plotted points.

It is usually convenient to determine the average value of the plotted points for each length of cycle, as due weight will then be given to values that recur several times. If a curve is simply struck through the mean of all the points, values that recur several times in the same cycle will have no greater weight than those which occur but once.

The average for each cycle is indicated by the crosses in Fig. 3. These are connected by the straight lines that give the rough curve AA. With this rough curve as a guide, an even curve BB may then be drawn, which will approximate the average conditions and smooth out the variations in the first rough curve.

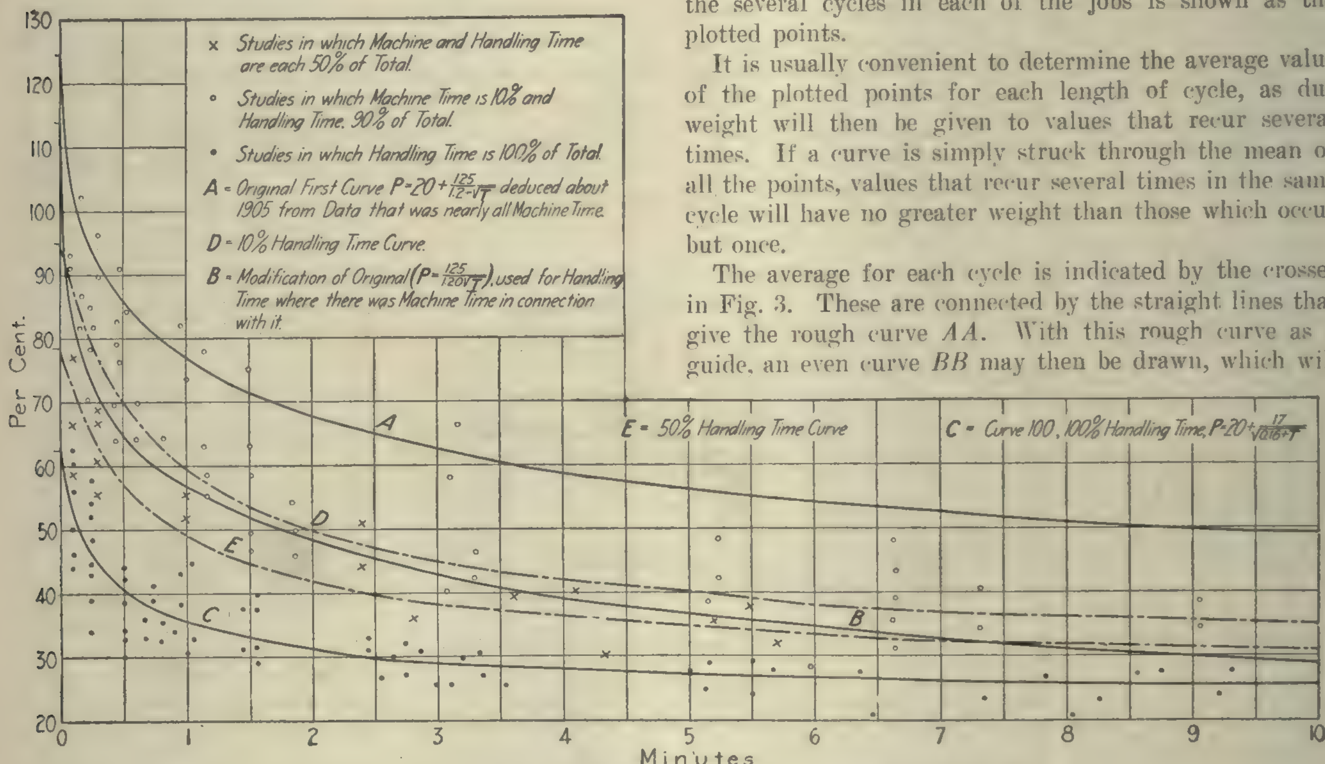


FIG. 4. COMPARISON OF THE EARLY AND RECENT FATIGUE CURVES

Similar curves are plotted for all the jobs with different percentages of handling time, and the shop is then prepared to set tasks and fix allowances with a certainty that the tasks can be accomplished. The final step is to superimpose the curves for the different percentages of handling time and ascertain if they agree with one another. If the work has been carefully done, it will be found that the several curves are approximately parallel and that it is possible to derive a mathematical formula to which they will all conform. It is usually advisable, where the mathematical ability is present, to derive this formula and to replot the curves in accordance with it.

Fig. 4 represents developments of several classes of curves that finally resulted in the series shown in Fig. 5.

Curve A, Fig. 4, represents the curve obtained by plotting Barth's original formula,

$$P = 20 + \frac{125}{1.20 + \sqrt{T}}$$

This curve, based on comparatively few observations and a limited number of machine types, gave allowances far in excess of those necessary for certain classes of work. It was later modified to curve B, which was used where machine time and handling time occurred in combination. It was later found that still more differentiation should be made between classes of work that varied greatly in the percentage of handling time involved in them, and the curve representing the work involving percentages of handling time, ranging all the way from zero to 100, was plotted from observations on work of the above character.

This is the procedure that has been adopted with the curves given in Fig. 5. These curves are the same as those presented in the initial article of this series, but drawn to a larger scale and with finer subdivisions of the coördinates. They represent the result of thousands of actual studies in many different shops, extending over a long term of years. It is thought that in the present form they will be more available for use in the machine shop.

The formula for these curves, which was derived by Mr. Barth, is

$$P = 20 + \frac{49.5 - 0.325C}{\sqrt{(0.376 - 0.00002166)^2 + T}}$$

in which P is the percentage allowance, C the percentage of handling time, and T the minimum selected time.

The curves are applicable to the average machine-shop practice in the ordinary well-lighted, well-ventilated and properly heated shop. It should be emphasized that they may not apply to other industries or where temperature and ventilation conditions are such as to tend to the enervation of the workers. The allowances given by the curves are applicable to studies taken and analyzed according to the methods used by the writer, which have been described in previous articles. They cannot be guaranteed as applicable to studies taken and analyzed by any other method.

In using the curves, the particular curve is selected which corresponds most nearly to the percentage of handling time in the cycle on which allowance is to be made. Thus, when there is no machine time involved, curve 100, representing 100 per cent. handling time, is used. If the cycle represented 50 per cent. handling time and 50 per cent. machine time, then curve 50 is used. The percentage allowance is made upon the total of the handling time; that is, if a job comprised 3 min. machine time and 2 min. handling time, the 40 per cent. curve would be used and the intersection of the 2-min. ordinate with this curve would determine the allowance that would be added to the handling time in making up the instruction card. For machine time with power feed a flat allowance of 5 per cent. is added, and for machine time with hand feed an allowance of 20 per cent. is added to the machine time.

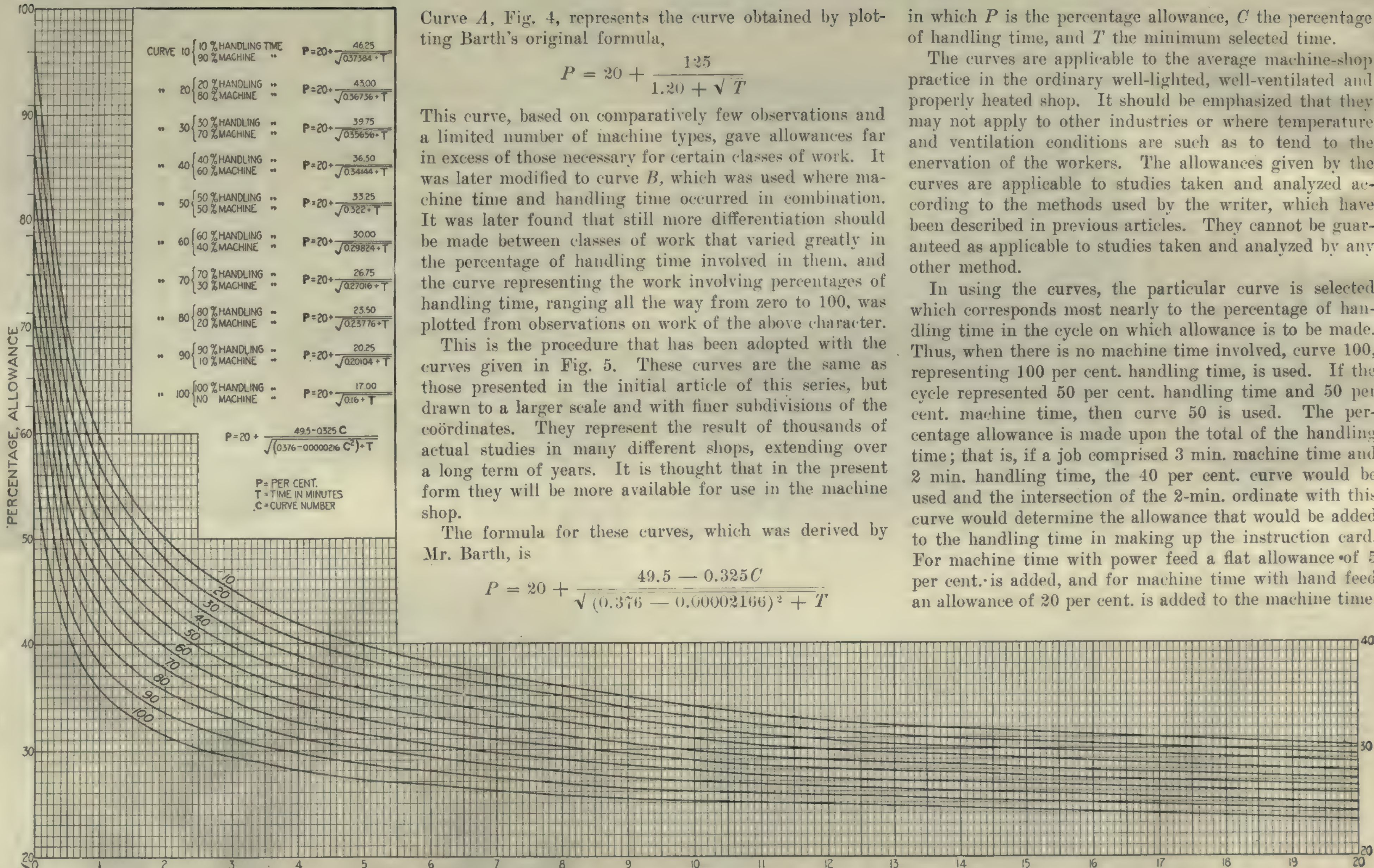


FIG. 5. VARIATION ALLOWANCES FOR MACHINE-SHOP PRACTICE

The method of making allowances by means of curves derived from data furnished by production studies takes into consideration the delays to the work due to other considerations than fatigue. It is so obvious as hardly to require comment that, even in the most highly organized and best managed shops, occurrences are bound to take place which will delay the work more or less. Some of these are avoidable, and others are not, as has been explained in the article on production studies. The avoidable delays are eliminated from the record before the percentages that are plotted as in Fig. 3 are calculated, and only the net productive time, the delay due to fatigue and the unavoidable delays that in all fairness should be allowed for are taken into consideration. The method of doing this is explained in the article on production study, and the reader is referred to that for further information on this point.

Inasmuch as the curves illustrated include other factors than fatigue, the term "variation allowance" has been adopted as a better expression than the term "fatigue allowance," which has been widely used. Fatigue does play a large part in slowing down certain classes of work, particularly where the cycle is short, necessitating frequent and rapid movements on the part of the operator, and where the handling time or period of actual physical exertion on the part of the operator is a large percentage of the total cycle. Its influence is relatively less as the length of the cycle increases and the percentage of handling time diminishes. In such cases the influence of the unavoidable delays may be greater than that of fatigue. These features are clearly shown by the curves, in which the allowance for the short cycles, where there is little opportunity for the operator to recover from fatigue, calls for higher percentage of allowance, while the long cycles, which offer rest periods in the cycles themselves, call for much lower percentages of allowance.

War-Time Fire-Prevention Campaign

Since the first publication of the statement that the National Board of Fire Underwriters had undertaken an extensive work of war-time conservation in the service of the Federal Government, much correspondence has been received from those desiring particulars. While some of the work is confidential, it is believed that a brief outline of certain phases may now be given.

The National Board has been working out extensive plans for providing fire protection, as distinguished from mere fire indemnity.

To this end, President Bissell has appointed local subcommittees in New York, Chicago, Philadelphia, Boston, San Francisco, Minneapolis-St. Paul, Atlanta, New Orleans and Dallas. These committees have already entered into active coöperation with the governors, state councils of defense, committees of safety, fire marshals and the financial and commercial interests of their localities, particularly with committees of grain dealers' associations, representative owners, etc.

Their activities are of a far-reaching nature, involving inspections, the correction of structural hazards and the promotion of careful methods, including cleanliness.

This campaign is enlisting the services of approximately four thousand trained fire-prevention engineers, inspectors, surveyors and appraisers located in every part of the country, as well as of numerous supplementary insurance organizations and an army of officials, leagues, committees and associations, all coördinated into a single movement, working earnestly for the nation's safety.

It is of the utmost importance that every individual in the nation should consider himself as a committee of one to coöperate in the removal of all unnecessary fire hazard that may come within his knowledge.

Marking Names on Tools

By W. S. Standiford

Many tools used by machinists are so delicate in construction that it would ruin them if they were marked with the owner's name or initials put on in the usual way by means of a steel stamp. Many would be sprung and thrown out of adjustment, rendering them useless for accurate work. By the chemical method adopted by the writer, names or initials may be placed upon tools without any risk of their being damaged. The corrodent employed does not injure the hands, nor does it wear off the metal, while the solution is cheap and easily applied. The formula is as follows:

	Oz.
Distilled water	4
Copper sulphate	1
Salt	1
Zinc sulphate	½
Alum sulphate	¼

Mix all the chemicals in the water and shake the mixture vigorously until they are dissolved. The solution is then ready for use. Taking the articles to be marked, clean the rust off the metal with fine sand or emery paper on the spot where the name is to be inscribed. Smear the place with good soap; then write down the name with a scriber or other sharp instrument, and cover the marking with the fluid—or better still, fill up the tracing with it.

Leave the object alone until the name has turned copper-colored. Moisten the soap with water and rub it off. Five minutes is long enough to leave the solution on the writing. The mixture is to be used only on iron and steel goods. To those who would like to have their names put on tools in a neater manner than is possible by the use of a scriber, rubber type, which can be bought in a 10c. store, is recommended.

Set the name in type in the holder in the reverse direction from that it is to have when printed—or in other words, reading from right to left. Tack a piece of cotton cloth to a level piece of wood, and using a flat stick, spread on the cloth a small amount of asphaltum varnish. Press the type on the cloth, which in turn is pressed lightly on the metal, which is left to dry. Make a small, rectangular piece of wood about ⅜ in. thick, the length and width depending upon the size of the tool and the name. The object is to have as wide margins as possible around the name. Bevel the sides of this rectangular piece of wood with a knife or file; a steep angle makes it withdraw easily from the soap. Put a tack in the middle of the piece of wood to serve as a handle. Lay the piece of wood over the name, making sure that the margins are equally spaced; then put soap or putty around the sides of the wood so that none of the solution will escape. Withdraw the wood and fill the place with the corrodent. Pour the latter off; clear away the soap as previously described, and you will have the name in black letters on a copper-colored background. The type should be cleaned with turpentine after using.

Manufacturing Lockers and Cupboards with the Spot Welder

SPECIAL CORRESPONDENCE

In Fig. 1 is shown a group of five lockers in the manufacture of which the electric spot welder plays an important part at the plant of the Terrell Equipment Co., Grand Rapids, Mich. One of the lockers is shown with the door open, and the construction of the interior may be seen. These lockers each measure 60 in. high by 12 in. wide by 12 in. deep.

A cupboard 30 in. high, 15 in. wide and 6 in. deep, which has been manufactured by the spot-welding method, is illustrated in Fig. 2. One of the doors is open, and

FIG. 1. GROUP OF LOCKERS

FIG. 2. SPOT-WELDED CUPBOARD

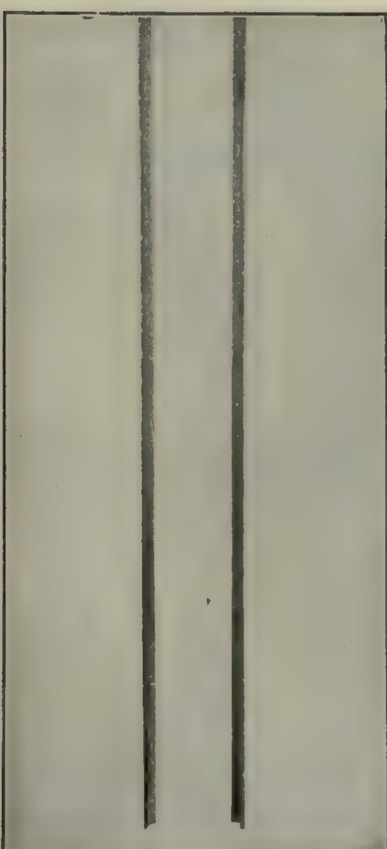


FIG. 3. FRAME ELEMENTS

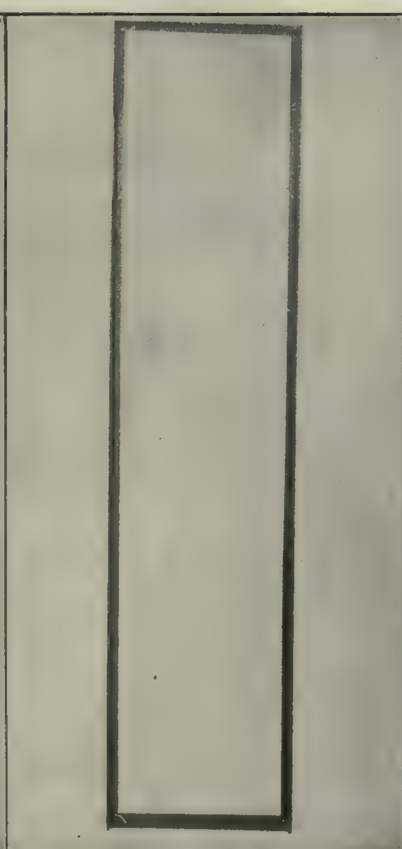


FIG. 4. SPOT-WELDED FRAME

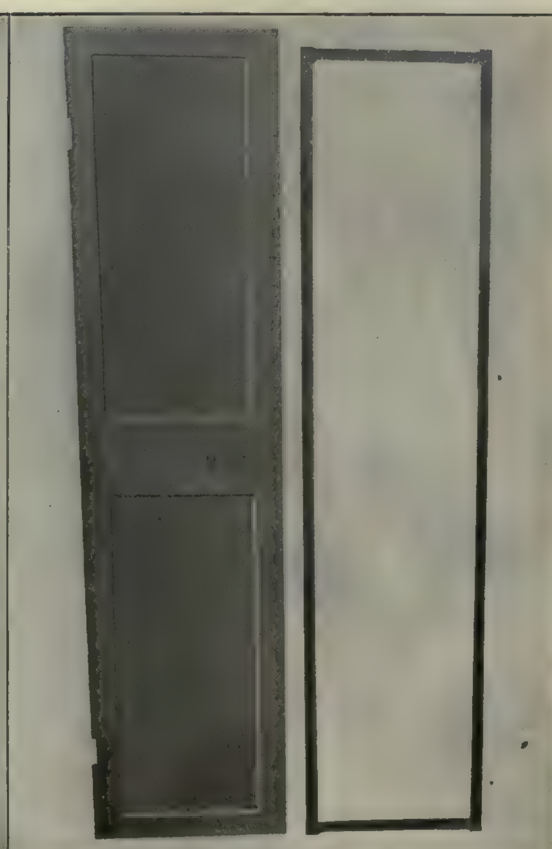


FIG. 5. CUPBOARD DOOR AND FRAME

it will be observed that the shelves may be placed in various positions, the holding and locating strips being spot welded at the back for that purpose.

The machines used at this factory for the various operations are Toledo and Winfield electric spot welders.

FIG. 6. TWO SPOT-WELDED DOORS

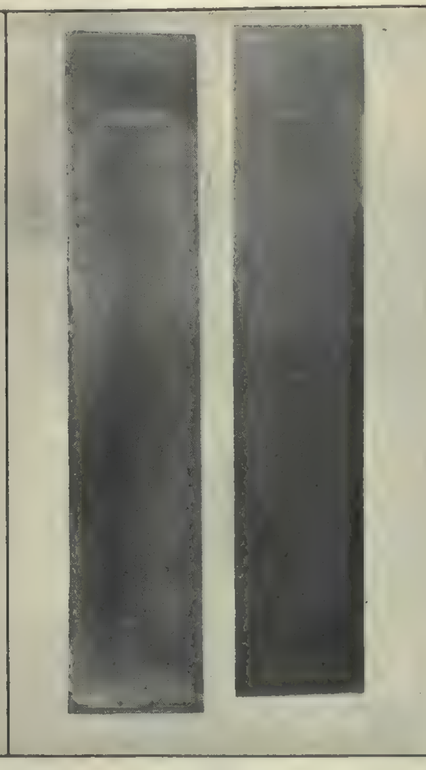


FIG. 7. WELDED SHELF SUPPORT

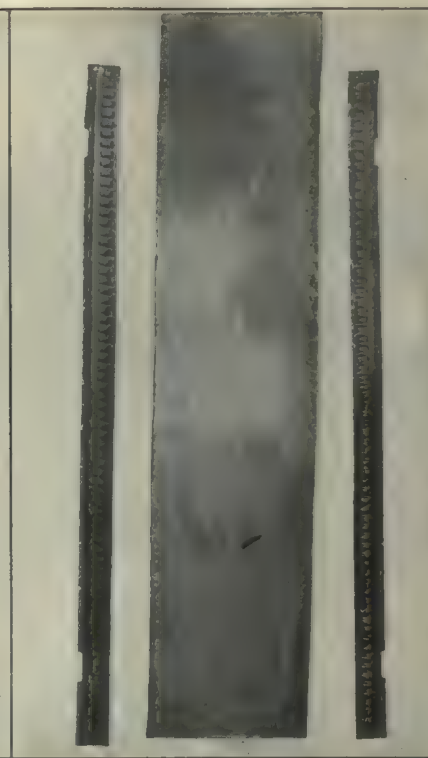


FIG. 8. PARTS FOR LOCKER END

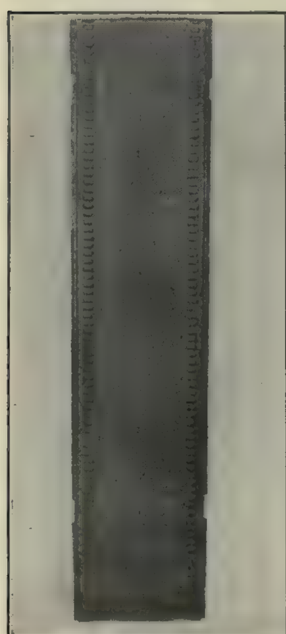


FIG. 9. LOCKER END

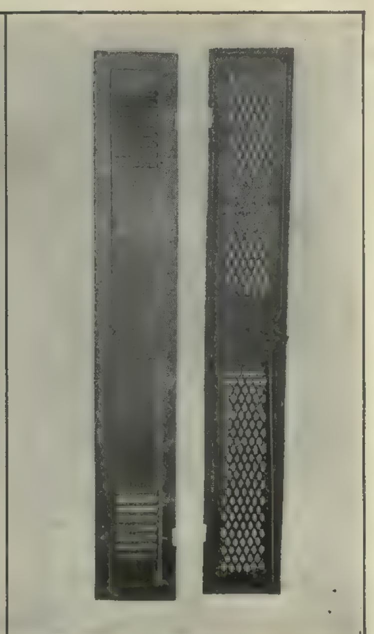


FIG. 10. LOCKER DOORS

In Fig. 3 is shown a set of the parts for a cupboard-door frame. These parts are made from angle-section steel (No. 14 gage) 0.078 in. thick and are first cut to the correct lengths. The four pieces are then placed in position and the corners united by means of the spot welder. For this operation, eight welds are made, and the time required is 1 min. One of the welded frames and a cupboard door may be seen in Fig. 5. The door is made from steel (No. 16 gage) 0.0625 in. thick.

The frame is then placed over the door, the correct location being obtained by measuring the frame from the edge of the door. The two parts—door and frame—are fastened together by means of 30 spot welds, and the time required is 2 min. Two of these welded doors are shown in Fig. 6.

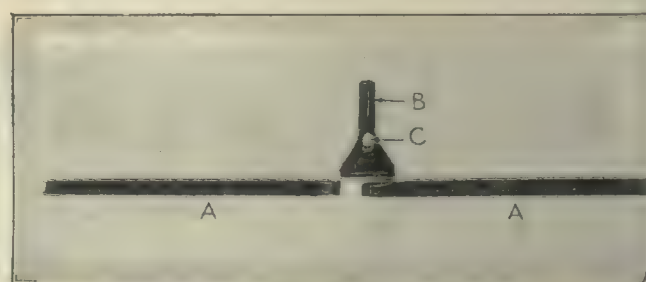


FIG. 11. WELDED FRAME AND LEG

In Fig. 7 are illustrated two shelf supports for cupboards. The cleat spot welded at the bottom is of steel (No. 16 gage) 0.0625 in. thick, and the clips at the upper part of the piece are 1 x 3/32 in. thick. Four spot welds are made to unite the parts in position, requiring approximately $\frac{3}{4}$ min.

Welding Locker Parts

A set of the elements used in the construction of a locker end is shown in Fig. 8. These parts are cut to the correct lengths to form an end, as shown. The shelf-support strips are then placed at the end of the back, and the angle strips at the top and bottom. Twenty-five welds are made on each strip and nine in each of the top and bottom angle strips. The time required for these locker ends, as shown in Fig. 9, is $4\frac{1}{2}$ min.

The back and shelf-support strips are both of steel (No. 24 gage) 0.025 in. thick, and the angle or reinforcing strips are of steel (No. 18 gage) 0.050 in. thick. Two types of locker door are shown in Fig. 10. The one at the left is the Louvre and that at the right the Diamond.

To attach the frame and the door, 28 spot welds are made, and the time required is 2 min. The door is made from steel (No. 18 gage) 0.050 in. thick, and the frame from steel (No. 14 gage) 0.078 in. thick.

In Fig. 11 are illustrated two pieces A, which are used on the door frame to hold the bolts after they have been shot for locking the doors. The angles at the inner ends of the strips A are fastened with two spot welds in each.

At B is shown one of the legs used on the lockers. In this piece a threaded bolt is spot welded at C, the flat head of the bolt fitting in a recess of the leg. A flat disk or base is afterward screwed on the threaded bolt to complete the leg.

Curves for Disk Brakes or Clutches

By Brent C. Jacob

In this chart are shown curves that will make it possible to obtain factors for disk brakes and clutches. In the notation used,

P = Total load in pounds on disk, uniformly distributed over the entire area A;
μ = Coefficient of friction;
R = Outside radius in inches;
r = Inside radius in inches;
p = Pressure per square inch;
A = Area of disk in square inches;
R_1 = Mean or effective radius of friction;
T = Torque, in inch-pounds, due to friction of one disk contact;
$A = \pi(R^2 - r^2) = bR^2$, where b is a value taken from curve b, depending upon the ratio $\frac{r}{R}$;
$R_1 = \frac{2}{3} \times \frac{R^3 - r^3}{R^2 - r^2} = aR$, where a is a value taken from curve a, depending upon the ratio $\frac{r}{R}$;

also,

$R_1 = dr$, where d is a value taken from curve d, depending upon the ratio $\frac{r}{R}$.

If p is kept constant, then the torque is given by the equation

$$T = pA\mu R_1 = p \times bR^2 \times \mu \times aR = p\mu abR^3 = p\mu cR^3$$

where c is a value taken from curve c, depending upon the ratio $\frac{r}{R}$. Curve c shows that the torque decreases as r increases, if p, μ and R are constants.

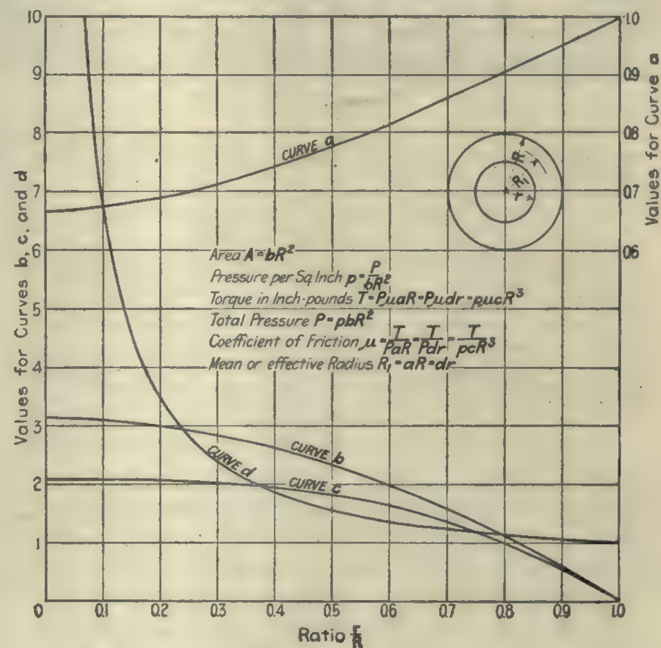
If P is kept constant, then the torque is given by the equation

$$T = P\mu R_1 = P\mu \times \tfrac{2}{3} \times \frac{R^3 - r^3}{R^2 - r^2} = P\mu aR = P\mu dr$$

Curve a shows that the torque increases as r increases, if P, μ and R are constants.

If P, R and μ are fixed by design and if $\frac{P}{\pi R^2}$ is less than the maximum permissible value of p, find the value of $b = \frac{P}{p_{max.} R^2}$; and from curve b, using the value just found, find the ratio $\frac{r}{R}$. Multiplying this ratio $\frac{r}{R}$, just found, by R gives r, the inside radius to give a maximum permissible torque $T = P\mu aR$, a being given by curve a from the foregoing ratio $\frac{r}{R}$.

If P, r and μ are fixed by design and a given torque is required, the outside radius R may be found as follows:



CURVES FOR FACTORS FOR DISK BRAKES AND CLUTCHES

From $T = P\mu dr$, $d = \frac{T}{P\mu r}$. This value of d on curve d corresponds to a definite ratio $\frac{r}{R}$; therefore,

$$R = \frac{r}{\frac{r}{R}}.$$

To show the application of the chart, the following examples are given:

1. Given, $p = 50$ lb., $\mu = 0.15$, $R = 4.3$ in., and $r = 3$ in. Find P and T.

$$\frac{r}{R} = \frac{3}{4.3} = 0.7$$

$P = pbR^2 = 50 \times 1.6 \times 4.3^2 = 1480$ *lb.*
$T = P\mu aR = 1480 \times 0.15 \times 0.861 \times 4.3 = 821$ *in.-lb.*
or
$T = P\mu dr = 1480 \times 0.15 \times 1.23 \times 3 = 818$ *in.-lb.*
or
$T = p\mu cR^3 = 50 \times 0.15 \times 1.37 \times 4.3^3 = 817$ *in.-lb.*

2. Given $P = 1480$ lb., $\mu = 0.15$, $R = 4.3$ in. Find T, when $p = 50$ lb.

$$b = \frac{P}{pR^2} = \frac{1480}{50 \times 4.3^2} = 1.6$$

This point on curve b corresponds to the ratio $\frac{r}{R} = 0.7$, and a at this ratio $= 0.861$. Therefore,

$T = P\mu aR = 1480 \times 0.15 \times 0.861 \times 4.3 = 821$ *in.-lb.*

3. Given, $P = 1480$ lb., $r = 3$ in., $\mu = 0.15$ and $T = 818$ in.-lb. Find R and p.

$$d=\frac{T}{P\mu r}=\frac{818}{1480\times 0.15\times 3}=1.23$$

This point on curve d corresponds to the ratio $\frac{r}{R}=0.7$. Therefore,

$$R=\frac{r}{\frac{r}{R}}=\frac{3}{0.7}=4.3$$

and

$$p=\frac{P}{bR^2}=\frac{1480}{1.6\times 4.3^2}=50$$

4. Given, $P = 1480$ lb., $R = 4.3$ in. and $r = 3$ in. Find μ, when $T = 818$ in.-lb.

$$\frac{r}{R}=\frac{3}{4.3}=0.7$$

and a at this ratio $= 0.861$. Therefore,

$$\mu=\frac{T}{PaR}=\frac{818}{1480\times 0.861\times 4.3}=0.15$$

5. Given, $p = 50$ lb., $\mu = 0.15$, $R = 4.3$ in. and $T = 817$ in.-lb. Find r and P.

$$c=\frac{T}{\mu p R^3}=\frac{817}{0.15\times 50\times 4.3^3}=1.37.$$

Therefore,

$$\frac{r}{R}=0.7 \text{ and } r=0.7\times 4.3=3 \textit{ in.}$$

$$P=pbR^2=50\times 1.6\times 4.3^2=1480 \textit{ lb.}$$

6. Given, $p = 50$ lb., $\mu = 0.15$, $T = 821$ in.-lb., $P = 1480$ lb. and $\frac{r}{R} = 0.7$. Find r and R.

$$R=\frac{T}{P\mu a}=\frac{821}{1480\times 0.15\times 0.861}=4.3 \textit{ in.}$$

and

$$r=0.7\times 4.3=3 \textit{ in.}$$

All the above figures are slide-rule values.

Combination Die for Automobile Valve Spring Cup

By Fred Rauter

The die about to be described was designed for the manufacture of automobile valve spring cups (see Fig. 1) and was used in a double-acting press.

In the construction of the die the blanking and forming ring A, Fig. 2, is seated in a base B. The blanking punch C, which serves as a guide for the forming punch D, is fastened to a cast-iron holder E. The part F strips the scrap from the punch. The knock-out G is supported by four push pins H abutting against the washer J, which serves as a retainer for the spring K the tension of which is controlled by the nut L. The stud M, which supports the knock-out arrangement, is drilled through to allow the scrap punchings to pass. Slots were cut on the top face of the punch holder to prevent the entrapment of air in the guide pin bushings, eliminating unnecessary power and wear on the die. The operation of the die is as follows: The blank is cut from the strip by the punch C and forced down to the draw edge. The forming punch D and the piercing punch N then descend, completing the cup. As the press ascends, the punch D disappears through the opening of the blanking punch C, stripping the cup, while the knock-out ejects the cup from the die ring. The work turned out by the die has been very satisfactory, and the speed of production maintained has been very good.

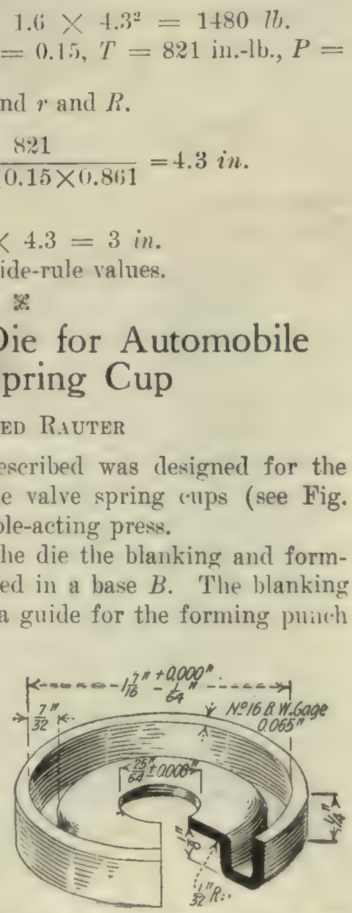


FIG. 1. THE SPRING CUP TO BE MADE

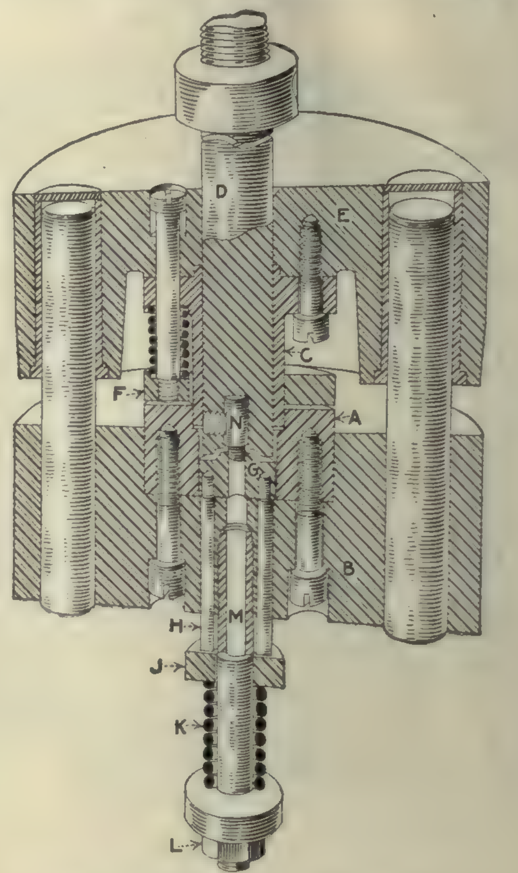


FIG. 2. THE COMBINATION DIE USED

Repair Work on a Drilling-Machine Spindle

By Howard Bogart

A repair recently made on an upright drilling-machine spindle may be of interest to some other readers. The machine had been used for boring holes far beyond its capacity, with the result that the faces of the tang slot in the spindle were destroyed. The method of repair decided on was to tap holes from opposite sides of the spindle and fit in hardened screws to replace the worn sides of the slot.

The spindle had a No. 3 Morse taper, $\frac{25}{32}$ in. at the small end. The screws were made $\frac{3}{4}$ in. by 16 threads and were screwed in to engage the tang of a drill. Their length was such that the outer ends were a little below the surface of the spindle. The edges of the holes were then peened over to fill notches filed in the corners of the screws, effectually preventing them from unscrewing. For the sake of speed, the holes were drilled with an electric drill. The whole job took scarcely an hour and proved to be a very satisfactory and cheap way of making the repair.

Series for Draftsmen and Designers

Getting a Draftsman Job

By Charles M. Horton

WHEN it comes to getting a draftsman job, or to talking about getting a draftsman job, I believe I am the one Simon-pure *hombre* for the task. I have probably stepped into and stepped out of more drawing rooms than the average among draftsmen. I like to do it—both ways. At least, I used to like to do it. I am getting old now, and my hair is slipping back, and my wife won't let me—I got married a short time ago. Don't get married, fellows. Marriage stops things—some things. It starts some other things—rolling-pins and the like—toward you, in your general direction. Even so, I am good at getting a job. Experience teaches in this as in any industry; and in scouting about the country I learned many things which, I feel, will prove of interest, if not actually of benefit, to you—along these lines, of course.

The popular mediums through which to land a job are three. These are respectively the newspapers, employment agencies and one's personal connections. Of these three mediums the least satisfactory—or so it has proved in my case—is that offered by the newspapers. Desirable employers do not make use of news columns in securing help. They don't have to—at least, employers who have use for only one or two draftsmen. These employers usually are so connected themselves that they can secure their help through the employment bureaus conducted by the secretary of their respective societies. Therefore, jobs advertised in newspapers are jobs to be approached with a due modicum of caution and to be entered upon with all senses alert for the unexpected. For the unexpected frequently happens.

The Result of One Newspaper Ad

Not long ago there was a draftsman working in a line not his line. It was a steady job, but he did not like the class of work. Riding downtown in the subway one morning, he saw in his daily paper an advertisement for a draftsman. The advertisement set forth among other things, one of these things being a line of work this man was familiar with, that salary was no object. Now, that kind of an advertisement will *get* anybody. "Salary no object"—Oh, boy! Forty—fifty—dollars a week—huh? You said it! And work right in his line, too! Why, the job was as good as cinched, if he only got to it. And getting to it, I might say parenthetically, is twelve-tenths of landing any job. Beating out the other fellow—by appearing at eight-thirty when an advertisement requests applicants to call at nine—is a trick well worth bearing in mind in this matter of landing a job.

Well, this draftsman got off at the wrong station for his regular job, but the right one for this advertisement. He was early. But early as he was, he found three men there ahead of him, which only strengthens the point I make—that you can't get there too soon. And the boss was interviewing all three men at once. So my friend horned in and was pleasantly received, and the boss very kindly went into the proposition again for his benefit. It was a special machine, which had already been designed, and the company wanted details out within a week in order to make a contract. The drawings *had* to be got out in that time in order to meet the contract; and as a result, salary for the particular job was of no importance.

My friend looked at the general arrangement. He saw that one man could not get it out within a week. He said so. The boss looked troubled. Evidently he didn't know, himself. He scratched himself—his head—for a moment, then made the group a most magnanimous offer. Aside from the salary no object, he would give the man who took the job a bonus of one hundred dollars if he would get the drawings out on time. A hundred dollars! Oh, boy—Oh, boy! *An* hundred dollars!

My friend took another look. To make a short story shorter, it was decided to put two men on the job; and in order to be fair to these early birds—the outer office was rapidly filling up with rolls of drawing and handbags attached to applicants—the boss offered to toss up a coin, heads or tails, and the two men who guessed right could go to work. That, too, sounded good. So the coin was flipped up; the candidates took sides and made their guesses; the coin dropped to the drawing table. My friend and the gentleman who

had taken sides with him won. Hurray! There was a wild stripping off of coats, a mad rolling up of shirt sleeves, a nervous uncovering of drafting instruments. They were off—off in a cloud of dust—the while the boss shooed the remaining host of sorrowful applicants out the door. It was an office in a New York office building, a wildcat concern of some unknown and unknowable brand, lacking a shop of its own. That was about six months ago. My friend and his co-worker finished the job on time, working on tingling nerves far into the night of each day. But though they finished the job on time, and though all this happened some six months ago, my friend has yet to see any money for his work. They stalled him at the end, talked of banking hours and the like, and told him and the other chap to return Monday morning. Monday, it was some other bluff. The treasurer had forgotten, or something. Tuesday, he had been called out of the city. Wednesday, his grandmother had died. Thursday, he would have it Friday. Friday, come around Monday morning.

I doubt if he ever gets that money, unless he puts the matter into the hands of a lawyer. And even then he will probably have to hire another lawyer to collect the sum from the first lawyer. That can happen, too, you know.

A Caution Regarding Employment Agencies

Beware of newspaper jobs. Also, unless your needs be most pressing, stay away from the employment agencies. Employment agencies may be a necessary evil, but I very much doubt it. That they are evil, in that they bleed a man for his first two weeks' salary; in that they attempt to corral, and usually do corral, all advertised positions before the prospective employer has an opportunity to try out other and more decent means to secure help—any man out of a position will tell you. It used to be, some ten years ago, and perhaps is yet, that a man could not get a draftsman job in the Rocky Mountain region without the assistance of one of these modern Juggernauts of labor. They fatten on the luckless; and any concern or organization of men that does that belongs, by the right of kings, in the limbo of the unsanctified. Hell is paved with such men. And be sure your listeners are in good working order. I know of one needy draftsman who lost an excellent opportunity because he failed to hear aright. It was in this same Rocky Mountain region. The year was 1907—that year of banking-house certificates, when jobs were as scarce as hen's teeth. I was there, and know from long, sad and bitter experience.

This friend of mine—I've got a lot of friends in the business—had struck Denver with about a dollar-eighty in his clothes, a ravenous appetite and no prospects of a job. Suitcase in one hand, a handbag in the other and his loose change in a third, he sallied out in quest of lodgings. Furnished rooms cost two and three dollars a week in Denver at that time, as in any other city. He found one for two dollars, paid a half week's rent in advance, girded up his loins and went out after a job.

It was not a case of his seeking a position; nor was it a case of his wanting one; it was the pure-quill thing of his having to have a job. Doughnuts and coffee could be procured for five cents on Larimer Street—he discovered that joint in ten minutes—but one must have much more substantial food than doughnuts and coffee if one would subsist in order to perform one's allotted daily task of drafting. Doughnuts and coffee are all right in their place, but their place is on the counter of the beaneries.

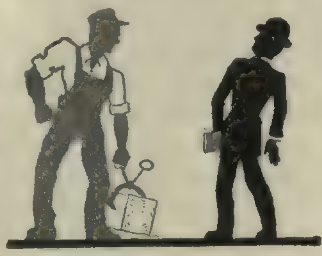
He struck an opening. It was luck, if ever luck was his. The superintendent was just about to think of putting on an extra man and told my friend so, and after asking him the usual questions added that he had better come in the morning prepared to go to work. This was Friday, and it might have been the thirteenth; I never learned. But my friend, thinking that the superintendent said Monday morning, nodded consent, bowed pleasantly and tiptoed out of the engineering office. Needless to say, he blew himself that day on eats with green trimmings to the limit of his capital, with such due regard for future inner yearnings as would be his to the first payday. How he did this is a secret. I will tell it. He pawned certain of his drawing instruments that he figured he could well get along without.

But he was doomed to bitterest disappointment, Monday morning, when he presented himself for work at the plant. The superintendent looked puzzled and inquired very solicitously why he, the applicant, had not appeared as requested. Then it all came out. He had looked for my friend Saturday morning, and when the latter had failed to appear, had taken on the next man who had applied for the job—and they were applying pretty frequently those days out there. The superintendent had said "tomorrow," whereas my friend had thought he said Monday. Woe was him! Sadly he went out and caught a job on the front end of a trolley car—motorman, you know—and learned that motormen, when employed, eat, just as draftsmen, when employed, punish viands. So what the difference!

So much for the grievous side. And now for the lighter side. I have great respect for the employer who disdains letters of recommendation. As one such employer once said to another friend of mine—I've already said I have a number of friends in the business—this friend of mine having presented a strong letter from his last employer: "But, my good man, who have you got to recommend this letter writer? I know absolutely nothing about him. He recommends you, and that forcibly, but who recommends him?" Which put it all very neatly, it seems to me. Letters of recommendation are today, and for the most part, taboo; but some employers still like to have them. Also, these employers still like to know who the applicant's grandmother

was and whether she took snuff and what the nature—if any—of her education.

Personally, I like a man who will take a gambler's chance. Sometimes it costs money, to be sure—money belonging to the company. But likewise, the applicant is taking a chance on his employer, as my friend did on that bonus job; and while the average draftsman values his time but little in learning the nature of his job and employer, he should not. Time spent in learning whether he likes his job or employer is time lost or gained, depending on his decision later; and he ought to, and has a perfect right to, inquire into the nature of the position, even as his employer deems it his right to inquire into the past career of the applicant.



Questions of a particularly pointed nature often bring out the fact that the concern cannot hold its men. Why this is so should engage the thought of the applicant. Sometimes such an inquisition brings to light some very interesting material. Had my friend on that bonus job had a little talk with the iceman, for instance, he would have learned that this particular office had not paid a bill in three months. But who wants to talk with an iceman, I hear somebody say. My answer is, Nobody—especially an iceman. Yet out of the mouths of fools and sucklings, as Shakespeare and quite a number of kings long ago discovered, come words of infinite wisdom.

To sum up, then: Be cautious about newspaper advertisements; seek employment agencies only when you have exhausted all other possibilities; make use of your connections, if you have any, with sincere effort. And when you are talking with a prospective employer, put all your cards on the table. If you have had trouble somewhere with an employer, say so; and if he wants to know what it was, give him the details with all the honesty you can command. The little man may turn you down. If he does, you can call that your good fortune—you don't want to work for that kind of a man, anyway. But tell the truth. It pays in the long run. Don't hide anything.

If your employer is worthy and well qualified, he will perceive in a very short time whether you are capable or not and retain your services or fire you out, as the case may be. If he discharges you, all your early talk, whether the truth or otherwise, won't hold you. So you might as well tell the truth at the start. If he fires you out, keep on looking for a job. You will find many splendid opportunities advertised in the reliable journals being published, and eventually you and the right boss will get together.

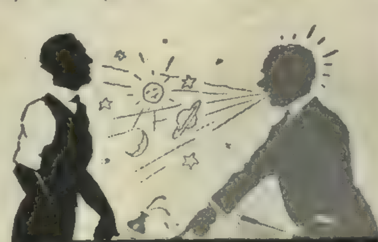
I recall a particularly sensitive young man who had had only a few years' experience. He caught a job in a concern, a small establishment, through an advertisement in the daily paper, space bought by an employment agency. From the first day, almost, he met with trouble. His ideas and those of his foreman proved diametrically opposite in every sphere. And the longer he remained under this man the less he believed he knew about the business. The man would eternally hammer home his own ideas as against anything in the way of suggestions or even actual drafting on the part of my young friend. And one day, after about a month, this man fired my friend as incompetent.

It was a pretty heavy blow. My friend was not incompetent. Merely, he was young and lacked a broad experience. But he came to me heavy-hearted. He was for quitting the business. I scented something irregular about the job he had just lost, and certain quiet investigations of mine brought to my attention the fact that this drafting-room chief stood in league with the chief operator of the employment agency, to the end that he hired and fired applicants one after another in order to make room for more guileless individuals who paid good money to the agency, which in turn handed over a certain per cent. to the chief of the drafting room. It was all a poor piece of business. But worst of all, it nearly broke the spirit of my young friend.

I interceded for him in the way of a position soon afterward. He went in there feeling pretty sore and inclined to sidestep it. But he didn't. He hung on and eventually, having found the right sort of employer, went on up to a point where today he has full charge of that room—and this all in a matter of less than a year. So he was not an incompetent. He was just unfortunate in not having closed with the right man for him.

Which points its own moral. Keep on moving until you land right. You may be weak in mathematics and strong on shop methods in the matter of machine design. Alert to new opportunities, you will strike a chief one day who is strong on mathematics and a little weak on shop practice. He will welcome you with open arms and will take care of that which you normally shrink from and heap you up with the thing you like to do. If you *are* weak in mathematics, by the way, and many rattling good designers are, do not hesitate to say so if asked the question. It will save you a lot of worriment later on.

I have before me a form of application made use of by some genius in the game whom I have not the honor of knowing. This form came to me in friendly manner; and while I do not know who filled it out, I shall pass it along to the brotherhood in an equally friendly manner, believing that my unknown friend would not raise a dissenting voice, if he knew. It looks to me like an ideal way to apply for a position advertised in the journals. I shall copy it verbatim, and it undoubtedly would be well for you to copy it when applying for your next position.



APPLICATION FOR POSITION. AVAILABLE IN 30 DAYS

Structural Engineer—Engineer of design and sales. Structural.

American—30 years; 6 ft. 3 in.; 170 lb. Dark complected. Married. Two children. Excellent habits.

Education—Graduate Yale, degree C. E. Post graduate, Yale Graduate School. Correspondent for "Engineering Record" constructional features.

Specialties—Coal-mining structures, tipples, loaders, conveyors, trestles, railroad bridges, mill buildings, blast-furnace equipment and industrial cars.

Business Engagements—Present with steel company in Pittsburgh as a foreman of drawing-room squad.

1914—Structural checker Hoosatonic Bridge, Hoosick Building Co., Hoosick, N. Y.

1913—E. P. Fuller Co., New York, structural checker.

1912—H. C. Frick Coal and Coke Co., Scottdale, Penn.

1911 and 1910——Structural designer of coal and coke machinery, loaders, charges, pockets and all plate and shape work.

1909—Bollinger-Andres Co., Pittsburgh, Penn., draftsman on all classes of coal- and coke-handling machinery—industrial cars, buckets, charges, loaders, hoists, conveying machinery, flight tables, etc.

Remarks—Will not leave present position for simply designing position, but will undertake to pursue a course through drawing room, estimating, commercial designing and contracting leading to sales-engineering connection covering above line in any metropolitan district.

Try some such thing as this. The facts are there. The prospective employer of your services cannot but rate you at a glance, if you fill in some such form of application as this.

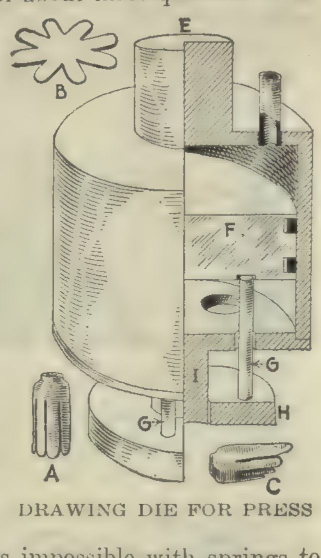
And tell the truth.

Air-Operated Pressure Ring for a Punch-Press Job

By D. C. Giles

How we managed on a small single-acting Bliss press to do work that ordinarily would be put on a double-acting press may be of interest.

The work was a brass ferrule about $\frac{3}{4}$ in. in inside diameter and $1\frac{1}{4}$ in. long. Instead of being solid around the circumference, however, for about three-quarters of its length it was composed of fingers, as at *A*, and was to be left spring temper, as it came from the final draw. It was blanked as illustrated at *B*, and a regular drawing die was made, with a rubber-backed pressure ring. This would not work, so springs of all sorts were tried. Finally, by using a long spring beside the punch, we could get the draw all right on some; but a discouraging number came lop-sided, as shown at *C*. This seemed to be due to the difference in thickness between the two sides of the blank. As it was impossible with springs to compensate for the difference in thickness of the blank, the contrivance shown was evolved.



DRAWING DIE FOR PRESS

It consists of a cylinder, the upper side having a stem *E* fitting the press ram, and the upper part seating against the under side of the ram like an ordinary punch block. A piston *F* is fitted into the cylinder, and the pins *G* bear against the piston. These pins reach through the lower end of the cylinder and bear against the hold-down ring *H*. In the center of the lower end of the cylinder is the punch *I*, held in a punch holder. The pressure was even on the blank (using about 80-lb. air from the shop system); or at least if it was not, no one ever knew it. The pressure was also constant; and while it has seemed to the writer on looking back over the job that a means of reducing the pressure at the latter part of the stroke would have been an improvement, still the device produced the goods with small loss. Consequently, every one was thankful and did not continue the research any farther.

Incidentally, we inclined the press so that the blanks would slide in; their own slight spring away from the punch made them strip nicely.

Drawing Angular Lines

By Leslie S. Little

For drawing angular lines I use a duplicate of the fixed head of the T-square. Holes are bored through it and the fixed head at their centers, and a bolt with a thumb-nut is inserted, binding the two together. When a special angle is wanted for the blade, all that is necessary is to turn the square over, set the extra head to the desired angle and tighten the thumb-nut. This arrangement permits working nearer the upper and lower edges of the board and does not make it necessary to "destroy" the angle when it is desired to draw horizontal lines.

I find the accompanying table of tangents convenient in setting the square. To use the table, lay out two points *A* and *B* 12 in. apart on a horizontal line on the drawing board, and draw a perpendicular at point *B*. Then lay off the tangent of the angle desired, on the perpendicular to the point *C*, and set the square so that the edge of the blade passes through the points *A* and *C*, which gives the required angle. For convenience, the table could be pasted or inked directly on the square.

TANGENTS OF ANGLES FROM 1 TO 45 DEG., WITH 12 IN. AS A BASE, TO THE NEAREST SIXTY-FOURTH OF AN INCH

Deg.	In.	Deg.	In.	Deg.	In.
1	$\frac{13}{64}$	16	$3\frac{7}{16}$	31	$7\frac{13}{64}$
2	$\frac{27}{64}$	17	$3\frac{21}{32}$	32	$7\frac{1}{2}$
3	$\frac{5}{8}$	18	$3\frac{29}{32}$	33	$7\frac{51}{64}$
4	$\frac{27}{32}$	19	$4\frac{1}{8}$	34	$8\frac{3}{32}$
5	$1\frac{3}{64}$	20	$4\frac{3}{8}$	35	$8\frac{13}{32}$
6	$1\frac{17}{64}$	21	$4\frac{39}{64}$	36	$8\frac{23}{32}$
7	$1\frac{15}{32}$	22	$4\frac{27}{32}$	37	$9\frac{3}{64}$
8	$1\frac{11}{16}$	23	$5\frac{3}{32}$	38	$9\frac{3}{8}$
9	$1\frac{29}{32}$	24	$5\frac{11}{32}$	39	$9\frac{23}{32}$
10	$2\frac{7}{64}$	25	$5\frac{19}{32}$	40	$10\frac{1}{16}$
11	$2\frac{21}{64}$	26	$5\frac{55}{64}$	41	$10\frac{7}{16}$
12	$2\frac{35}{64}$	27	$6\frac{7}{64}$	42	$10\frac{51}{64}$
13	$2\frac{49}{64}$	28	$6\frac{3}{8}$	43	$11\frac{3}{16}$
14	3	29	$6\frac{21}{32}$	44	$11\frac{19}{32}$
15	$3\frac{7}{32}$	30	$6\frac{59}{64}$	45	12

Chicago Machinery Club Elects Officers

The Machinery Club of Chicago has elected the following officers: President, Clyde W. Blakeslee, Abrasive Material Co.; first vice president, F. Le Roy Peterson, Hendey Machine Co.; second vice president, John D. Powell, L. S. Starrett Co.; treasurer, Arthur L. Beardsley, Cleveland Twist Drill Co.; secretary, Norton A. Booz, Machinists' Supply Co.; directors, Horace A. Stocker, Stocker-Rumely-Wachs Co.; Edward R. Welles, Charles H. Besly & Co.; John D. Porter, Marshall & Huschart Machinery Co.; Harry E. Witham, Warner & Swasey Co.; E. L. Beisel, Gardner Machine Co.; Oscar P. Wodack, of James J. Clark, Jr.; and Ambrose A. Bowyer, *American Machinist*.

How Automobile Starters Are Made

Special Correspondence

SYNOPSIS—The operations entering into the manufacture of the frame for an automobile starter are illustrated and described. The broaching of this part is of interest, as both ends are machined at one time, two broaches being used and the correct spacing obtained with a distance block. The pole piece is bored in a drilling machine, the bars being guided through bushings at the upper and lower ends, so that the holes will be in alignment.

Accuracy and interchangeability are essential factors in the making of parts for automobiles, and nowhere is this more exemplified than in the manufacture of the starting mechanism. The methods followed and the tools employed have been developed so carefully, and the operations follow one another so smoothly, that a maximum production is thus made possible.

Fig. 1 shows how the ends of the frame are broached. The two broaches are kept the correct distance apart by means of the spacing block *A*. Approximately 30 frames an hour can be broached by the method illustrated.

The next operation, which is to machine the sides of the frame, is accomplished in the fixture shown in Fig. 2. This is designed to hold five frames at one time, these being located on pins and against spacing blocks. Straps are then tightened by means of bolts and nuts, the frames thus being held securely in position. The cutter employed in this operation is 7 in. in diameter, has inserted teeth, and operates at 52 r.p.m. with a feed of 0.13 in. per revolution.

The next step is to drill the holes in the frame. The method of doing this is shown in Fig. 3. The piece is placed on height pins and pushed back against stops by means of the setscrews *A*. The cover is then fastened down by a thumb-screw, as shown, and the screw *B* tightened on the frame. Four No. 2 (0.221 in.) and four ⅜-in. holes are then drilled. The average rate of production for this operation is about 15 pieces an hour.

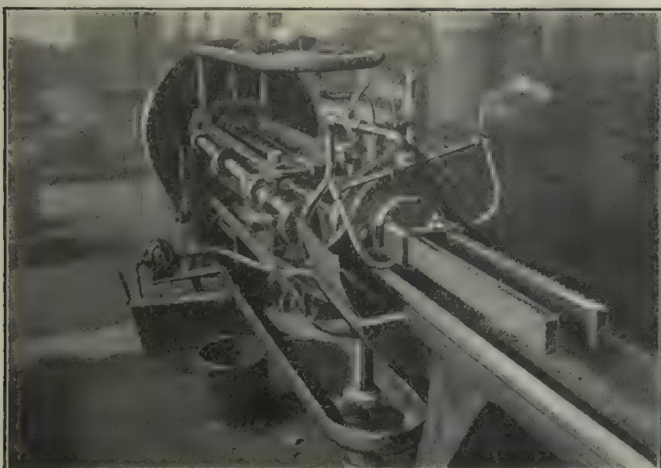


FIG. 1. BROACHING THE ENDS OF THE FRAME

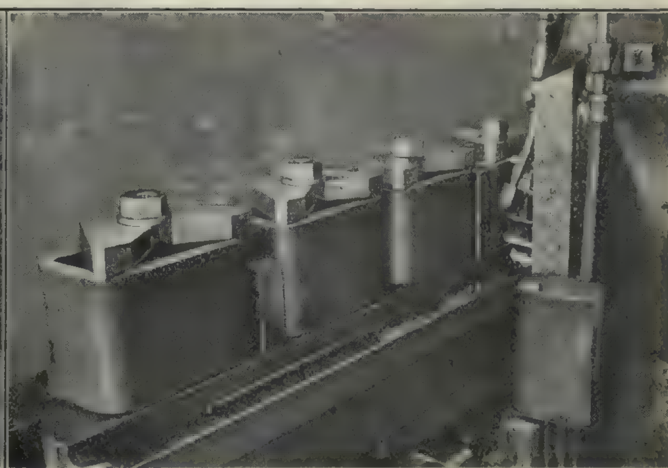


FIG. 2. MILLING THE SIDES OF THE FRAME

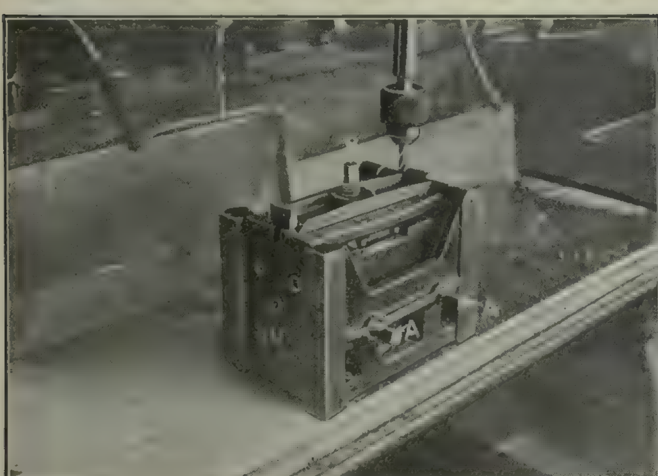


FIG. 3. THE FIRST DRILLING OPERATION ON THE FRAME

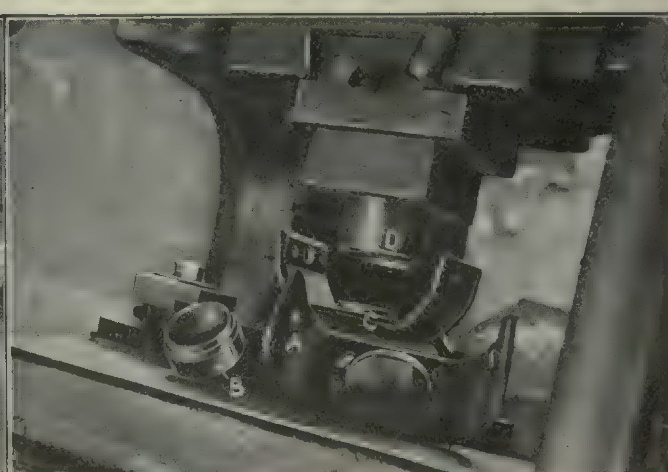


FIG. 4. PRESSING THE BEARING CAGE INTO THE END PLATE

Fig. 4 is an illustration of the press on which the bearing cage is fitted into the end plate. The bearing cage, shown at *B*, is made from bar stock; the end plate, shown at *A*, is a forging. The cage is slid into the end plate and placed under the press as shown at *C*. The punch *D* is then caused to descend, which upsets the projecting

end of the cage and attaches it securely to the end plate. The rate of production is 300 an hour.

The punch press and the tools used for bending in the ends of the plates are shown in Fig. 5. The work is placed on the die, being located by a pin that fits into the hole in the bearing cage. When the punch descends, the projections *A* come in contact with the sliding jaws *B* and force them down, the lower ends of the jaws coming against the lower ends of the end plate and pushing them back against the die block, thus bringing the end plates to the correct shape. The rate of production is about 500 an hour.

The pole pieces and the end plates are then assembled in the frame, after which the pole pieces are bored on one of the four spindle drilling machines shown in Fig. 6. The frames, which are located against stop pins, are forced back by means of setscrews, which can be seen on the sides and front. The covers, one of which is shown raised, are then fastened down on the fixtures by means of the hook latches. Bushings are provided in

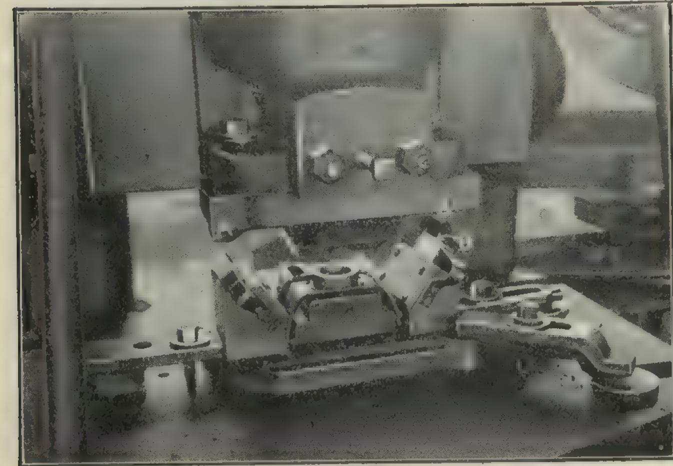


FIG. 5. BENDING IN THE ENDS

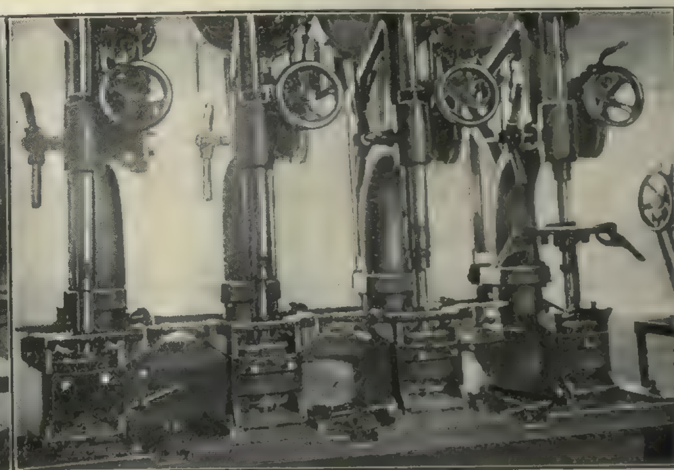


FIG. 6. BORING THE POLE PIECES

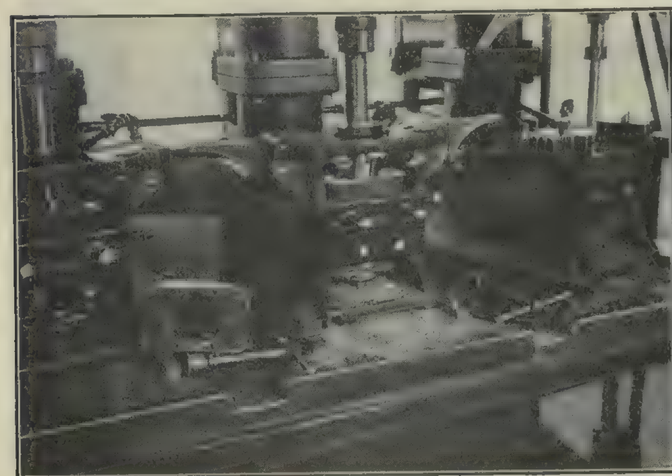


FIG. 7. CLOSE-UP VIEW OF ONE OF THE FIXTURES

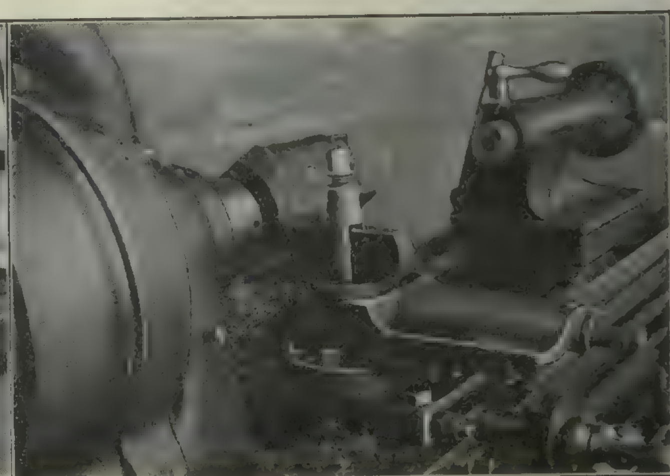


FIG. 8. FACING THE END OF THE PLATE

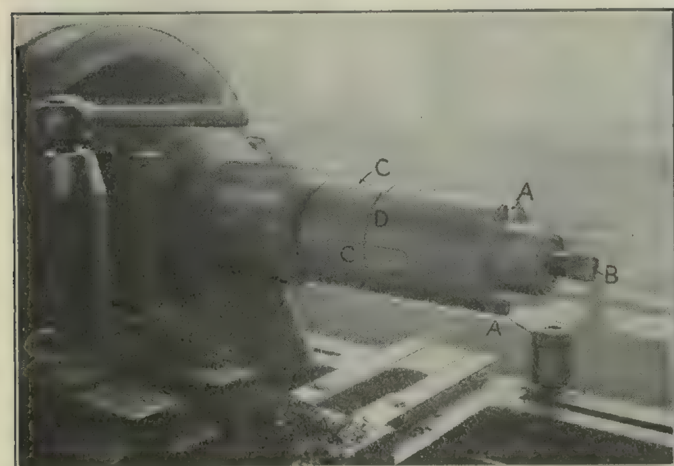


FIG. 9. DETAILS OF THE EXPANSION ARBOR

FIG. 10. MILLING THE ENDS OF THE FRAME

the covers and also in the base of the fixtures, to guide the bars in alignment. The pole pieces and the hole in the end plate are then machined in one operation.

A close-up view of one of the fixtures and a machined frame is shown in Fig. 7. The construction details of the fixture and the manner in which the boring operation is performed may readily be observed from this illustration. The rate of production from eight spindles is 210 in 9 hours.

Facing the End of the Frame

The facing operation on the end plate is shown in Fig. 8. The part is held on an expansion arbor and machined so that the assembled frame will be the correct length over all. A view of the arbor with the frame removed is shown in Fig. 9. The frame is pushed onto the arbor until the two locating pads *A* come in contact with the end of the piece. The screw *B* is then tightened, thus forcing out the pads at *C* by means of a taper. These pads come against the machined pole pieces and locate the frame central on the arbor. A spring fitted in the groove *D* keeps the locating pads from dropping out of the arbor. The rate of production from the facing operation is 30 frames an hour.

The next operation is to mill the ends of the frame, which is located on a mandrel that fits into the bored pole pieces and the bearing-cage holes. The mandrel and frame are then placed in the fixture, located against hardened-steel blocks, and the small side or end machined. This operation is performed with a 5-in. cutter operating at 52 r.p.m. with a feed of 0.13 in. per revolution. While one frame is being machined the operator is assembling an arbor into another piece. One of these frames already mounted is shown in the illustration at *A*, Fig. 10.

Drilling the Holes on the Side

The jig used for drilling the holes on the side is shown in Fig. 11. As in the preceding operation, the frame is located by a mandrel, which fits into the machined pole pieces and the bearing-cage bore. One of the mandrels is shown at *A*. The mandrel and frame are then dropped into the jig and the cover fastened down, after which four $\frac{5}{16}$-in. holes are drilled. One of the machined frames is shown at *B*. The gages for testing the accuracy of the holes are shown at *C*. The rate of production for this operation is 32 an hour.

FIG. 11. DRILLING THE SIDE HOLES

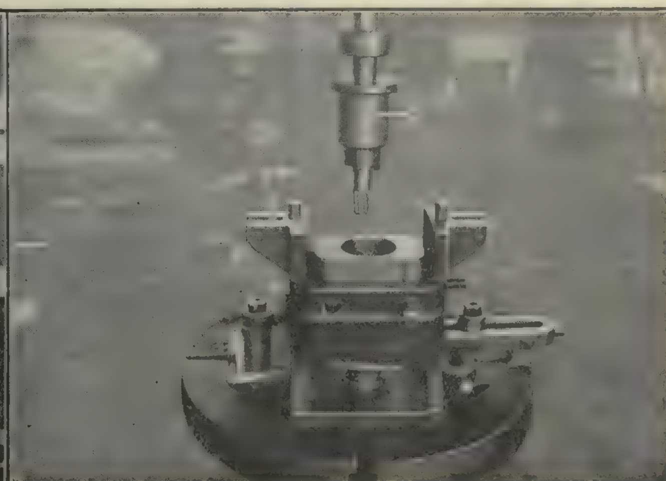


FIG. 12. LINE-REAMING THE FRAME

The line-reaming fixture for the frame is shown in Fig. 12. The frame is located on pins and, by means of the setscrews at the front and end, is forced against locating pads. The bushing *A* fits into the bores of the pole pieces, thus keeping the reaming bar in alignment. The bearing cage is then reamed and counterbored, the production being 45 an hour.

Doing Your Bit To Prevent Waste

By John R. Godfrey

Taking one's own medicine is one of the most disagreeable things most of us mortals have to endure, but now is the time to quit preaching and get down to doing. We read about the great need for economy of food, and keep right on eating more than is good for us, using three lumps of sugar in our coffee and demanding seven kinds of dessert on the bill of fare from which to choose. We agree fully that we ought to begin economizing right now, but we wait to let the other fellow start it.

Real, national economy does not mean "letting George do it," it means doing it yourself. And the sooner we realize it the less privation there will be and the better it will be for everyone. While there has been some little hysteria on the question of economy, there is less danger in this than that we will not realize in time that real, personal economies are necessary now and are likely to be necessary for some time to come. It is the worst kind of hysteria to stop buying drills and taps and necessary tools for work in hand and work to come, but we can very well postpone spending a few thousand dollars for a large electric sign which we would charge to advertising, but whose main object is to bolster our own personal pride by showing how nice the name Jones looks when we spend money enough so the world can see it as it should be writ.

Hard on the Sign Makers

Of course, it's a bit hard on the sign makers; but the tinsmiths can be set to work on the fittings for the galleys of the new ships. The electric lamps will also be needed for the same ships and in other useful places, and the coal used in the central station will help our new ally, France, a lot more than if it was burned to display

our name across the starlit sky. Just remember that there is going to be work for every mother's son of us, old and young, short and tall, no matter what kind of training we have had. It may not be just what we would like, perhaps, but it is going to be a case of doing what you can and not what you want; and we may as well get used to it first as last.

Economy is absolutely necessary in all lines, and it isn't a matter of issuing orders and waiting for something to happen, but for each of us to get busy and economize in our own particular way. It doesn't mean going without enough to eat; that isn't economy. But it does mean to stop wasting food and other supplies because we are afraid of having some one think we are a piker and haven't money enough to buy more than we want. It isn't a question of money at all, for money makes the most unsatisfying fodder you ever tried to masticate. But it is the things we eat and wear and use, which we think of in terms of money, that count. It is shoes and shirts and other clothes, and gasoline and iron and rubber and the thousands of things that we use every day as a matter of course, without batting an eyelash, because we have always had them. And we forget that they do not grow on bushes and that some of them come across the water where the U-boats are playing hide and seek and tagging vessels with torpedoes so cheerfully and far too successfully at present.

We do so many thoughtless and wasteful things in ordinary times that we never think of them as being anything but necessary. We throw away sheets of paper that are only partly used up, or because they are wrinkled a trifle, when they are perfectly good for scribbling or doing some little problem that we ought to be able to do in our head, but can't. Then we are as apt to burn it as not, instead of sending it back to the paper mills to be properly chewed up and digested and come back to us as brand new paper.

Some of the Small Preventable Wastes That Count Up

We do not use up our pencils because we lose them or think it looks cheap to use a stub, or for some other equally foolish reason. We waste material of all kinds, from tracing cloth and blue-print paper to high-speed steel at $3 a pound, because we do not figure closely enough on our needs. We burn electric lights unnecessarily and waste coal and lamp filaments in so doing. We waste water and again the coal pile suffers. We use leather where a substitute would be as good, or better, and thereby keep leather at a high price for commodities which really require it. We demand rings of platinum if we can afford it, and prevent its use for such necessary things as chemist pans and other scientific apparatus. And all because we measure things by money values rather than by their real uses in the world. The whole matter is a purely personal problem and one that we cannot pass on to the next fellow if we would.

Don't think for a minute that any little saving you might make would be too small to count. The millions of "yous" go to make up a tremendous total. Don't be fooled by the ads of the brewers that they consumed less than three-quarters of 1 per cent. of the grain production of the country. You don't eat percentages, but grain. And they admit using nearly forty-six million bushels last year, which would make several good meals, as it is nearly a half bushel for every man, woman and child in this little old U. S. A.

It isn't a question of how much George economizes that is your problem, it is how much you do to prevent waste and help things along. If George doesn't do his share, he may hear from it in unpleasant but forceful ways a little later; and it isn't a bad trick to learn how before the "waste preventer" gets on your trail. And even if he never does, there's a heap of satisfaction in knowing and feeling that you have done your bit, whether the other fellow does his or not. And it has another advantage also. Every dollar you save from unbought sugar and unwasted electric light you can tuck away in a Liberty Loan bond, helping yourself and Uncle Sammy at the same time; or the Red Cross can make good use of a spare dollar now and then.

The Real Patriot

It's a heap harder to deny ourselves the little luxuries, to refrain from an unnecessary joy ride in the flivver and to otherwise really join the "savers," than it is to jump up and holler every time some one waves a flag. And the fellow who waves the flag and wastes food and other commodities isn't half as patriotic either. If every one of us looks after our own little part, there won't need to be any firing squad for the wasters.

Conserve the Energy of American Workers

The following extract from the report of the Health of Munitions Works Committee, which was appointed by the British Parliament to investigate the general health of munitions workers and the constitutional effects wrought upon them by long hours and arduous work, should act as a signpost pointing the direction in which American workers should be asked to travel.

"Taking the country as a whole," the report states, "we are bound to record our impression that the munition workers in general have been allowed to reach a state of reduced efficiency and lowered health which might have been avoided without reduction of output by attention to the details of daily and weekly rests." The signs of fatigue are even more noticeable in the case of managers and foremen and the practical results here are probably even more serious than in the case of the workmen. The report refers to "a pronounced and common symptom of industrial fatigue which appears to be the reflection in the workmen's general health and spirits of the results of accumulated nervous fatigue, rather than a direct and measureable sign of it." It explains:

"At the present time in many munitions factories the complaint is made by workers, and not the least by the most intelligent and willing of them, that they are feeling 'done up' or 'fair whacked,' to use the local phrase, and the evidence shows that this state of staleness is becoming increasingly common and obvious. By experienced managers and medical officers this staleness is attributed almost wholly to persistent long hours and neglect of weekly rest periods.

"Proper attention earlier in the war to the need for weekly rest would have prevented a large part of the diminished capacity of this kind, and would have averted much costly and wasteful expenditure upon imperfect work."

United States Munitions*

The Springfield Model 1903 Service Rifle

Making the Stock—II

SYNOPSIS—The various woodworking operations involved in the manufacture of the stock are continued in this installment.

The rough cut for the receiver is made with the turret-head bedding machine, Fig. 1985, the work holder being shown in detail in Fig. 1986 and the cutting tools in Fig. 1987. These tools are guided by a master form, Fig. 1988. Gages for this operation are shown in Fig. 1989. top and bottom of the butt is shown at the right on the machine and in detail in Fig. 1993. The gages used are shown in Fig. 1994. The top edge is next finish profiled in the same type of machine, the work holder being illustrated in Fig. 1997.

A combination saw and wood shaper, Fig. 2000, is used for the final trimming to length and shaping of the butt for the plate. The holding fixture may be seen in Fig. 2002.

The multispindle bedding machine, Fig. 1942, is used to cut the top of the butt for the tang of the plate. As

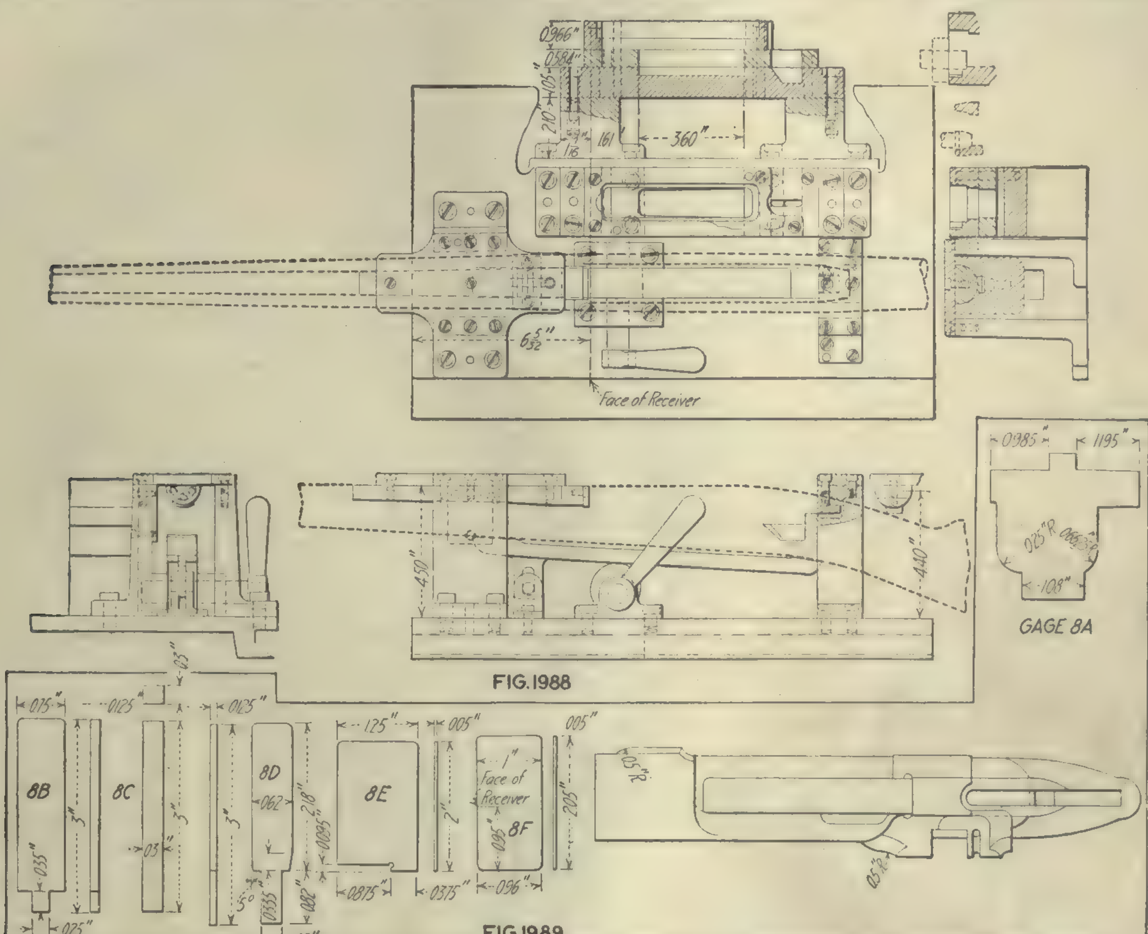


FIG. 1988

FIG. 1989
OPERATION 8

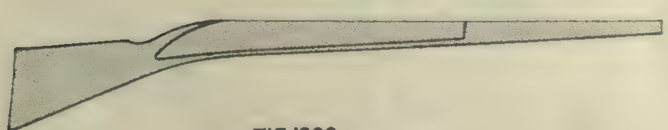


FIG. 1990

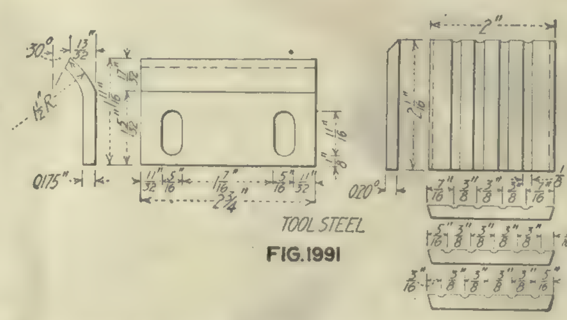


FIG. 1991

Profiling of the sides and the top and bottom of the butt is done in the three-spindle shaping machines, Fig. 1941. Two holding fixtures clamp the work to master forms. The fixture for the side profiling is illustrated at the left, and in detail in Fig. 1992. The one for the in most of these operations, a master form serves to guide the tool. The screw holes for the plate are bored at the same setting by means of a horizontal attachment shown

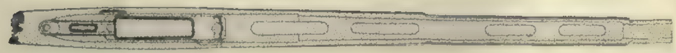


FIG. 1984

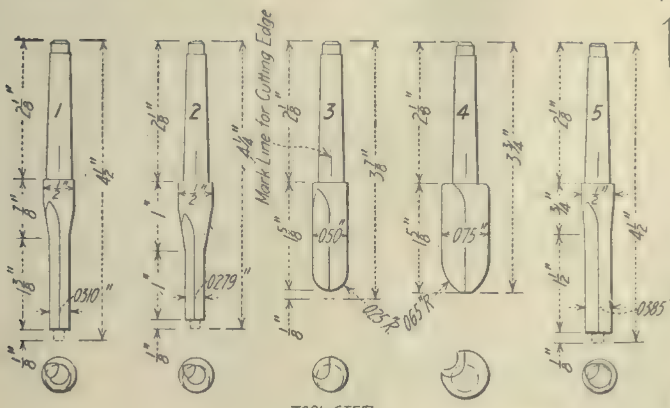


FIG. 1987

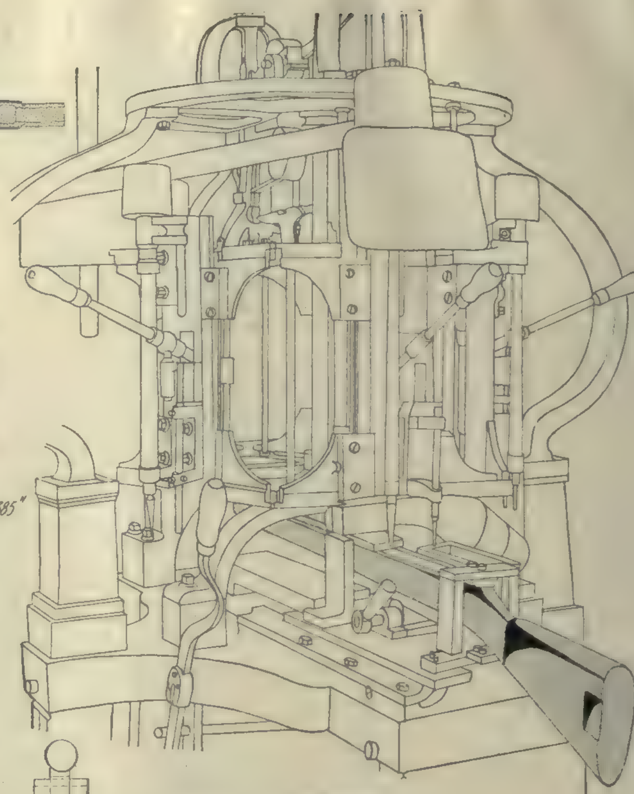


FIG. 1985

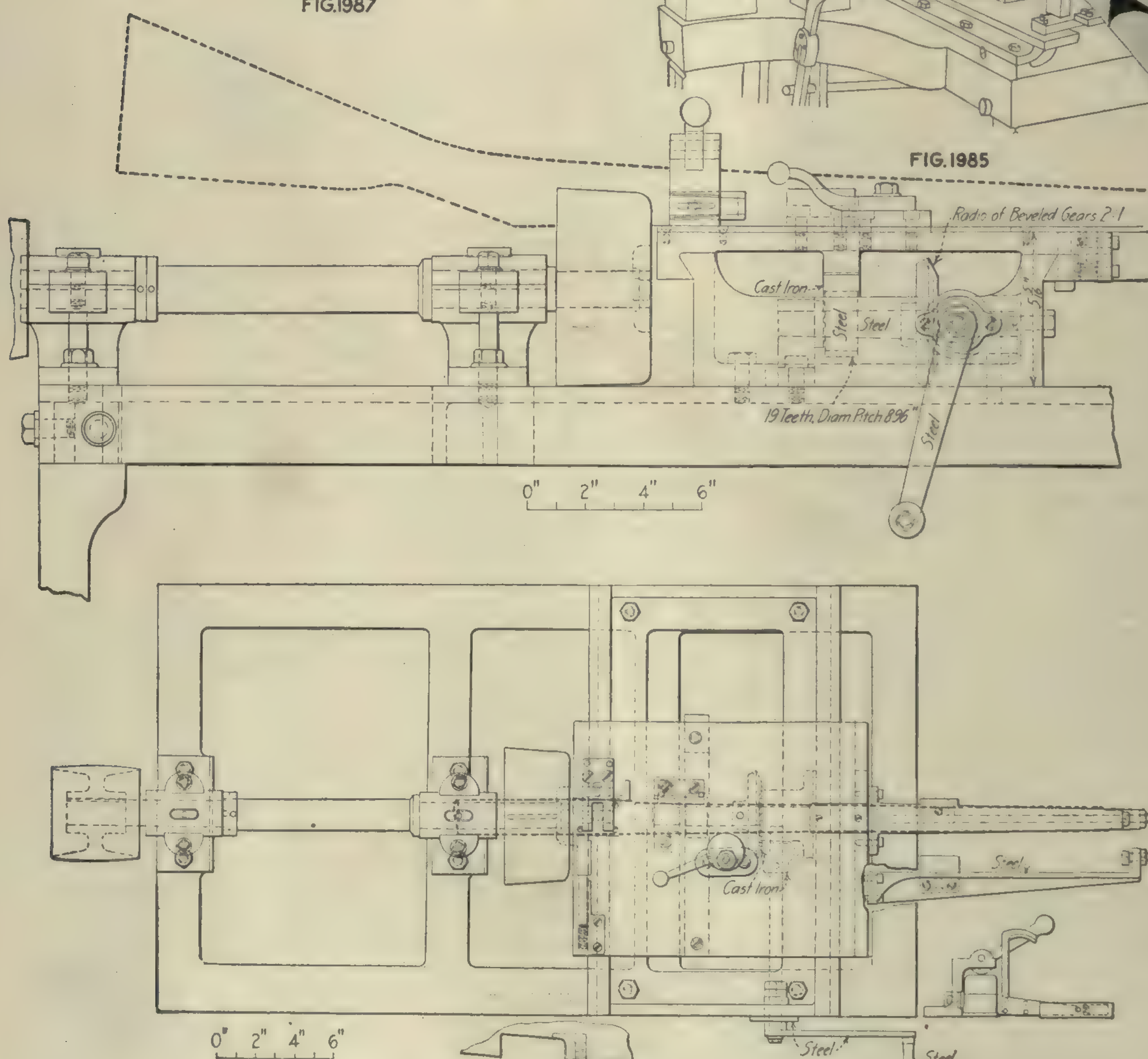


FIG. 1986
OPERATION 8

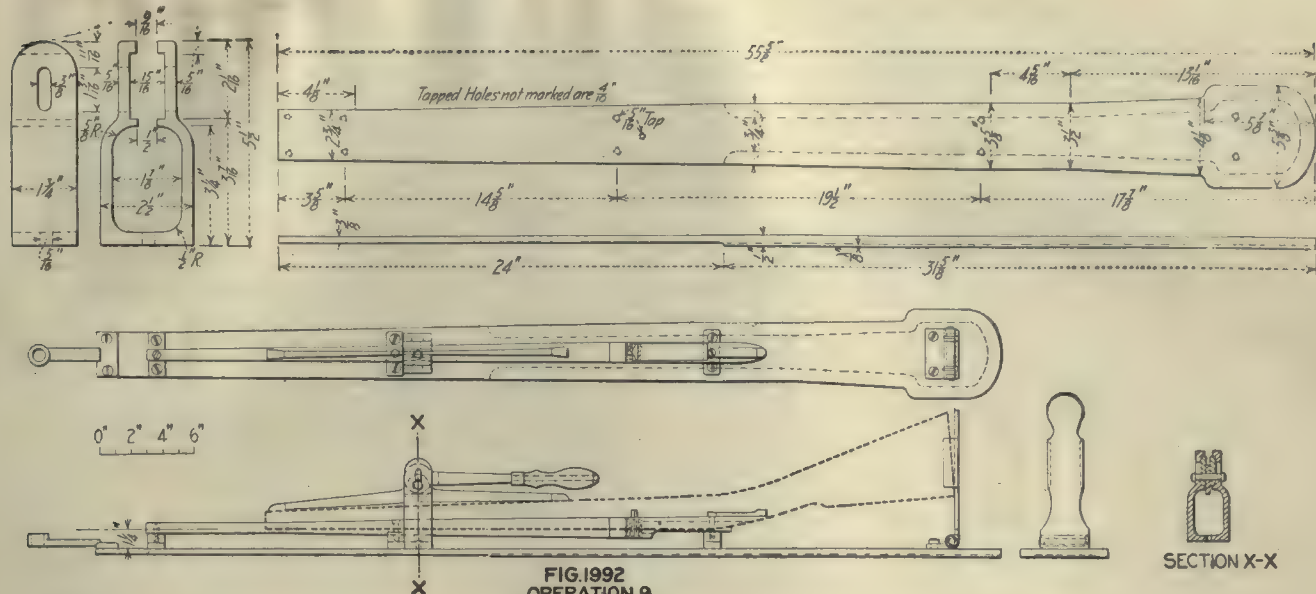


FIG. 1992
OPERATION 9

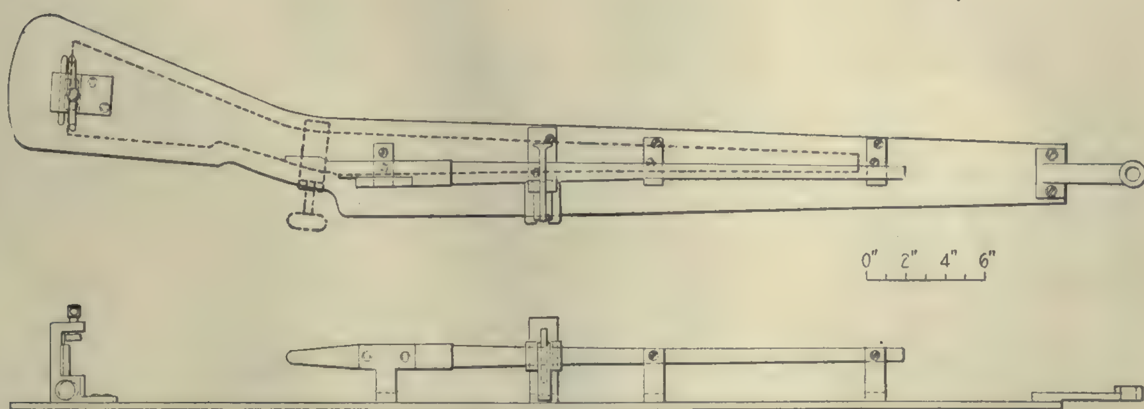


FIG. 1993

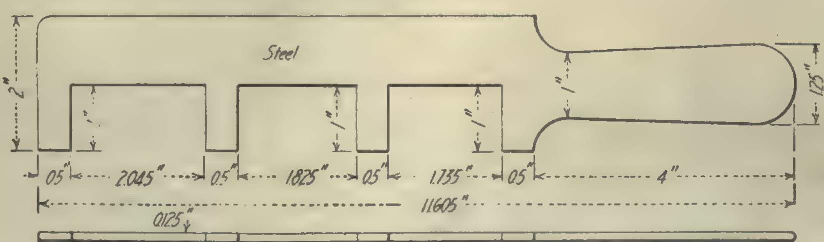


FIG. 1994
OPERATION 9

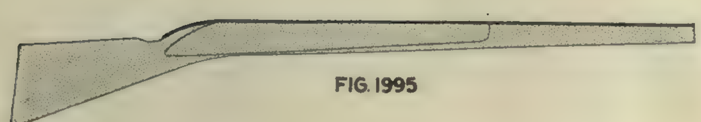


FIG. 1995

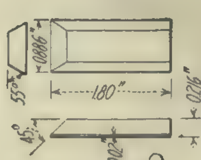


FIG. 1996

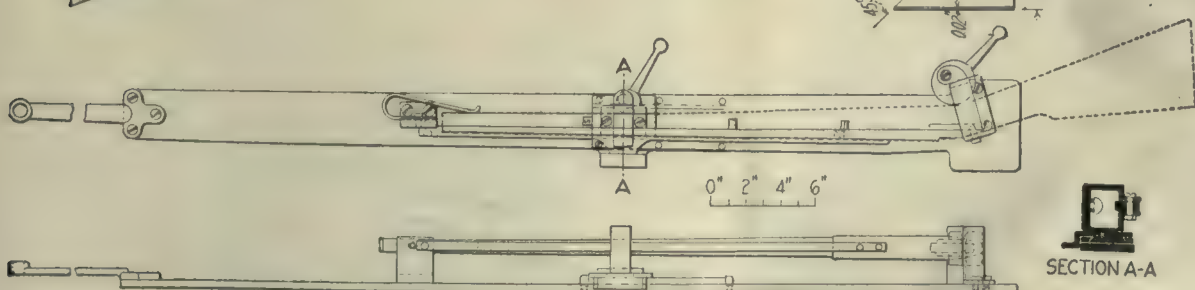


FIG. 1997 OPERATION 10

FIG. 1998

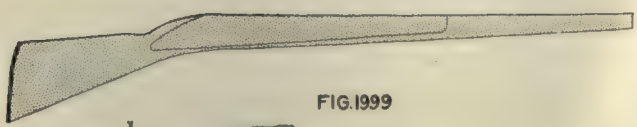


FIG. 1999

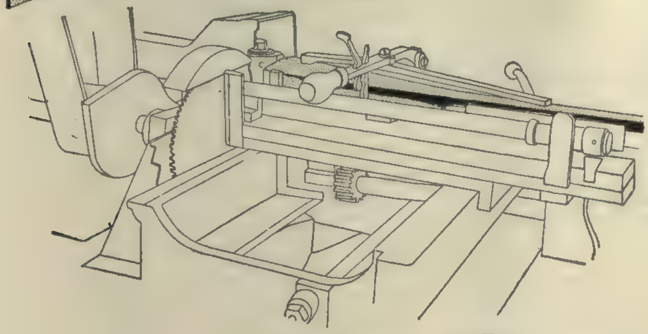


FIG. 2000

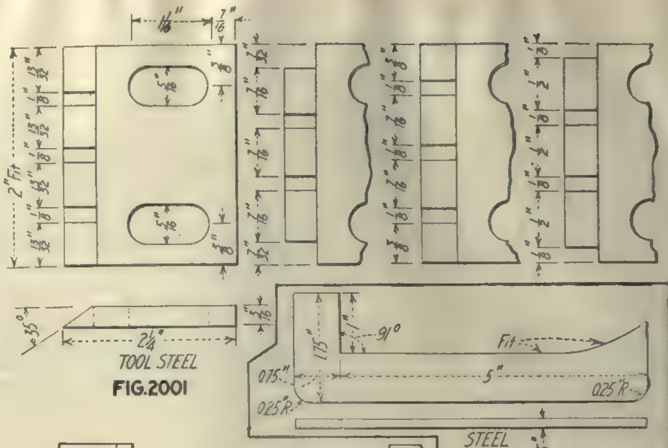


FIG. 2001

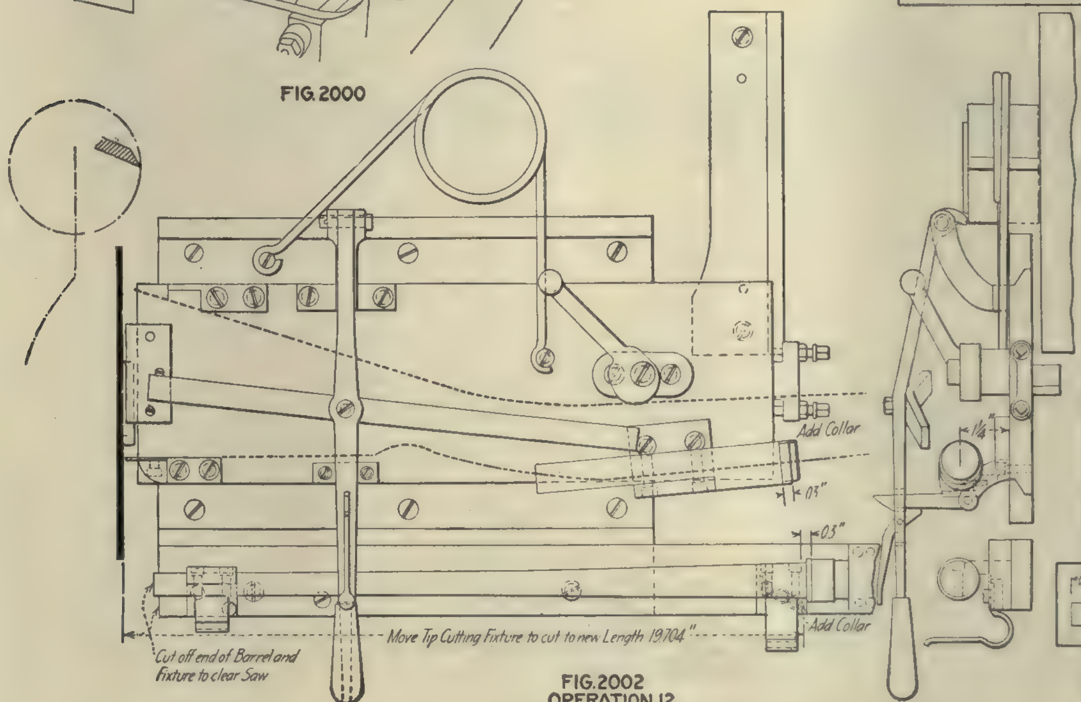


FIG. 2002
OPERATION 12

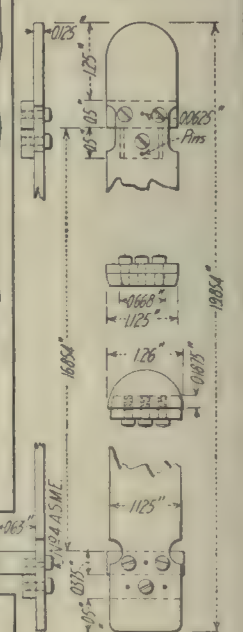


FIG. 2003

at the right. Details of the work-holding and profile fixture are given in Fig. 2006.

OPERATION 8. ROUGH-CUT FOR RECEIVER

Transformation—Fig. 1984. Machine Used—Turret-head bedding machine, Fig. 1985. Number of Operators per Machine—One. Work-Holding Devices—Fig. 1986. Cutting Tools—Fig. 1987. Cut Data—Spindle, 7000 r.p.m. Average Life of Tool Between Grindings—100 pieces. Special Fixtures—Master form, Fig. 1988. Gages—Fig. 1989. Production—528 per day.

OPERATION 9. PROFILE SIDES, BOTTOM, TOP OF BUTT

Transformation—Fig. 1990. Machine Used—Special shaping machine, Fig. 1941. Number of Operators per Machine—One. Tool-Holding Devices—Standard heads. Cutting Tools—Fig. 1991. Cut Data—3800 r.p.m. Average Life of Tool Between Grindings—Stoned every day; ground once a week. Special Fixtures—Side-profiling form and work holder, Fig. 1992; top and bottom profiling form and work holder, Fig. 1993. Gages—Fig. 1994. Production—363 per 8-hr. day.

OPERATION 10. PROFILE TOP EDGE TO FINISH

Transformation—Fig. 1995. Machine Used—Same type machine as for operation 9. Number of Operators per Machine—One. Cutting Tools—Fig. 1996. Special Fixtures—Master form and work holder, Fig. 1997. Gages—Fig. 1998. Production—1144 per 8-hr. day.

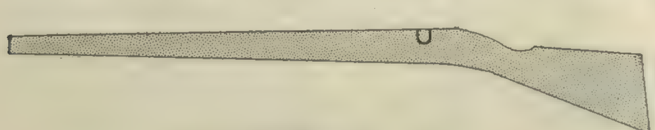


FIG. 2008

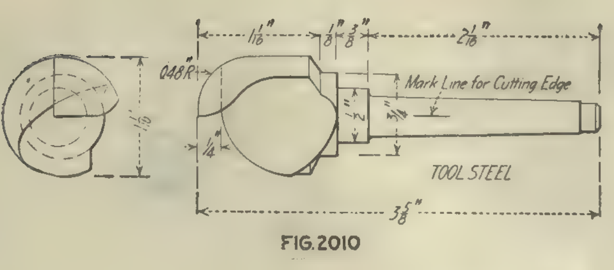


FIG. 2010

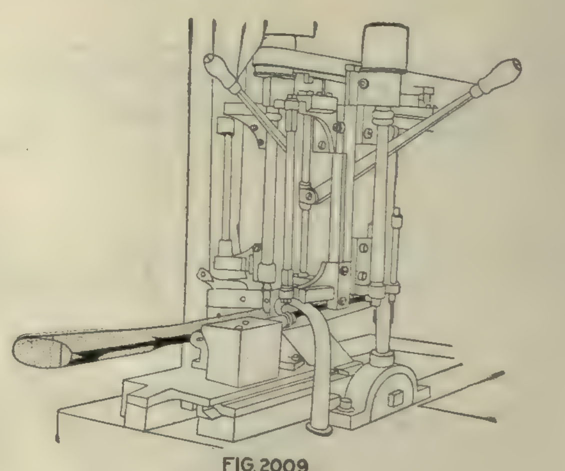


FIG. 2009

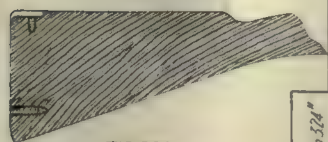
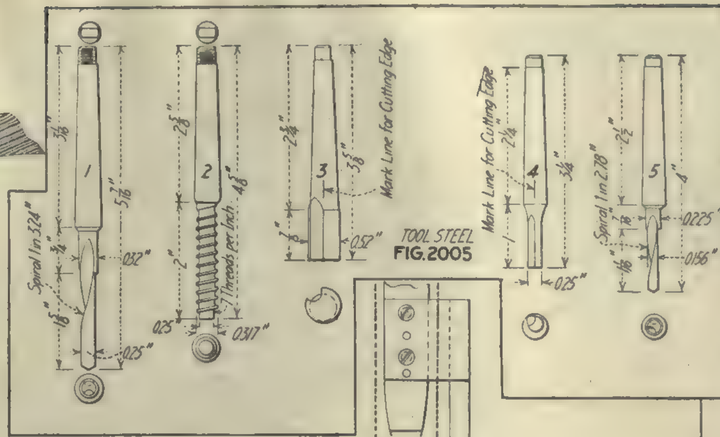


FIG. 2004



TOOL STEEL
FIG. 2005

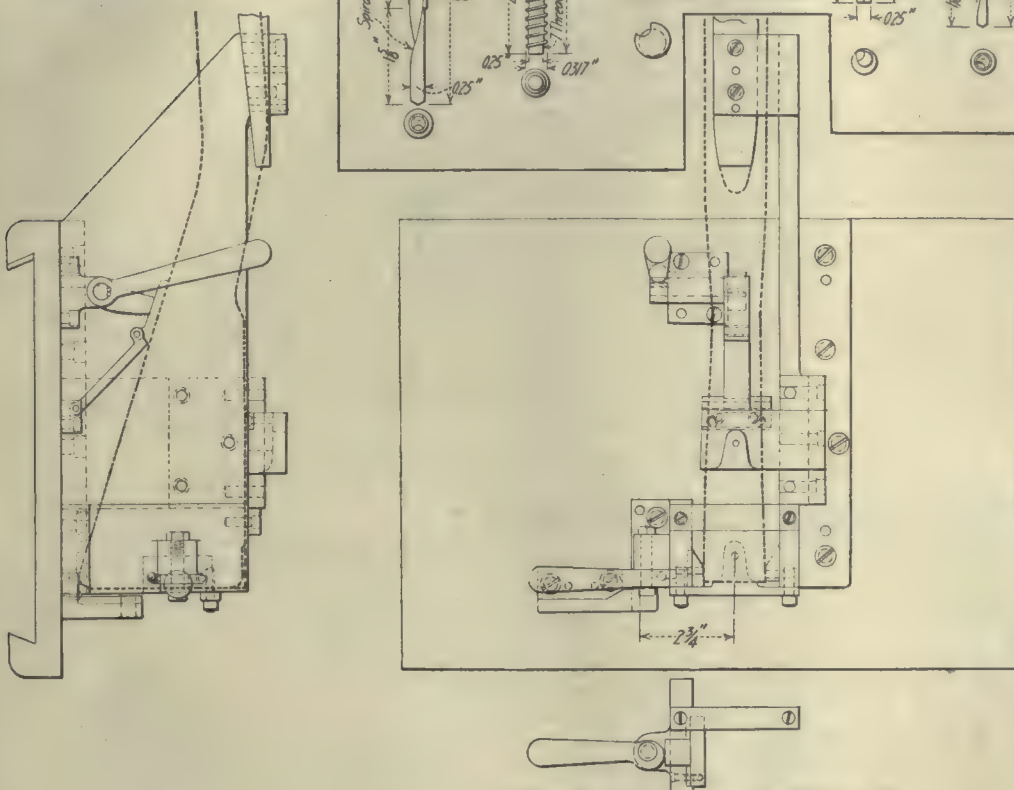


FIG. 2006

OPERATION 13

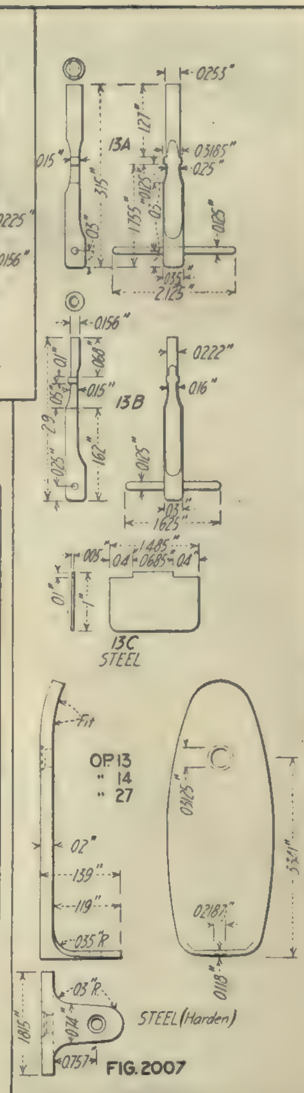


FIG. 2007

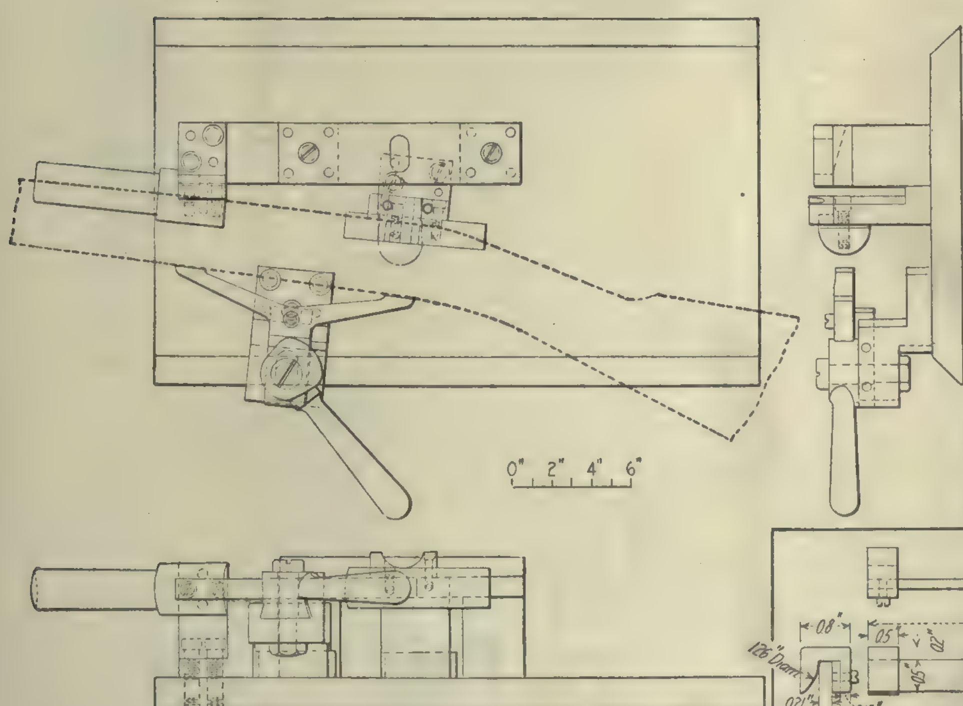


FIG. 2011

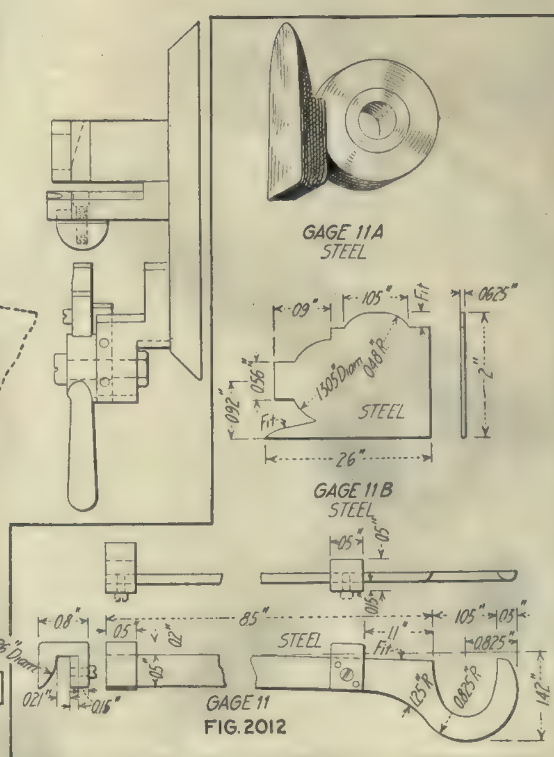


FIG. 2012

OPERATION 11

FIG. 2013

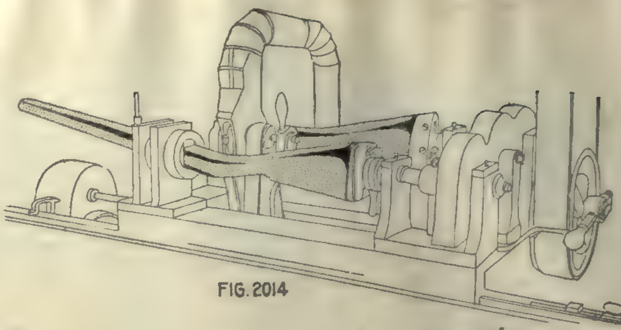


FIG. 2014

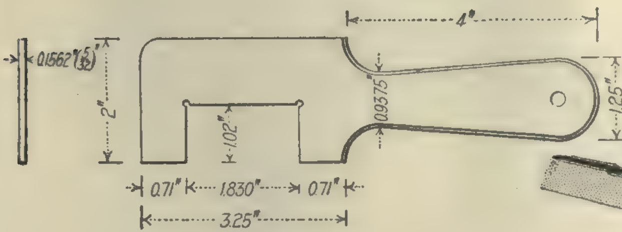


FIG. 2016

FIG. 2016

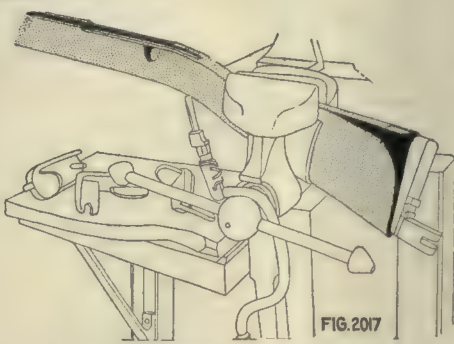


FIG. 2017

OPERATION 14

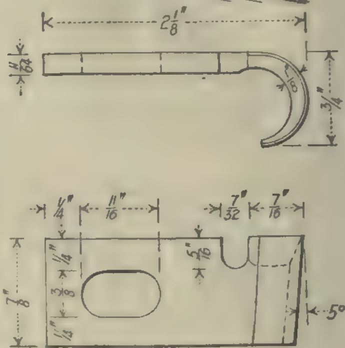


FIG. 2015

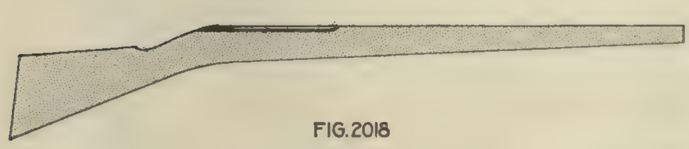


FIG. 2018

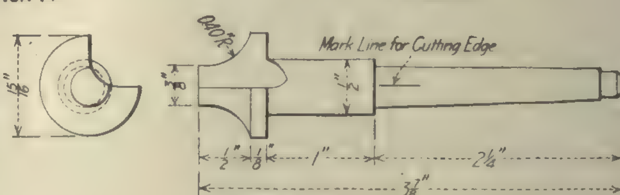
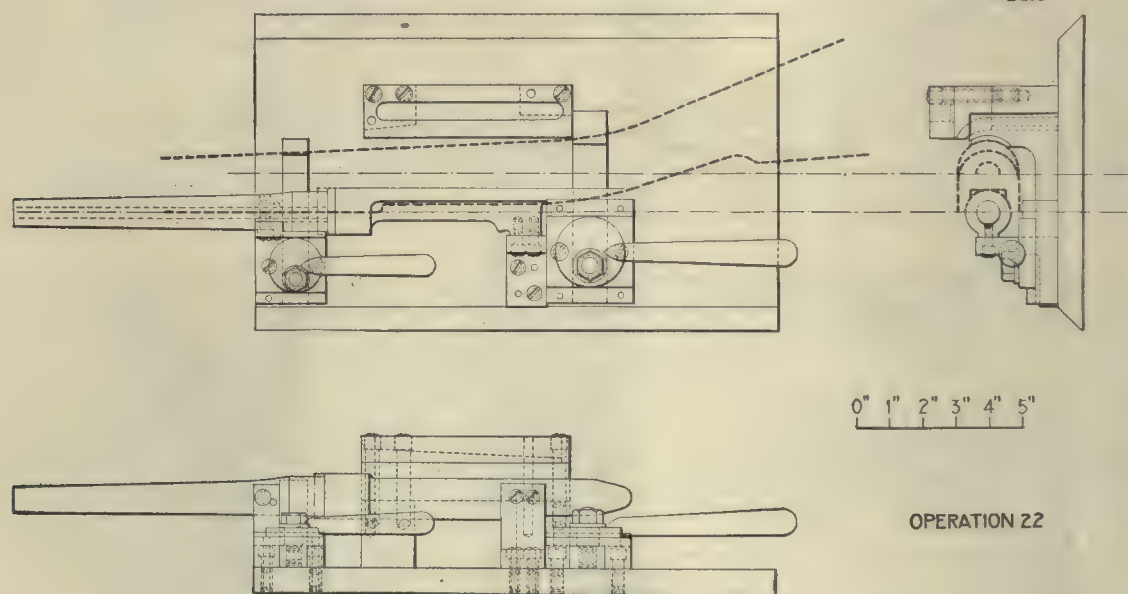


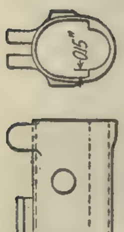
FIG. 2019



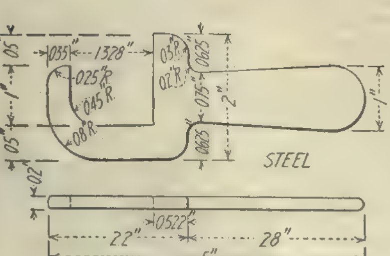
OPERATION 22

FIG. 2020

FIG. 2021



GAGE 15B



GAGE 15A

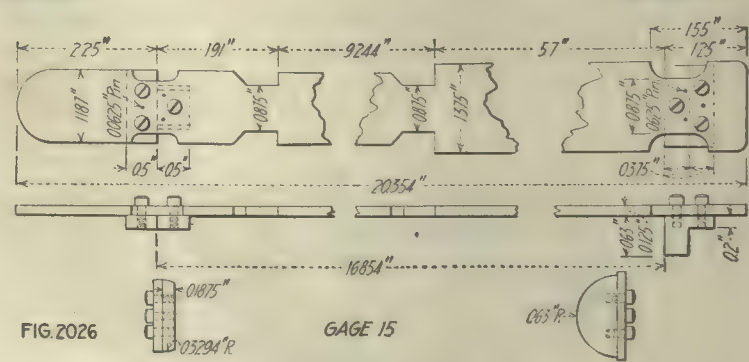


FIG. 2026

GAGE 15

OPERATION 15

OPERATION 12. SHAPE BUTT FOR PLATE AND TRIM TO LENGTH

Transformation—Fig. 1999. Machine Used—Combination saw and wood shaper, Fig. 2000. Number of Operators per Machine—One. Cutting Tools—Fig. 2001, saw, 8½ in. in diameter, No. 12 gage, ½-in. pitch. Cut Data—Saw, 3000 r.p.m.; shaper head, 3800 r.p.m. Average Life of Tool Between Grindings—Saw, one week; head, one week, but stoned daily. Special Fixtures—Work-holding and profiling fixtures, Fig. 2002. Gages—Cutting off muzzle end and butt shape, Fig. 2003. Production—1100 per day. Note—Operator trims muzzle end on front fixture with saw, then places stock in rear fixture and shapes butt.

OPERATION 13. CUT TOP OF BUTT FOR TONG OF PLATE AND BORE SCREW HOLES

Transformation—Fig. 2004. Machine Used—Multi-spindle bedding machine, Fig. 1942. Number of Operators per Machine—One. Cutting Tools—Fig. 2005. Cut Data—Spindles run about 4500 r.p.m. Average Life of Tool Between Grindings—200 pieces. Special Fixtures—Work-holding and profile fixture, Fig. 2006. Gages—Fig. 2007. Production—660 per 8-hr. day.

OPERATION 11. CUT FOR CUTOFF THUMB-PIECE

Transformation—Fig. 2008. Machine Used—Special turret bedding machine, Fig. 2009. Number of Operators per Machine—One. Cutting Tools—Fig. 2010. Cut Data—Spindle runs about 5000 r.p.m. Average Life of Tool Between Grindings—500 pieces. Special Fixtures—Fig. 2011. Gages—Fig. 2012. Production—1716 per 8 hr.

OPERATION 14. TURN BUTT AND STOCK UNDER RECEIVER FOR FINISH

Transformation—Fig. 2013. Machine Used—Blanchard type lathe, Fig. 2014. Number of Machines per Operator—Three. Tool-Holding Devices—Regular cutter head. Cutting Tools—Fig. 2015. Cut Data—Cutter runs about 5500 r.p.m.; work about 50 r.p.m. Average Life of Tool Between Grindings—Stone every day, grind 700 pieces. Gages—Fig. 2016. Production—300 per 8-hr. day. Note—Before placing in the lathe a driver plate is screwed on, as shown in Fig. 2017.

OPERATION 22. CUTTING RIGHT TOP OF EDGE AT RECEIVER OPENING

Transformation—Fig. 2018. Machine Used—Wood shaper. Number of Operators per Machine—One. Cutting Tools—Fig. 2019. Cut Data—Spindle runs about 4500 r.p.m. Average Life of Tool Between Grindings—Stoned once a day. Special Fixtures—Fig. 2020. Gages—Figs. 2021 and 1989. Production—1061 per 8 hr.

OPERATION 15. FINISH-TURN FOR BANDS

Transformation—Fig. 2022. Machine Used—Modified Blanchard, Figs. 2023 and 2024. Number of Operators per Machine—One. Cutting Tools—Fig. 2025. Number of Cuts—Three at once. Cut Data—4000 r.p.m. Average Life of Tool Between Grindings—Stoned once a day, ground once a week. Gages—Fig. 2026. Production—670 per day. Note—Operator feeds work by hand, according to grain of wood.

The machine illustrated in Fig. 2009 is similar in many ways to others shown. On it the cut for the cutoff thumb-piece is made, using the tool shown in Fig. 2010 and the fixture in Fig. 2011.

The butt and stock under the receiver are next finish turned in the lathe, Fig. 2014, and then the right top edge at the receiver opening is shaped off, using the holding fixture seen in Fig. 2020.

In finish turning for the bands only a narrow strip is turned in the three places where the bands are to be placed. A modified type of Blanchard lathe, Figs. 2023 and 2024, is used, the three cuts being made at once. The work is revolved by hand, the speed of the feeding depending upon the hardness and the grain of the wood.

FIG. 2022

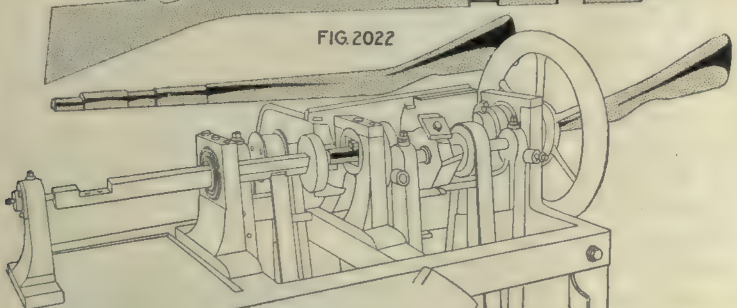
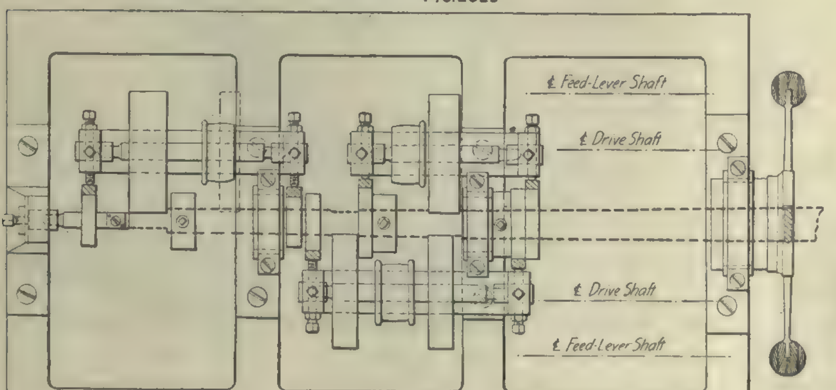


FIG. 2023



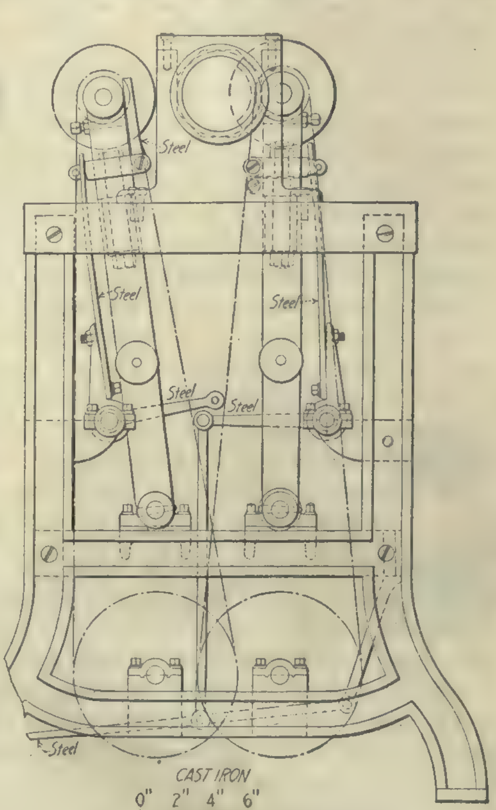


FIG. 2024
OPERATION 15

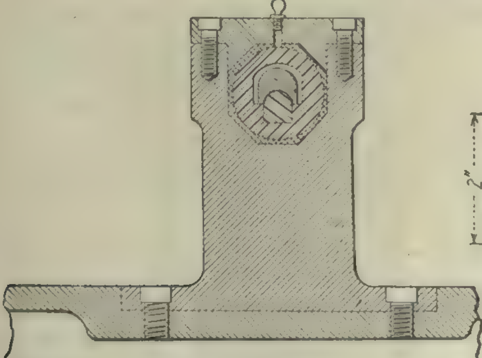


FIG. 2024

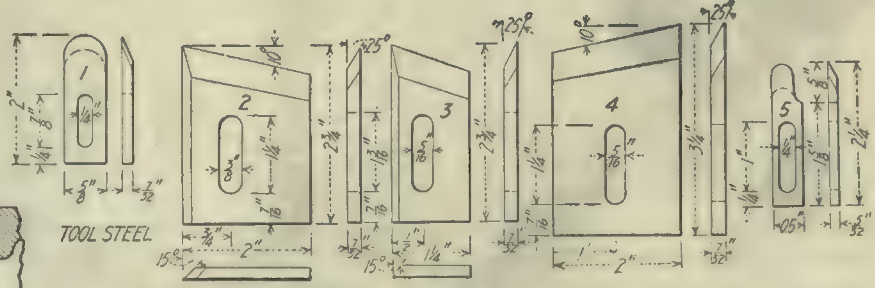


FIG. 2025

Precision Grinding

By C. A. Macready

If the tests given by Mr. Murphy in his article on precision grinding, page 313, are applied to reproduce the travel of the ways of a grinding machine, they will show accuracy, or a plane, where none exists.

There is no difference between Mr. Murphy's method and that used for testing bridge milling. The wheel, as it passes over, reproduces all the irregularities existing in the ways, or bridge, and these will also be reproduced in the test employed by Mr. Murphy if the indicator be placed in the position of the cutter or grinding wheel. If this surface is like the "rocky road to Dublin," it will show as parallel lines when the table is moved at right angles and lengthwise.

There is only one thing that will show the condition of a magnetic chuck that has been ground and retained on the bed of the grinder, and that is a knife-edge straight-edge.

Retruing Grinder Ways

I once had the job of retruing the ways of a No. 2 B. & S. surface grinder, and I was astonished when I tested the crossways while I had them on the planer. They were in the form of a curve that had no center. The front end was worn more than the rear end, and the middle was flat for about 8 in. at the center. I wondered how this condition could have been brought about. Anyway, I trued the ways and scraped the pedestal ways to fit. When I thought I had a good percentage of surface contact, I assembled the carriage without the longitudinal ways and trued the magnetic chuck with a light cut. I did not have a dial indicator, but used a Starrett. This showed that the face of the chuck was all right, and I concluded I was finished with the job.

As I looked at the chuck, however, it occurred to me to try the surface with a straight-edge. I did this, and discovered such a decided crown that I pulled the machine down and once more scraped the pedestal ways.

Ways Scraped Low at Center

This time I made the ways low at the center, in order to be sure that the bearing was all taken at the ends of the ways and also to keep the wear at the ends. I figured that the overhang of the table was excessive when it was out to the full position required to grind the full width of the platen, so I placed most of the work to be ground at the edge of the chuck, to take advantage of the pole.

After assembling the grinder and returning the chuck, the straight-edge showed the edges to be a little low, but the center of the chuck, between the insulations, was very good. As this latter part of the chuck is the place that gets the most use, I let it go as good enough for the majority of surfaces that would need to be ground on the machine.

Thinking about the causes that would lead to the imperfect condition of those ways led me to consider the position that a man took when he was running the grinder. This thought was prompted by seeing a man lean comfortably on the dust guard and watch the wheel make sparks. It struck me that his weight added to the overhang, plus the weight of the dust guard, would have a big influence if one wished to wear or lap the front of the ways; and I think this is the reason why the front wore faster than the back ways.

Many mechanics have this habit of leaning on the dust guard, and I think that few of them realize that extra wear takes place when they add their weight to the lapping effects that are going on between the bearing surfaces of the ways.

The test with the angle plate is not a test of its accuracy to 90 deg. It simply shows how many thousandths the head is out of square with the platen, or chuck; that is, if the angle iron is 90 degrees.

There are no precision screws made to raise and lower the heads of surface grinders. No need for the screws exists, and even if there were a need, they could not be kept accurate, as considerable emery dust settles on the screw and wears it away at the parts most generally or frequently used.

Grinder To Correct Planer Errors

I am now utilizing 15-year old grinders to correct planer errors. Sometimes there is quite an amount to be removed, and this is rather severe use for a grinder to undergo, as the men that do this work do not appreciate the refinement to which a bearing must be adjusted if a lot of unnecessary lapping is to be avoided. These same grinders are employed to do accurate work on gage jobs and are standing up very well on the final cuts. The screws have been abused, but for a movement of 0.005 or 0.010 in. they are fairly accurate.

I have a vernier reading to 0.0001 in. that has been in use for over 15 years. This fine adjustment is used only for measurements within the last 0.001 inch.

If Mr. Murphy will drill and tap a few 10 x 32-in. holes in the back adjustable pole piece, so that he can attach a piece of ground stock, he will have a useful attachment when he wants a pole that will extend over the face of the chuck. If there is a notch cut in one corner of it, he will have a backer that will be very handy for top-heavy work. Also, he will be able to make a parallel that will be true with the longitudinal movement of the machine if he trues the edge with the side of the grinding wheel. He will be surprised to find how useful this piece will be.

Six-Inch Shells

Further information from the Puget Sound navy yard in regard to the manufacture of shells described on page 617 by Lieutenant Dibrell is of peculiar interest as showing good shop practice with very little special equipment.

Out of 2500 forgings machined, only eight were spoiled. The estimated cost of labor per projectile was \$3.92, but the actual labor cost was only \$1.73, a portion of which included the payment of "time and a half" for three hours' overtime per day. Otherwise, the cost would have been less than \$1.70 each.

As a recognition of this good work the Puget Sound yard has received a contract for 7500 projectiles, the bid being \$1.20 each for direct labor, which is considerably lower than before. Some new machinery has been added, and an output of 1500 projectiles per month, working three shifts, is confidently expected. The actual costs were: Direct labor, \$1.70; indirect labor, 79c.; cost of forging, \$11.88; cost of copper band, \$2.09; or a total cost of \$16.46.

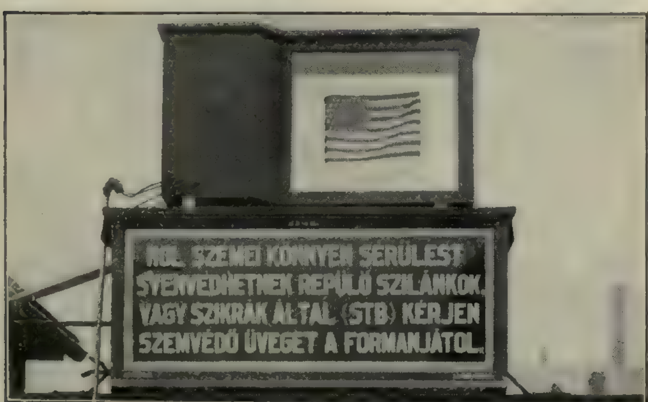
IDEAS FROM PRACTICAL MEN

Effective and Timely Bulletin for Shop Employees

By L. R. W. Allison

With patriotism the order of the day, the National Tube Co. is employing at its various plants an interesting and novel sign bulletin to impress upon its men existing national conditions and the need for extreme care and precaution in different departments of operation. At the same time the sign is arranged to inspire a regard and appreciation on the part of all employees of all nationalities for the Stars and Stripes, making possible direct messages on any important subject with prompt and universal reading throughout the works.

This news bulletin consists of a wooden frame constructed in two separate sections, as shown in the accompanying illustration. The lower section is designed to hold a glass slide or transparency carrying whatever individual message may be desired; these glass slides are



EFFECTIVE SHOP BULLETIN

easily placed in the frame and allow for change of announcement every day or so, as deemed necessary. The messages are in terse and pertinent wording in different languages, so as to reach every employee, the one in the reproduction being in Hungarian. A recent message in English reads: "It is your duty to report unsafe conditions to your foreman or superintendent."

In the upper portion of the device an American flag has been placed and is kept waving by means of a small Sirocco blower, concealed. Both the flag and the message panel are illuminated at night, the sign being wired and equipped with interior electric lamps for this purpose. This device is particularly opportune, the interchangeability feature effecting timely and important announcements to all employees and embracing messages not only pertaining to current-day topics, but shop instructions.

News-bulletin signs of this type have been placed by the company at its Lorain plant as well as at other branch factories in all parts of the country—in duplicate when necessary to encompass the entire works. Stationed over the entrances, these signs are noticed promptly by the men upon entering or leaving the plants and convey the particular message in an effective and distinctive manner, simultaneously calling the American flag to prominent attention.

Transfer Center Punch and Its Use

By Hugo F. Pusep

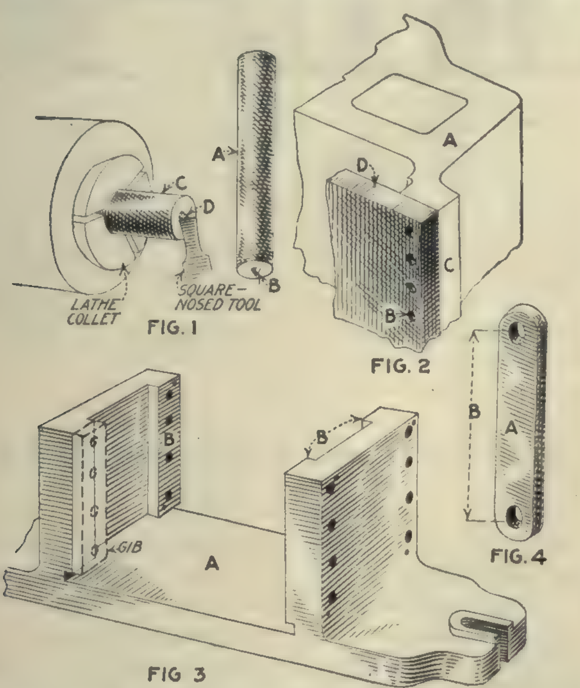
The machinist is often confronted with a job where a number of holes already drilled in a piece of work are to be transferred to another part of the same job. In the majority of cases the holes thus transferred are for tap or bolt holes; and although great accuracy is not necessary, the two sets of holes must correspond in order to accommodate the bolts or screws that secure the pieces in correct relation to each other.

It is common practice in jobs of this kind to "spot" the holes with a drill—through the holes that have been already drilled—to the part to be drilled. This is a satisfactory method where both pieces are of comparatively light weight and easy to handle under the drill press; but where either of the components is heavy or of irregular shape, the spotting method sometimes means a lot of lifting, clamping and setting up. There is another method employed by mechanics; namely, scribing circles on the piece to be drilled while it is clamped to the one in which the holes are already drilled. The scribing is done through the holes, and the centers for the new holes are laid out with a pair of dividers from the scribed circles. While this is a much easier way than that of spotting, it means considerable work in laying out with the dividers; and in cases where the holes through which the circles were scribed are quite deep, the results are not always satisfactory, as all mechanics have learned to their sorrow.

Most of this trouble and unnecessary work can be eliminated by using the simple tool shown in Fig. 1, and known as the transfer center punch. Although by no means a new device, it is not used so extensively as it should be, and therefore a few words of explanation regarding its construction may not be amiss. It is made of drill rod (the diameter of the drill rod corresponds to the size of holes through which the transferring is to be done), is of convenient length and can easily be turned up in the bench-lathe collet in a few minutes. The body *A* and the centering bit *B* should be concentric if satis-

factory results are to be expected, and for this reason it is advisable to use the bench lathe, or an engine lathe whose collets run fairly true.

As the drill rod comes in all standard sizes, it is just a matter of selecting the right size of drill rod, slipping it into the lathe collet and running a square-nosed tool—set at the proper angle—across the end of the rod, as shown at *C*, Fig. 1, till there remains the center tit *D*. A length is cut off to suit the depth of hole. After this,



FIGS. 1 TO 4. THE TRANSFER CENTER PUNCH AND ITS APPLICATION

the punch is hardened at the working end and drawn to a dark straw color, thus completing the punch. Of course, for some odd sizes of holes the body *A* may also have to be turned down to fit the hole, but it must be remembered that once a punch is made it will be ready for the next job that comes along, because the punches themselves will last indefinitely.

In Fig. 2 is given an example where the transfer center punch will save time in repair work. At *A* is a section of a heavy machine casting that required gibs. The $\frac{3}{4}$-in. holes through the flange *C* are transferred to the gib *D* (which is shown placed in position) with a $\frac{3}{4}$-in. transfer center punch. A brief description of the mode of procedure will make clear the advantages of using the transfer center punch method in this particular job. The gib *D* is held in its correct position to the flange of the casting with clamps, not shown; the transfer center punch is now entered into the $\frac{3}{4}$-in. bolt holes of the flange till the end of the punch touches the gib, when a light blow is struck on the punch with a hammer. After every hole has been treated in like manner, the gib is removed, the center punch marks on the gib being the correct centers for a $\frac{5}{8}$-in. tap drill. It is the usual practice to scribe a circle the diameter of the hole to be drilled before deepening with a regular heavy center punch. The holes thus laid out can now be drilled and tapped, and if ordinary care is taken the gib is ready for assembling and will fit exactly where it was clamped when transferring the centers of the holes. So far only the transferring of bolt holes has been mentioned, but it is just as easy to drill dowel-pin holes by the same method. Holes for dowel pins are, of course, drilled $\frac{1}{64}$ in. under size and hand-reamed to size after the job has been assembled and secured by its permanent bolts.

In Fig. 3 is illustrated the advantages of the transfer center punch method. The heavy and rather awkward jig casting *A* requires four gibs to be secured to the machined surfaces *B* by sixteen $\frac{1}{2}$-in. fillister-head screws and eight $\frac{1}{4}$-in. dowel pins. In this case a $\frac{1}{2}$-in. transfer center punch for the screws and a $\frac{15}{64}$-in. punch for the dowels eliminated all possibility of having to set up the casting a second time in the drill press for the purpose of spotting the holes, which would also have meant the clamping of a heavy angle plate to the drilling-machine table and leveling up the casting by the surfaces *B*.

For closer work than is required for screw or dowel-pin holes, the transfer center punch can easily hold its own. In Fig. 4 is shown what can be accomplished with it in die work. When the die maker is given the task of building a progressive die for exact duplication of the model link *A*, he can transfer the correct center distance *B* direct from the model to the die block.

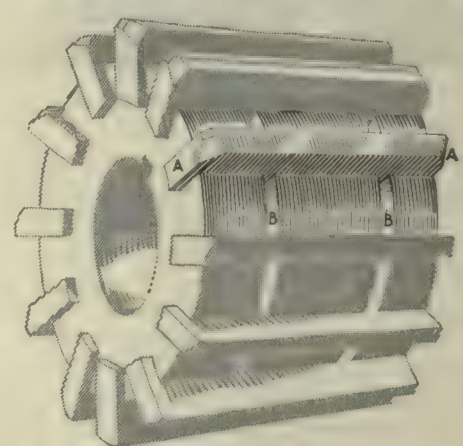
By using this method the holes of the model will not be damaged in any way; whereas, if he attempted to spot the die through the holes of the model, the chances are that the holes would have been made slightly oversize.

In conclusion it should be remembered that where accurate results are expected from the transfer center punch method the punch should be a good slip fit for the hole and the centering bit concentric with the body of the punch. Also where practicable—as in the last example—the transferred hole centers, if indicated with a center indicator in the lathe and bored out instead of depending on the drill and reamer entirely, the location of holes so bored will be found accurate.

Oxyacetylene-Welded Inserted-Blade Cutter

By K. F. Rausch

The illustration shows how the difficulty encountered in oxyacetylene welding inserted cutter blades was overcome. It was found that by depending on welding at



INSERTED-BLADE CUTTER

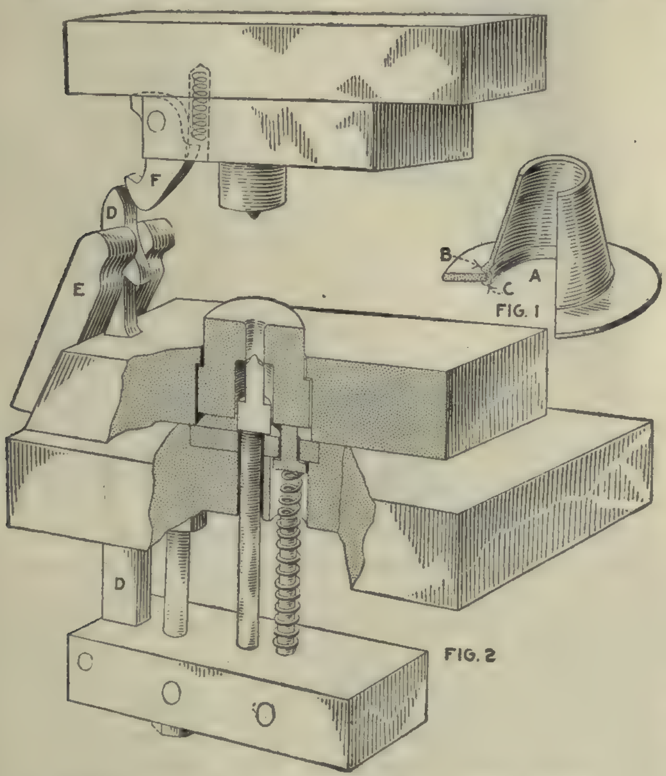
the outside points *A* only, some of the blades would work loose. By cutting a recess in the body of the cutter, as shown at *B*, thereby giving additional points to weld. the trouble was entirely removed.

Swaging Die for Air-Rifle Part

By W. B. Greenleaf

The die shown in Fig. 2 was made to produce the shot seat *A*, Fig. 1, for an air rifle. When the part was first designed, we intended to have the seat proper made in a screw machine from brass tubing $\frac{1}{4}$ in. by $\frac{11}{64}$ in. bore. It would have been taper reamed at the outer end to hold the shot and reduced at the other end on the outside to 7/32 in., leaving a square shoulder for the washer to rest against at *B*, Fig 1. The hole in the washer is 7/32 in. The two pieces were to be assembled and riveted together in a foot press.

We have no screw machine and could not get one, so we set to work to find a substitute method. We use brazed brass tubing $\frac{1}{4}$ in. outside, a little under $\frac{3}{16}$ in. bore, and make the washer hole slightly over $\frac{1}{4}$ in. in



FIGS. 1 AND 2. SWAGING DIE AND THE WORK

diameter. With a circular saw, the tubing is cut $\frac{37}{64}$ in. long and the pieces are tumbled. As can be seen at *C*, Fig. 1, the die upsets the walls of the tube, increases and tapers the outside diameter and forms a choke in the bore about $\frac{11}{64}$ in., leaving the outer end tapered to hold the shot; besides throwing up a bead at *B* and turning over the lower end, thus securely seating the tube in the washer. The total cost of the part is about one-eighth of what it would have been if made as first contemplated.

The construction of the die is shown in Fig. 2. The springs hold up the die and also return the knockout. In operation the washer and the tube are assembled and placed in the die, the tube resting on the knockout pin, which also acts as a mandrel to form the funnel-shaped mouth, and the washer resting on the die. The $\frac{1}{8}$-in. motion of the die keeps the washer in the right position on the tube while the latter is being upset. The die is countersunk at the top to form the bead over the washer.

On the downstroke the dog *F* swings in and passes *E* and *D*, but on the upstroke it engages the hook *D* and pulls out the finished piece; as *F* is wider than *D*, *E* pushes it out of engagement with *D*. The die being tapered, the only resistance that the knockout has to overcome is right at the beginning of the pull, when the dog is in full engagement with the hook. At the point of release the only stress is from the pair of light springs, so that the wear on the points is nominal.

The work is better and more uniform than could have been obtained from a screw machine.

Automatic Stop and a Depth Gage for Hobbing Machines

By Adolf Langsner

The principle of cutting gears by hobbing is well known, but a description of some simple devices that have helped greatly in the increase of production may be of special interest to owners and men in charge of the type of hobbing machine described herewith.

When cutting spur gears the hob has passed the blank soon after the cutting of the teeth is finished. This is due to the fact that the axis of the cutter runs at an angle approximating 90 deg. to the work arbor. The feed-stopping mechanism, which is installed in almost all makes of hobbing machines, can be set to throw out the automatic feed on the completion of the cut. There is, then, no interference between the hob and the gear already cut. The work and the machine are both safe, even when the cutter and the work are still rotating. Such is not the case when cutting helical gears. On account of the angle which has to be given to the setting of the hob in relation to the angle of the teeth to be cut, the cutting teeth of the hob are more or less still in mesh with the gear, even when the cutting action is ended. Considering, also, that the indexing or speed of the work must correspond with the feeding of the hob, it is evident that the finished gear would be partly milled off if the feed were stopped, while the hob and work would still be running. Again, if the hob were left to travel until it clears the teeth of gear, there is a considerable loss of time; besides, there is danger of running the hob or slide against the chip guard or the table upon which the work is mounted. To overcome these difficulties the machine has to be stopped each time at the point where the cutting of the teeth is finished.

When cutting the gear illustrated in Fig. 2 on the Schuchardt & Schütte machine a pointer *P*, Fig. 1, was first fastened to the saddle. The pointer projected enough to run between two fixed points that were marked on one of the ways of the column. When the hob finished cutting the pointer reached the lower fixed mark. The operator had to watch for that mark and stop the machine; but, although each machine had its operator, it often happened that the mark was overlooked, and the hob or slide ran against the chip guard and table. This was avoided by also stopping the feed at that point, which prevented injury to the machine but caused damage to many finished gears. Naturally, the only solution of the problem was to stop the whole machine automatically.

In Figs. 1, 3 and 4 are given details of the arrangement. On the back of a heavy iron plate *A*, which is made large enough to be attached to the back of the column

of the machine, a lever B is mounted and held in position by a strap illustrated at H. The lever B must have enough travel at T, so that when connected with the shipper rod F of the countershaft it will move the belt from the loose to the tight pulley and vice versa. On the front of the plate A a barrel C is so fastened that its center is in the middle of the saddle guide K. The barrel contains a pawl D that is made of round stock and is always pressed forward by the compression spring S. The pawl projects enough out of the barrel to lock the lever B when pressed down. The releasing lever E is hinged to the barrel C and engages, through a slot in the barrel, the pawl D. The pawl is slotted just enough to be guided forward and backward by the round head of the releasing lever E. At the same time the pawl is prevented from turning on its own axis, retaining the proper position of its flat to lock the lever B.

On the saddle guide K is mounted a small angle piece I that carries the adjusting screw J. The screw is made long enough for a large adjustment and is locked

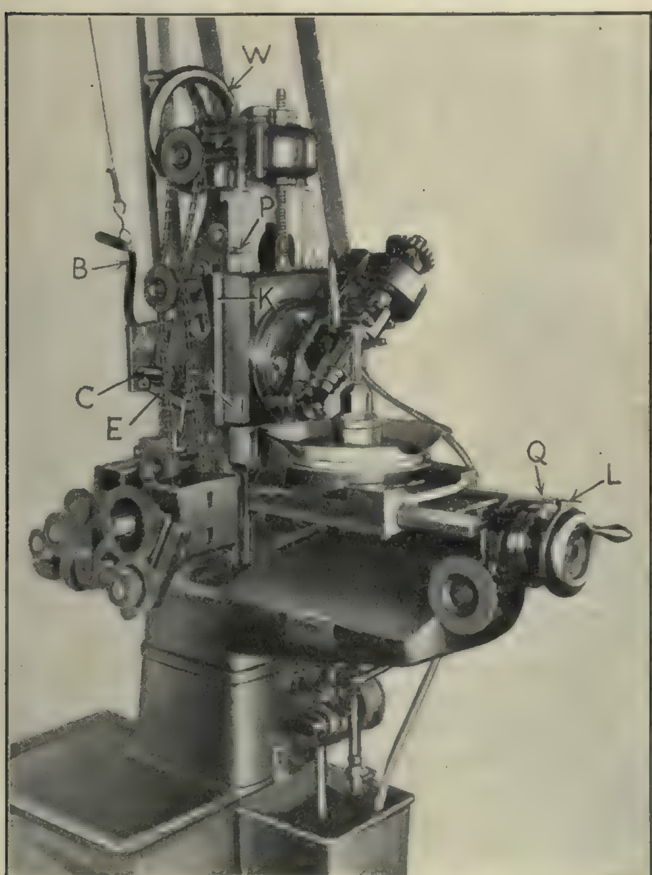
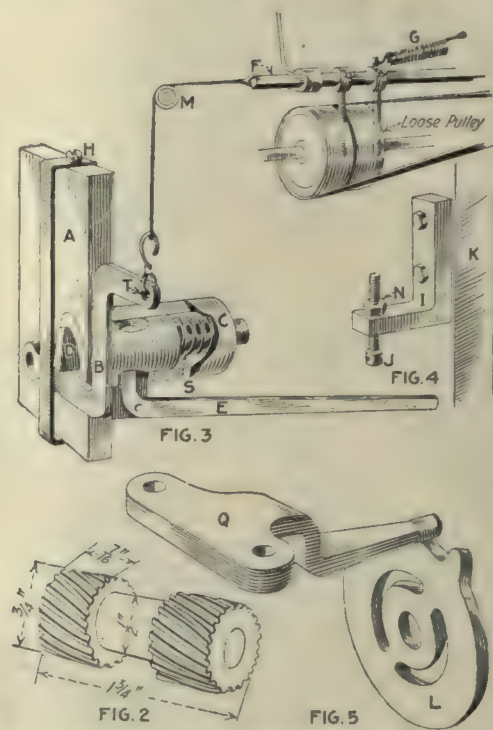


FIG. 1. THE COMPLETE ARRANGEMENT

by the nut N. The angle piece I, in most cases, can be held by the same bolts that hold the saddle guide. To the shipper rod at F, one end of the tension spring G is attached, while the other end is so fastened that it will always draw the shipper fork to the loose pulley. A rope pulley M is fastened in the position shown. The shipping rod F is connected by a rope over this pulley to the lever B. It is understood that the position of the rope pulley will be determined by the position of the lever B, to insure proper slide to the rod. The arc which the lever has to travel from its locked position to its stop, when released, will be determined by the travel of the belt from the loose to the tight pulley of the countershaft. After the distance of the hob feed has been determined, the screw J is so adjusted that when actual cutting of the gear is finished the releasing lever E is pressed down, drawing back the pawl D, and the lever B is released. The shipper rod, fork and belt are then drawn to the loose pulley by the spring G, and the machine is stopped. Fig. 1 shows the machine in that position. The operator withdraws the work from the hob and lifts the saddle by the handwheel W, Fig. 1. A new blank is mounted on the arbor and brought to the cutting position. The auto-



FIGS. 2 TO 5. THE GEAR, THE STOP AND THE GAGE

matic feed is thrown in and the lever B pressed down until locked; this starts the machine, and a new gear is cut without special attention.

In Figs. 1 and 5 are two parts that serve to insure a uniform depth of tooth and a positive setting of the work table. The cam L is mounted upon the handwheel at the front part of the machine. The projection, or finger, of the cam L strikes against the arm Q, so that when the operator makes one turn he sets or disengages the work. The arm Q, which is fastened to the bed, is strong enough to resist any side movement but springs enough to slide into the groove near the finger of the cam L. It locks the movement of the screw in that position. The slots of the cam provide ample adjustment for different depths of gear teeth. This stopping arrangement has done away with careful readings, and mistakes due to wrong setting.

The devices prevented spoiled work and also increased the output to a great extent. Instead of each machine having an operator, one man can operate four or more machines. The disengagement of the shift lever is heard through a sharp click that calls the operator's attention to the machine. Eight Schuchardt & Schütte hobbing machines of two different types were supplied with the automatic stopping devices described and were operated by only two men. Over 80 per cent. cost per gear was saved, and the work was uniformly good.

Editorials

Airplanes and the War

One of our greatest war writers, with a full knowledge of the conditions as they are both here and at the front, says that if the war goes on as it has the United States will lose *five million men* in the next three years.

But need it go on that long? How can it be ended with the least loss of life and in the shortest time? It is up to the United States individually and collectively.

The Allies and the Germans are practically at a deadlock. The German lines are one vast fortress, with shelters in many places a hundred feet or more underground, from which squads with deadly machine guns can emerge as soon as the Allies' artillery ceases and the men sweep forward in their attempt to get *through*. It will cost hundreds, thousands, millions of lives to get *through*. But if properly carried out, only a fraction as many to get *over!* How is this to be done? By having enough airplanes and operators to smother the German air squadron—to sweep them down and destroy them as fast as they are made.

At present each side realizes the importance of the mastery of the air, and each is striving with all its might to gain it; but the race is about even. England and France are building machines and training men at about the same rate as Germany. If the United States does her part, we can give our allies an overwhelming air force. This will mean the blinding of the eyes of the enemy so she cannot see where to send her projectiles nor where our troops are massed nor watch our movements.

With Germany's airplanes shot out of existence, our own machines need only to fear the anti-aircraft guns; and even machines that now are too slow to compete with enemy fighting planes can be used as well as other types to carry bombs *over* the enemy's lines into the enemy's country. We can pick out our targets and destroy all that are of any use to the enemy. We can destroy factories, munition dumps, submarine bases, battleships, submarines, food depots, transportation lines, troops, troop shelters—everything that is in any way of military value to the enemy. The moral effect will be as great as the military effect, and Germany will realize that *Schrecklichkeit* is not all in the power of those of *Kultur*. Only in this way can we make peace popular in Germany.

Each airplane is equal to a regiment of men in effect, and to many more in the saving of our soldiers' lives. We can go *over* the lines at comparatively small loss of life, but if we go *through*, every home in the United States will have cause to mourn for those who go down. We need 50,000 planes at the earliest possible moment and at least 10,000 trained aviators. The average life of an airplane on the front is 50 hours, and from 3 to 5 machines must be kept continually in reserve for each operator. In training, each man is apt to wreck several before he learns to handle a machine efficiently. So we must not stop at the 50,000 machines, but should go on and add 75,000 or 100,000 machines as fast as we can, with the proper quota of operators. But first we must get enough to the front to give our allies an overwhelming number.

We can save thousands of our men by remembering and acting on the slogan—*"It is easier to go over than through." Get the appropriation, even if it is a billion dollars. Get the machines, get the men to operate them, and get them right away!*

The Question of Artillery

Modern warfare requires the rapid manufacture of all sorts of munitions on a larger scale than has ever been known. And being a peaceful nation, we have comparatively few plants equipped for such manufacture, or men trained in this class of work. The past two and a half years have seen the establishment of many new shops for the making of shells and fuses, so that we are well provided for in this respect. But when it comes to making rifled cannon and similar necessary munitions, we are sadly deficient, in spite of the fact that several wide-awake plants are being fitted for this work.

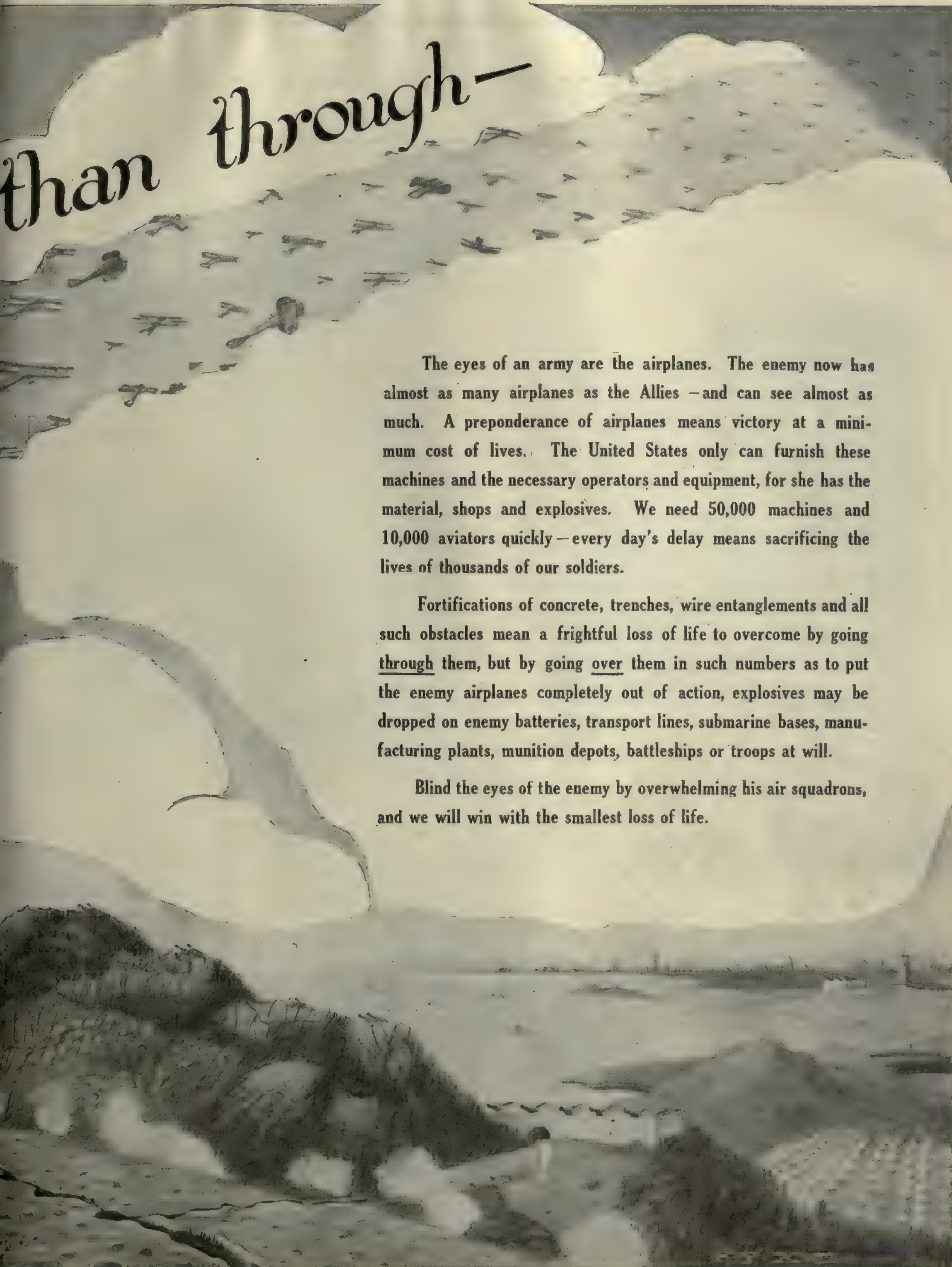
There are two good-sized private plants that make a specialty of such products, but they are busy with orders for our allies; and while they are engaged on some orders for our own Government, it is impossible for them to supply more than a fraction of our needs. This situation makes it absolutely necessary to establish new plants and to utilize shops that have turning and boring equipment which can be modified for such work. Moreover, men must be trained for this kind of manufacturing. And when time is such a big factor, everything that will facilitate this work must be brought into use.

This is the same problem that confronted the Canadian Shell Committee at the opening of the war, and the members of this committee are to be congratulated on the commonsense and efficient manner with which they handled the difficulty. Realizing that an interchange of experience was absolutely necessary to secure good results in the shortest possible time, they utilized the *American Machinist* and other agencies for circulating the needed information; and they freely acknowledge that this distribution of information not only increased production, but decreased its cost. There was no question as to secrecy. Everyone realized that withholding information that would assist in necessary manufacture was just as unpatriotic as any other act that helps the enemy by delaying action against him.

This is no time to let so-called trade secrets stand in the way of making the utmost preparation against the enemy. The shop that is closed to prevent assistance to others in manufacturing munitions of war is more of a menace than any other type of closed shop.

The spread of information as to making guns, gun carriages and similar munitions is one of the most important steps of preparation to defeat the enemy and end the war. The increase in supply must come from shops that are not now engaged in this work, and they must be taught how these munitions are made.


As the Eagle flies
It is easier to go over



The eyes of an army are the airplanes. The enemy now has almost as many airplanes as the Allies —and can see almost as much. A preponderance of airplanes means victory at a minimum cost of lives. The United States only can furnish these machines and the necessary operators and equipment, for she has the material, shops and explosives. We need 50,000 machines and 10,000 aviators quickly — every day's delay means sacrificing the lives of thousands of our soldiers.

Fortifications of concrete, trenches, wire entanglements and all such obstacles mean a frightful loss of life to overcome by going through them, but by going over them in such numbers as to put the enemy airplanes completely out of action, explosives may be dropped on enemy batteries, transport lines, submarine bases, manufacturing plants, munition depots, battleships or troops at will.

Blind the eyes of the enemy by overwhelming his air squadrons, and we will win with the smallest loss of life.

Shop Equipment News

Calling System

The National Scale Co., Chicopee Falls, Mass., is now marketing a calling system, the operating instrument of which is shown in the illustration. This instrument is connected to bells, horns, lights or other signaling devices throughout the plant and serves to locate any of the factory executives without loss of time or effort. The signals are controlled by means of the eight small levers projecting from the front of the instrument, these being sufficient to make 45 different code-number combinations. In operation the levers are set for the required code number, and the key to the right is turned. On the plate back of this key will be noticed the numbers from 1 to 7. The operation of the key to these various positions gives a corresponding number of complete rings of the code signal for which the levers have been previously set. A ruby light in the case flashes back the number that is being rung, as proof to the operator that the proper signal is being given. If the individual who is being called answers before the call is completed, the ringing may be shut off by raising the lever at the extreme left.

OPERATING INSTRUMENT FOR CALLING SYSTEM

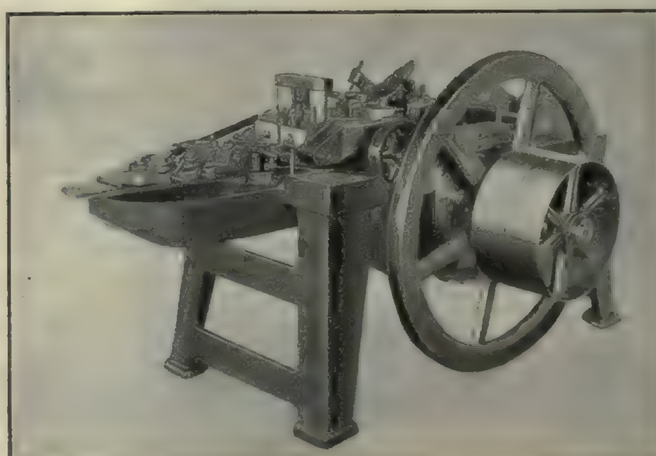
The instrument is made of pressed steel finished in black enamel with trimmings of brass. It measures 14 x 10 x 3½ in. A relay is used between the operating instrument and the signals in order to avoid sending the operating current through the instrument. Bells, horns and buzzers of various types are furnished as desired.

Wire-Nail Machinery

Sleeper & Hartley, Inc., 68 Prescott St., Worcester, Mass., are now marketing a new line of wire-nail machinery, one style of which is shown in the illustration. The machines consist of a reinforced frame or bed mounted on double legs. The working parts are mounted on top of this bed, being so arranged that they may be quickly removed. The working motions are secured by toggle joints operated from a single crankshaft instead of the customary cams. All working members operate in mechanical balance, which, it is claimed, reduces both the power required and the noise and allows higher operating speeds.

In order to reduce the heating effect on the dies, the pointing and heading operations have been separated, an intermittently operated carrier serving to carry the blank from the pointing to the heading dies and from the heading dies to the point of discharge. This carrier wheel holds three or four blanks and is operated from the main crankshaft through a Geneva movement.

In operation the wire is taken from the coil, passing through the straightener rolls mounted on the feed slide, the latter being operated through an adjustable connection from a crank. A single revolution of the shaft feeds, cuts and points a blank, heads the preceding blank and moves the carrier forward to the releasing position.



WIRE-NAIL MACHINE

Both sets of dies are accessible and may be removed in a few moments. The important bearings, the anvil and the dies are adjusted by means of wedges.

The machines are made in five sizes, handling wire from No. 17 to ⅜ in. in diameter and producing nails from ⅜ to 10 in. long.

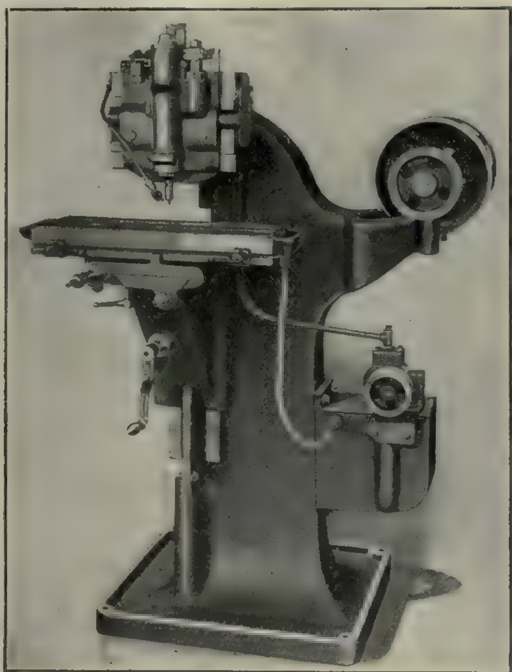
Spline-Milling Attachment

A vertical spline-milling attachment has been placed on the market by the Standard Engineering Works, Pawtucket, R. I., for use on the various hand and weight feed millers manufactured by this company. The attachment is an automatic, high-speed head adapted for milling tang slots, feather keyways, slots in fixtures and other similar work. Work can be handled up to 3 in. in length plus the diameter of the cutter, and up to 1½ in. in depth.

The front of the head carries the vertical spindle and is moved by means of an adjustable eccentric. The length of travel for which the eccentric is adjusted is indicated by a scale on the stationary part of the head. A second cam, operated by a ratchet gear, controls the vertical movement of the cutter. The spindle returns

to its upper position automatically when the proper depth has been reached, and the horizontal travel is stopped by means of an automatic knock-off. Eight spindle speeds and seven horizontal feeds are available.

Where a large number of duplicate parts are to be milled, special cams can be furnished, which overcome

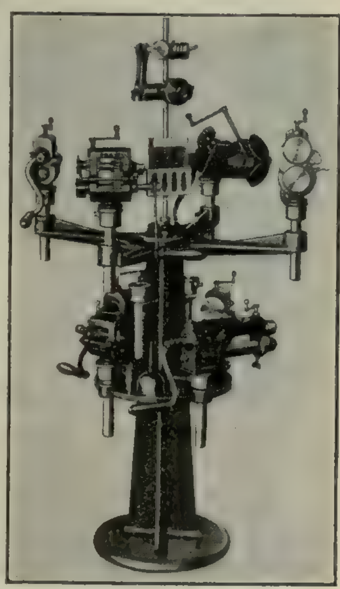


SPLINE-MILLING ATTACHMENT

the necessity of resetting after each operation. The attachment is designed to use fish-tail or two-lipped slotting end mills in sizes from $\frac{1}{8}$ to $\frac{5}{8}$ in. in diameter.

Revolving Machine Standard

The machine standard illustrated has been placed on the market by the Peck, Stow & Wilcox Co., Cleveland, Ohio, and Southington, Conn., with the intention of providing a convenient holder for sheet-metal working machines. The upper, or revolving, turret holds four machines and may be held stationary in any desired position by means of a clamping lever. The separate machine holders may be raised or lowered to suit conditions, the machines being approximately 40 in. from the floor. The lower turret is stationary and has a shelf for oil cans, tools, etc. it also holds four machines to be interchanged with those in the revolving turret. Two additional machine-storage posts are placed between the upper and lower turrets, thus making 10 machines the total capacity of the standard. The weight is 268 pounds.

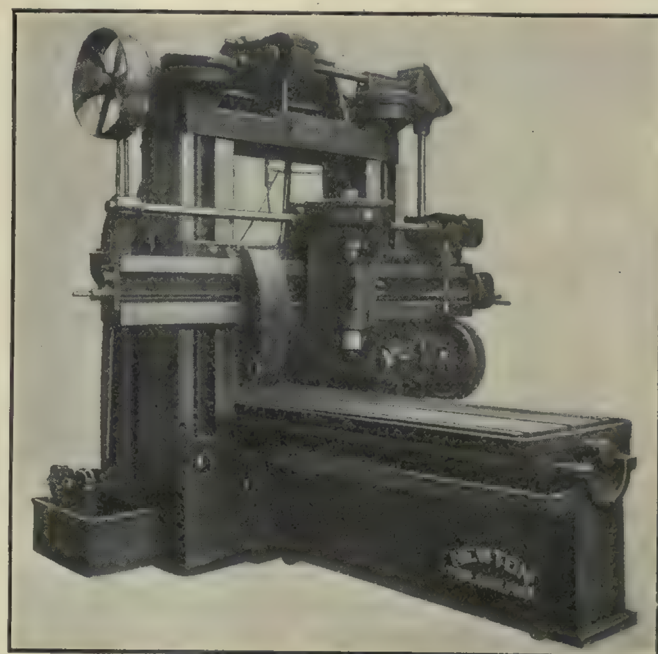


STANDARD FOR SHEET-METAL MACHINES

Two-Spindle Miller

The two-spindle miller illustrated is one of the latest additions to this type of machinery. The machine is equipped with two fixed spindles, one vertical and one horizontal. They are machined from hammered steel, finished by grinding, and have taper end bearings, through cutter retaining bolts, and broad-faced keys for driving the cutters. The driving gear is of the worm and gear type, the gear being of bronze and the worm of hardened steel. Roller thrust bearings are employed, and the gears are submerged in oil to insure proper lubrication.

Spindle speeds and feeds are independent, and a clutch is used to transmit all feed and fast traverse motions for the work table. The spindle sleeves are adjusted by



TWO-SPINDLE MILLER

Maximum height under vertical spindle, 36 in.; width between uprights, 42 in.; maximum width between end of horizontal spindle and opposite upright, 39 in.; diameter of spindle, in driving worm-wheel sleeve, 4 in.; diameter at large end of taper, 5 in.; width of work table over finished sleeve, 30 in.; width of table over oil pan, 36 in.; milling length, 8 ft.; hand adjustment of spindle sleeve, 6 in.; distance from center of horizontal spindle to work table, maximum 30½ in., minimum 4½ inches.

hand-operated rack pinion through a worm and worm-wheel and can be clamped in fixed position. Square lock bearings are used on the saddle, and adjustments are made by taper shoes. The horizontal spindle saddle has narrow guide construction to control the alignment. Counterweights for the saddle on the uprights are mounted inside the uprights, and vertical hand adjustment is supplied. Provision is made to clamp the rail to the saddle for power elevation and to control the alignment when a horizontal cutter arbor is used and supported at its outer end.

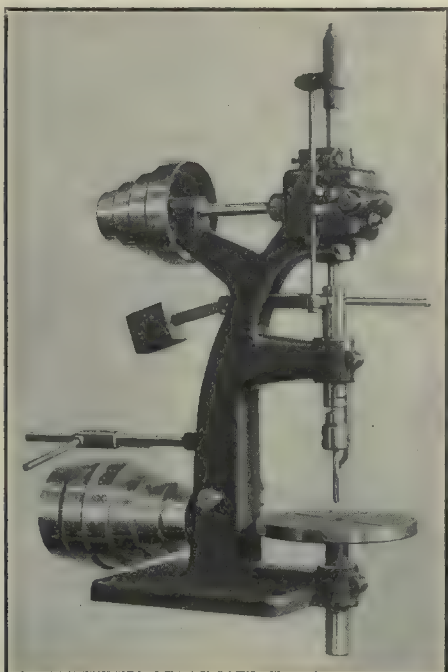
The vertical spindle has 12 changes of reversing cross-feed and reversing fast power traverse. Box-type construction is adopted for the table, which is surrounded by an oil pan and provided with T-slots. Twelve table feeds are possible, ranging from 0.355 to 13 in. per min. They are secured through an oil-tight feed box with gears running in a bath of oil. Hand feed of the table is also provided for. Box-type construction is also used for the base, which has a solid closed top and double crossribs.

The uprights extend to the floor line and are keyed and doweled to the base. The machine is driven by a single pulley from a countershaft or by means of a constant-speed motor.

The Newton Machine Tool Works, Inc., Philadelphia, Penn., are the manufacturers.

Drilling and Tapping Machine

To meet the demand for a small automatic tapper and bench drill, the machine shown in the illustration has been placed on the market by W. H. Simmonds &



AUTOMATIC TAPPING AND DRILLING MACHINE

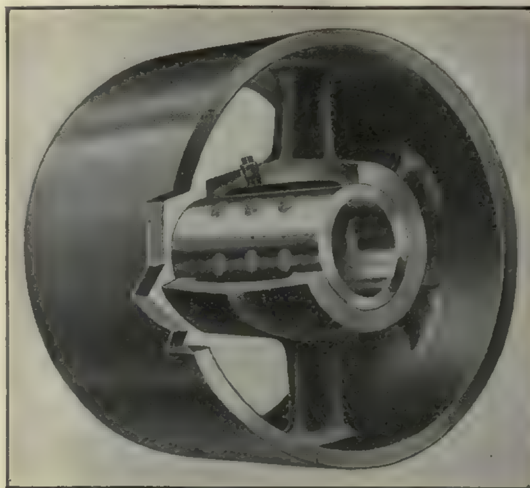
Works to center of 12-in. circle; maximum distance spindle to table, 10½ in.; vertical adjustment of spindle, 3¼ in.; vertical adjustment of table, 5 in.; diameter of spindle in sleeve, 13/16 in.; diameter of table, 10 in.; width of belt, 1½ in.; tapping capacity in cast iron, up to 3/8 in.; drilling capacity in cast iron, up to ½ in.; spindle speeds, 150, 250, 390 and 600 r.p.m. with driving cone running at 300 revolutions per minute.

Co., 208 Lawrence St., Cincinnati, Ohio. The spindle is equipped with a lead screw for any pitch of thread desired; 16-, 18-, 20- and 24-thread leads are standard equipment. Bronze bearings are used throughout, and the lower pulleys are bronze bushed. The belt-tightening device is adjusted by a knob on the right side of the column near the base. Automatic reverse is provided for stopping the tap at any desired depth, and the spindle is automatically stopped after the tap clears the work on the reverse movement.

Self-Oiling Bushings

With the idea of overcoming the throwing of oil and the danger of bearings running dry, the Moccasin Bushing Co., Chattanooga, Tenn., is now marketing a line of self-oiling bushings, one of which, installed in a pulley, is shown in the illustration.

Each bushing consists of a bronze ring provided with feeders that go transversely through the bushing to the bearing surface. These feeders draw the oil, by capillary attraction, from the oil reservoir and feed it to the bearing surface. In the illustration the oil reservoir is shown machined in the inside of the pulley hub, but this may be machined on the outside of the bushing if desired. The holes for the feeders are staggered, in or-



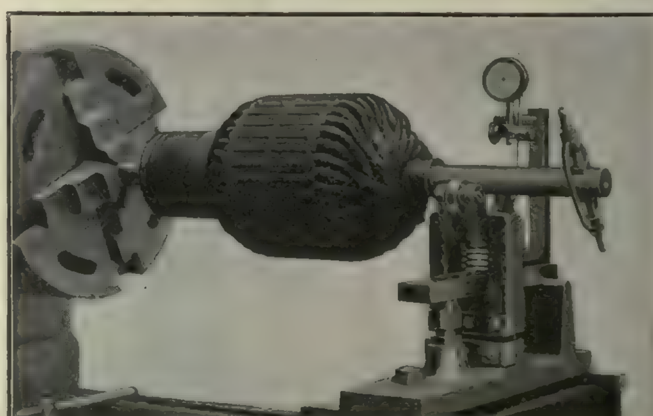
SELF-OILING BUSHING INSTALLED IN A PULLEY

der that the bushing will not be weakened, and the feeders are fastened firmly in place. It is said that the bushings will run three months on one oiling. If so desired, the bushings will be made up of bronze, meeting the customer's specifications.

Dynamic-Balancing Fixture

The illustration shows a dynamic-balancing fixture that has been placed on the market by N. K. Akimoff, 1013 Harrison Building, Philadelphia, Penn. The device is intended to be used for balancing revolving machine parts in an ordinary engine lathe.

One end of the part to be balanced is fixed in the chuck, while the other end rests freely on the rollers



DYNAMIC-BALANCING FIXTURE

of a yielding support shown at the right. The balancing fixture is held to the shaft by friction, the operator's task being simply to determine in what angular position it should be and how far off center the weight should be placed in order to secure quiet running as indicated by the dial gage. After these points are determined, specially prepared tables indicate how much and where drilling should be done to secure correct balance.

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., June 16, 1917—There is one thing that must be remembered and considered before criticizing the various departments because volunteered offers of service are not promptly accepted. Without criticizing any of the offers made, the great majority of them are, of necessity, based on a more or less reasonable compensation. This payment requires money, which has not been appropriated and which is only available when appropriated for a specific object. Even where it is appropriated, its disbursement is very often in the hands of departments which do not appreciate the broader principle of management, which do not see that the problems of making war are different now than in the past.

As a concrete example of lack of familiarity with war problems, the Senate recently cut out an appropriation for the Bureau of Standards for the establishment of a gaging department to test munition gages, on the ground that this was not a military measure and did not concern the conduct of the war. Steps are of course being taken to have this item restored, but it goes to show how little the otherwise learned lawmakers know of modern warfare or modern mechanics. It also emphasizes the fact that the time has come when it is absolutely necessary to the welfare of the country to elect a fair proportion of engineers to both branches of Congress.

Modern civilization as well as modern warfare is largely a series of engineering problems that must be met carefully and intelligently, if the country is to succeed in either war or peace.

Returning to the question of volunteer service, it will be seen why many good men have not been called, men who would be of great value. No provision has been made in many cases for paying them a living salary, which is of course absolutely necessary in most cases.

Industries Involved by the War

Few realize the great diversity of industries involved in the conduct of modern warfare. In addition to those which have solely to do with war, we have all the normal industries of peace time, except perhaps for a few of the luxuries such as jewelry and limousines. Just as one example, take the building of the 32 cantonments or towns for the housing of the first 500,000 men during their preliminary training in this country. Here are 32 cities, each to house 22,000 men, with all the attendant problems of sewage, water-supply, mess halls, bathhouses, storehouses and all the rest. Each town will cover about 720 acres and contain approximately 2000 houses, which will require about 19,000,000 ft. for each cantonment or 600,000,000 ft. of lumber for them all. The high price of canvas and its scarcity make the lumber more economical in the long run, especially as the canvas tent usually needs to be renewed every six months.

In view of these greatly diversified activities it is being urged by many that we follow the English example of relieving the War Department of the vast amount of work outside of the more or less strictly military matters, so as not to swamp it with details that might interfere with the work in which it specializes and about which civilians know very little. In other words, turn over to civilians such work as their training and qualifications fit them to do, so that the army and the War Department may devote their whole energy to military matters, for which they alone are fitted. They would then requisition such supplies as they needed, whether shells, howitzers or shower baths, and it would be up to the civilian departments to supply them.

The Question of Trucks and Airplanes

Some idea of the extent to which motor trucks have become necessities in modern warfare may be had from the fact that bids have already been asked on orders from one to 35,000 trucks of various sizes, ranging from 1½ to 5 tons, with 3 tons' capacity as the usual middle figure.

Luckily, we have been building thousands of trucks for use of the Allies, so that we know that our trucks are fairly satisfactory, even if they do not fulfill all the specifications formulated by the War Department Motor Transport Board. The major portions of these specifications can be easily met, and it will not take long to secure trucks that are in entire accord with the requirements.

If there were any shortage of trucks, it would of course be easily possible to commandeer many trucks that might be used to advantage. They would, however, have the disadvantage of not being uniform, which would add greatly to the cost of upkeep in the field and cause delays from spare parts not being available for all the different makes. On this account, it is the intention of the War Department to put into service fleets of new trucks that comply with the requirements as far as possible. Trucks of a certain make will be kept in units with similar trucks, so far as possible, to avoid the confusion due to repairs on a great variety of machines.

Now that the Aircraft Production Board has announced some of its plans, we see how utterly misleading the newspapers were in regard to getting all machines abroad on account of ours not being worth while. Not that we are perfection, by a long way, or that we build fighting machines as well as the English or the French; but

they are using their utmost capacity in their own army, and it is up to us to add to the number of aircraft available instead of using machines that our allies build.

This leads me to comment on some of the practices I have seen in airplane-motor shops, which apparently hinder production without in any way increasing the quality of the motor. I refer to the not inconsiderable amount of work that is entirely unnecessary, such as nickel-plating cylinders, scraping crank cases all over by hand, inside and out, and similar work.

Scraping crank cases inside is to get out all the sand from the foundry and keep this sand from getting into the bearings, which is of course highly desirable. But several excellent engineers in the airplane field assure me that equally good results can be had with a sandblast followed by an airblast and a bath of gasoline. And the hand scraping on the outside can surely be of no practical benefit whatever.

One motor builder summed it up in a few words, which may show an attitude that is permissible in peace times and for pleasure machines, but that has no place in manufacturing war machines where lives depend upon rapid production. He said, "We get such a good price for these motors that we can afford these little extravagances, and the purchasers want to see that they are getting the best for their money." This same excuse was offered for not adopting a new type of connecting-rod, which apparently has many advantages, but which does not look quite as attractive as the rod generally used. But when the rods now put into a certain high-powered motor cost $50 each in the shop and the new type can be made for much less, this becomes a problem for serious consideration. It is a matter not only of cost, but of the time which goes to make up that cost, that counts in such an emergency as this.

The Exemption Boards

Now that registration day is past, the question of selection and exemptions is uppermost in the minds of all who realize the great importance of keeping the necessary industries going with the least disturbance. Even though we all realize how important certain industries may be, we also know that there is bound to be some disturbance, for every man who goes must be replaced, and this means time for the training of the new man or woman, as the case may be.

While nothing has been definitely settled as to the method of deciding upon the exemptions, it can be safely assumed that one of the determining factors will be the evidence that all parties are acting in good faith. By making a careful list of the men considered of vital importance, before the selection takes place and regardless of their age limit, evidence is given that the list was not made to release anyone who was drafted. Such action is quite sure to carry weight with the exemption board, no matter who sits on it.

From present indications there will be an exemption board in every Federal judicial district or in such subdivision of this district as may be required by the population. The composition of the board will, it is said, probably consist of one engineer, a doctor, a lawyer and a business man, although this has not been fully decided upon as yet. At any rate, it will contain representatives of industry and will not be entirely an army board, if indeed the army is represented at all.

Some recruiting officers have also shown admirable judgment in some manufacturing towns by discouraging the enlistment of men engaged in machine work of great importance. In cases where men have already enlisted, there is talk of their being assigned to duty back in their old shop, where they can be of the greatest value. Just how far this plan will be carried out is by no means certain, but the mere fact that such actions are even being considered is encouraging in many ways.

The Problem of Engineering Ability

One of the greatest problems at present is to utilize the engineering ability that is lying around loose, so to speak, waiting to do its share in the great work which we have ahead of us. This is a most difficult problem for several reasons, and I wish to counsel the many who write me inquiring how to get in touch with the right men or the right department, to be as patient as possible while the solution is being worked out. Few realize the magnitude of the job we have tackled and how much organization is necessary before we can be nearly as efficient as those who have been studying the war game and been preparing for it for 40 years.

There are thousands of engineers whose experience will be of value in various ways when some rational means are devised for utilizing their experience to the best advantage. One of the present difficulties is that all the civilian engineering boards are purely advisory, the members in nearly every case giving their own services without remuneration. Moreover, they have no funds with which to employ engineers who must have even a living wage during their employment. This is the case with most engineers, because the return which they, as a rule, receive for their services is not sufficient to enable them to work without salary at present, much as they might wish to do so.

Another difficulty is that the only way in which such engineers can get on the payroll, in most cases, or for that matter be given any authority, is to give them a commission in the army or navy. It often happens, however, that a perfectly capable engineer could not pass the required physical tests and might be debarred on that account. But entirely aside from these difficulties, the whole method is hardly in keeping with our desire to crush militarism, as we are certainly not crushing it when we extend it to engineers simply to get them on the payroll and invest them with their proper authority. Much thought is being given to this problem, and it is sure to be worked out satisfactorily in the near future.

Establishing New Industries

Just to show that work is actually progressing in many important lines, even if not at all connected directly with the making of war, let me cite once more some of the activities of the Bureau of Standards. Not only has this bureau worked out a satisfactory method of making optical glass and set about making it regularly for military use, but it has also found the process of making chemical porcelain, which was formerly made in Germany and without which our chemical laboratories would be seriously handicapped. This porcelain is being produced commercially in this country as a result of the bureau's efforts, and we are now independent of foreign countries for our supply. The Bureau of Standards has also helped place the synthetic dye industry on its feet, and we are now making good dyes.

Experiments are also going forward on the tanning of the hides of shark, porpoise and grayfish, with a view to relieving the leather market in some particulars. The substitution of textiles for many uses of leather will also assist greatly in this respect.

I am also glad to be able to state that contracts are under way for the making of field artillery and that new firms are establishing shops for its manufacture on a large scale and in rapid time.

One of the difficulties in the making of field and other guns of calibers of 3 in. or over is connected with the steel forgings and their heat-treatment. As with projectiles, the number of each heat must be kept on each forging, this number being transferred from place to place as the work progresses. The forgings, which must be of domestic steel, to insure our ability to duplicate it at any time, are of two classes. "Gun steel" is simply a carbon steel, while the "alloy steel" occasionally specified requires such additions as may be necessary to secure certain physical characteristics. In either case the sulphur and phosphorus content must not exceed 5 per cent.

The ingots are required to be at least four times the maximum area of the cross section of the rough forging, so as to insure a thorough working of the steel in forging. The lower end of each ingot, as cast, forms the breech end of the gun.

When practicable, the forgings are rough-machined before heat-treating, but in the case of hoops and small forgings of less than 4 in. in thickness they may be heat-treated first. This first heat-treatment calls for an annealing from a temperature above the upper critical point. Should much straightening be necessary, the forging must be heated to at least 800 deg. F., but not higher than the last heat-treatment temperature; but minor straightening may be carried on as low as 300 deg. Fahrenheit.

The usual requirements in gun steel for gun tubes, liners and jackets are 90,000 lb. tensile and 50,000 lb. elastic limit on guns under 8 in. and from 3 to 5 per cent. less than this for larger sizes. For hoops the tensile requirement runs to 93,000 lb. and the elastic limit to 53,000 lb. for all sizes. For alloy steels the requirements are 95,000 lb. tensile for small calibers and 90,000 lb. for larger sizes. The elastic limit is 65,000 lb. for the smaller guns and from 55,000 to 60,000 on the larger sizes. For breech blocks or plugs, breech bushings, spindles or mushrooms and other parts, a tensile strength of 95,000 and an elastic limit of 65,000 lb. are required. In all cases an elongation of 18 per cent. and a reduction of area of 30 per cent. are specified. The weight of material paid for is figured on the basis of 0.2836 lb. per cu.in. for carbon or gun steel and 0.2840 lb. for alloy steel.

FRED H. COLVIN.

Personals

R. E. Wells has been appointed engineer of the motor-car division of the Hyatt Roller Bearing Company.

Arthur Letherby, formerly of the Kern Machine Tool Co., Hamilton, Ohio, has taken a position with the E. A. Kinsey Co., Cincinnati, Ohio.

R. S. Lane, formerly chief engineer of the Hyatt Roller Bearing Co., has accepted positions with the Bearings Service Co. and the United Motors Service, Inc.

Ambrose Swasey, president of the Warner & Swasey Co., Cleveland, Ohio, has been elected to the presidency of the Cleveland Young Men's Christian Association.

C. A. Newman, formerly manager of sales promotion for Hennion & Hubbell, Chicago, Ill., has become sales manager of the Boiler-Kote Co., Fisher Building, Chicago, Ill.

James Gibbons, formerly manager of the Baltimore office of the Van Dorn Electric Tool Co., has been appointed manager of the new office recently opened at 524 Wells Building, Milwaukee, Wis.

F. T. Coup, formerly connected with the Chicago office of the Wagner Electric Manufacturing Co., St. Louis, Mo., is to take charge of the new Milwaukee office just opened in the First National Bank Building.

C. S. Butler, formerly of the Hess-Bright Manufacturing Co., and **C. F. Varoon,** formerly chief production engineer of the Greenfield Tap and Die Corporation, have become connected with the Carlson-Westrom Co., a subsidiary of the Carwen Steel Tool Company.

Henry S. Moos has been appointed director of sales in Spain by the manufacturers for whom the Sociedad General de Representaciones-New York has acted as agents in Spain. Offices, salesrooms and warehouses will be in Barcelona, Bilbao, Cartagena, Gijon, Madrid, Santander, Sevilla and Valencia. The New York office will continue to be in the Hudson Terminal Building.

Obituary

William W. Green, late president of the Garden City Fan Co., Chicago, Ill., died at Niles, Mich., on June 2. Mr. Green was responsible for the removal of his company from Chicago in 1902, and this proved to be a large factor in the industrial development of Niles, which is now a busy manufacturing center.

Business Items

The General Electric Co. has moved its New York offices from 30 Church St. to 120 Broadway.

James H. Matthews & Co., Pittsburgh, Penn., held their third annual outing and picnic at Homestead Park on June 9.

The Bridgeport Machine Co., Augusta, Kan., manufacturer of oil and gas well tools, is making an addition to its present plant.

The Inter-State Machine Products Co., Inc., Rochester, N. Y., has opened an automatic screw-machine department for handling outside work.

The Driggs-Seabury Ordnance Co., Sharon, Penn., has acquired all the property and assets of the Savage Arms Co., Utica, N. Y., and changed its name to the Savage Arms Corporation.

The Vanadium Steel Alloys Co., Latrobe, Penn., has purchased all Liberty bonds subscribed for by its employees and will allow easy payments covering the period of approximately a year.

The Union Switch and Signal Co., Swissvale, Penn., is installing a number of 5000-lb. steam drop hammers and will increase its facilities for forging automobile axles, large gear blanks, crankshafts and camshafts.

The 20th Century Brass Works, Minneapolis, Minn., is erecting a two-story brick building 65 x 66 ft., to be used as a brass, bronze and aluminum foundry, and a machine shop for brass finishing and special manufacturing.

The American Machine Tool Engineering Works, 4854 West Kinzie St., Chicago, Ill., has taken over the lathe business of the National Engineering and Tool Works, of Oak Park, Ill., and will continue to manufacture the lathe under the trade mark "AMTEW."

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

The American Society for Testing Materials, affiliated with the International Association for Testing Materials, will hold its twentieth annual meeting at Atlantic City, June 26 to 29, 1917. Headquarters are to be at the Hotel Traymore.

The Society of Automotive Engineers will hold its annual convention at Washington, D. C., June 25, 1917.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineer's Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, except July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The American and Canadian engineers and architects of Norwegian birth and descent will hold an informal congress and reunion at the Chicago Norske Klub, Logan Square, Chicago, Ill., Sept. 27 to 29, 1917.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Qutations were current as follows at the points and dates indicated:

	June 15, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham..	$40.00	$40.00	$15.00
No. 2X Northern Foundry, New York..	47.00	44.00	20.75
No. 2 Northern Foundry, Chicago......	50.00	44.00	19.00
Bessemer, Pittsburgh	55.95	44.95	21.95
Basic, Pittsburgh	50.00	42.00	18.95
No. 2X, Philadelphia................	46.75	42.50	20.50
No. 2, Valley.......................	50.00	42.00	18.50
No. 2, Southern Cincinnati...........	42.90	42.90	17.90
Basic, Eastern Pennsylvania..........	42.50	38.00	20.50
Gray forge, Pittsburgh..............	47.95	40.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	June 15, 1917	One Month Ago	One Year Ago	June 15, 1917	One Year Ago	June 15, 1917	One Year Ago
Structural shapes ...	5.00	5.00	3.50	5.00	3.25	5.00	3.10
Soft steel bars.....	4.75	4.75	3.55	4.50	3.25	4.50	3.10
Soft steel bar shapes	4.75	4.75	3.50	4.50	3.25	4.50	3.10
Plates	8.00	7.00	4.25	7.00	3.65	8.00	3.50

BAR IRON—Prices in cents per pound at the places named are as follows:

	June 15, 1917	One Year Ago
Pittsburgh, mill	4.25	2.60
Warehouse, New York......................	4.60	3.25
Warehouse, Cleveland	4.45	3.25
Warehouse, Chicago	4.50	3.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		June 15, 1917	One Month Ago	One Year Ago	June 15, 1917	One Year Ago	June 15, 1917	One Year Ago
*No. 28 black......	7.75	9.50	9.25	3.65	8.25	3.20	8.50	3.20
*No. 26 black......	7.65	9.40	9.15	3.55	8.15	3.10	8.40	3.10
*Nos. 22 and 24 black	7.60	9.35	9.10	3.50	8.10	3.05	8.35	3.05
Nos. 18 and 20 black	7.55	9.30	9.05	3.45	8.05	3.00	8.30	3.00
No. 16 blue annealed	8.10	9.20	8.50	4.70	7.95	3.70	8.70	3.60
No. 14 blue annealed	7.85	9.10	8.50	4.60	7.85	3.60	8.60	3.50
No. 12 blue annealed	7.60	9.05	8.50	4.50	7.80	3.50	8.55	3.45
No. 10 blue annealed	7.35	9.00	8.50	4.55	7.75	3.55	8.50	3.50
*No. 28 galvanized..	9.75	12.00	10.75	5.65	10.00	5.50	10.50	5.50
*No. 26 galvanized..	9.45	11.70	10.45	5.35	9.70	5.20	10.20	5.20
*No. 24 galvanized..	9.30	11.55	10.30	5.20	9.55	5.05	10.05	5.05

*For corrugated sheets add 25c. per 100 lb.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	June 15, 1917	One Year Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 20%
Chicago	List plus 10%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	45%
Cleveland	45%	50%
Chicago	45%	50%

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	June 15, 1917	One Year Ago
New York	$20.00@26.00	$6.00
Cleveland	12.30	6.30
Chicago	12.00	5.25

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*	
⅜, 11/32, 5/16, ¼, 7/32, 3/16	21.00@30.00
No. 3, 5/32 and No. 10	
⅛	
No. 12	
3/32, No. 14 and 1/16..	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods	
3/16 by 12 in. long.........	16.00
¼ by 19 in. long.........	14.00
⅜ by 19 in long.........	12.00
½ by 21 in. long.........	12.00

*Special Welding Wire	
⅛	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York June 15, 1917	Cleveland June 15, 1917	Chicago June 15, 1917
Tire	5.00	4.50	4.50
Toe calk	5.00	5.00	4.75
Openhearth spring steel...	7.00	8.25	7.50@ 8.50
Spring steel (crucible analysis)	8.00	11.25	12.00
Carbon tool steel, base price	14.00	13.00	....
Special best cast steel....	14.00@18.00	20.00	....

*In bars.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh basing card in effect May 1, 1917:

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
BUTT WELD					
⅛, ¼ and ⅜..	42%	15½%	¾ to 1½.....	38%	22%
½	46%	31½%			
LAP WELD					
2	42%	27½%	1¼	23%	8%
2½ to 6......	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4......	33%	20%
			4½ to 6......	33%	20%
BUTT WELD, EXTRA STRONG PLAIN ENDS					
⅛, ¼ and ⅜..	38%	20½%	¾ to 1½.....	38%	23%
½	43%	30½%			
¾ to 1½.....	47%	34½%			
LAP WELD, EXTRA STRONG PLAIN ENDS					
2	40%	28½%	1¼	24%	8%
2½ to 4......	43%	31½%	1½	30%	16%
4½ to 6......	42%	30½%	2	32%	19%
			2¼ to 4......	34%	22%
			4½ to 6......	33%	21%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
¾ to 3 in. steel butt welded	38%	22%	43%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list price. Cast iron, standard sizes, 34 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	June 15, 1917	One Month Ago	One Year Ago
Copper, electrolytic (carload lots)*....	31.00	33.00	29.00
Tin	61.00	65.00	45.00
Lead	12.00	11.00	7.00
Spelter	9.25	9.50	13.75

*Third-quarter copper; for spot copper the market price is 33c.

ST. LOUIS			
Lead	12.00	10.75	7.00
Spelter	9.25	9.25	13.62½

At the places named, the following prices in cents per pound prevail:

	New York			Cleveland		Chicago	
	June 15, 1917	One Month Ago	One Year Ago	June 15, 1917	One Year Ago	June 15, 1917	One Year Ago
Copper sheets, base.	42.00	42.00	37.50	42.00	38.50	42.50	37.00
Copper wire (carload lots)	39.50	39.50	37.50	39.00	33.00	40.00	37.50
Brass pipe, base...	47.50	47.50	46.50	48.00	45.00	47.50	38.50
Brass sheets .....:	45.00	45.00	44.50	41.00	42.00	43.50	46.00
Solder ½ and ½ (case lots)	39.75	39.50	28.00	39.50	32.50	39.50	38.50

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	June 15, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	......
New York	45.50	45.50	$44.50
Cleveland	38.00	42.00	38.00
Chicago	42.50	42.50	40.00

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill.................................. 19.00

	In Casks		Broken Lots	
	June 15, 1917	One Year Ago	June 15, 1917	One Year Ago
New York	21.00	24.00	21.50	24.50
Cleveland	23.00	26.00	23.25	26.50
Chicago	22.50	26.00	23.50	26.50

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	June 15, 1917	One Year Ago
New York	20.00	23.00
Cleveland	28.00	52.50
Chicago	27.50	46.00

Handling 8-in. Shell Forgings

By M. E. Hoag

SYNOPSIS—The work-handling methods of the Curtis Co. are exceptionally interesting at this time, when every bit of available information regarding munition methods finds ready application in our shops.

At the time the contracts for 8-in. shells were let by the British Government, the Curtis Pneumatic Machinery Co., St. Louis, Mo., was engaged in the manufacture of pneumatic hoisting machinery and air compressors. It is interesting to note that the company has not only continued the manufacture of its regular lines, but that it has increased its output over 50 per cent. For handling munition work, it was renamed the Curtis & Co. Manufacturing Company.

Some large manufacturers of forgings and many steel mills refused to consider this method of forging, as they considered it impracticable, if not impossible; but the Curtis company was so sure that it staked practically everything on the success or failure of its ideas. That these ideas were correct is evidenced by the fact that the company now has a capacity of about 100,000 shell blanks per month. While its process is fully protected by patents, it has been patriotic enough to give a number of mills and forge plants free use of its patents and has aided these concerns in every way possible; and it has given free use of its experience and patents to the United States Government.

There are some details in the process which make this method of forging practical. As information about these items would be of great benefit to enemies of the United States and its allies, it is considered best to omit them; but no doubt any manufacturer who wishes to use them in a legitimate way can secure permission from the Curtis company. When the forging of these shells was first started, the stock was secured in rolled bars and cut to length, as shown at *B, C, D,* Fig. 1. Later, it became impossible to secure sufficient raw material to meet the demands, so it was found necessary to use steel castings, as shown at *A*. The dimensions of these blanks, or ingots, are given in Fig. 2.

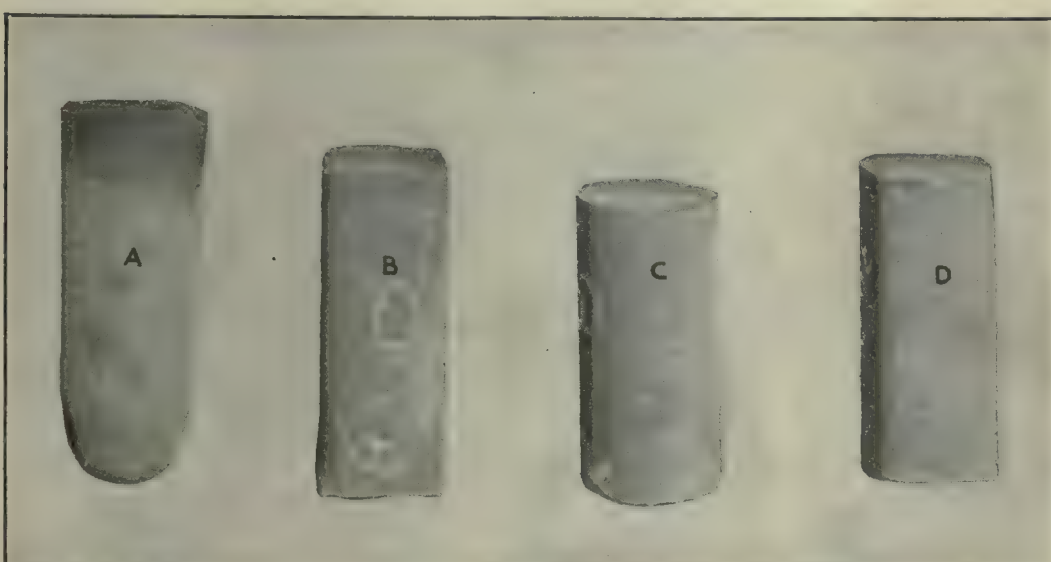


FIG. 1. A CAST AND THREE BAR-FORGING BLANKS

The first step in working up rolled stock is shown in Fig. 3, the blanks being first cut to length with oxyacety-

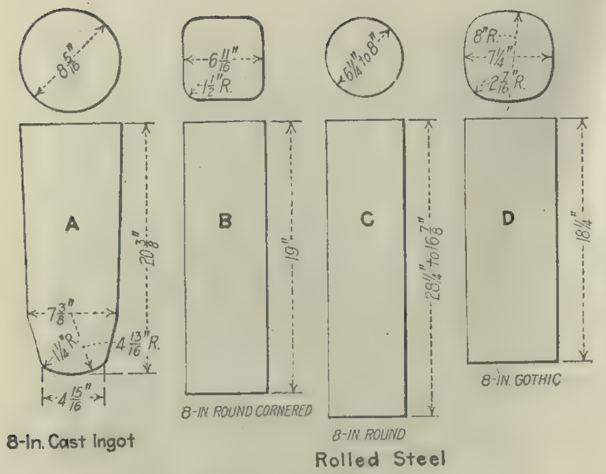


FIG. 2. DIMENSIONS OF CAST AND BAR INGOTS

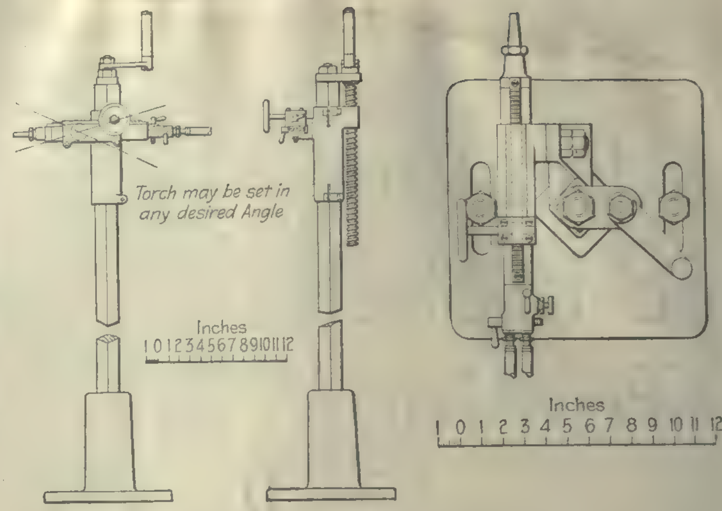


FIG. 4. DETAILS OF OXYACETYLENE-TORCH STAND

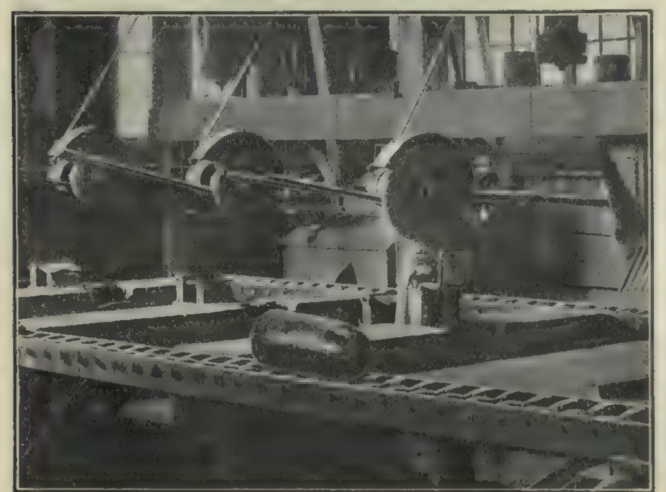


FIG. 5. APPARATUS FOR GRINDING OUT DEFECTS

lene torches, details of which are shown in Fig. 4. One torch operates on one side only of the stock and cuts to a depth of about $\frac{3}{4}$ in., after which the blanks are broken apart under a press. The steel ingots are cast in iron molds, which allow about 25 per cent. for riser and cutoff, thus insuring perfect castings. The first inspection and cutting off are handled at the steel foundry, and the blanks *A*, Fig. 1, are delivered to the forge shop ready for forging. The analysis of both castings and rolled stock is taken care of at the foundry and mills. It shows about 0.50 carbon and the correct proportions of manganese, sulphur and phosphorus.

All inspection is done by British Government inspectors. The first inspection after the stock is received by the forge plant is for cracks, seams and other defects. It also sometimes happens that pieces of the iron molds adhere to the castings. All rejected pieces are passed to the "hospital," where cracks and seams are ground out, as shown in Fig. 5, and other defects are removed with the oxyacetylene torch. It is very important that these defects be removed before forging. Otherwise, they will extend through the forging and cause it to be rejected later on.

From this point on, the process of manufacture is the same with both the cast ingots and the rolled stock, and the work is routed in such a manner that practically a continuous stream of shells passes through the various operations, through the final inspection and to the ship-

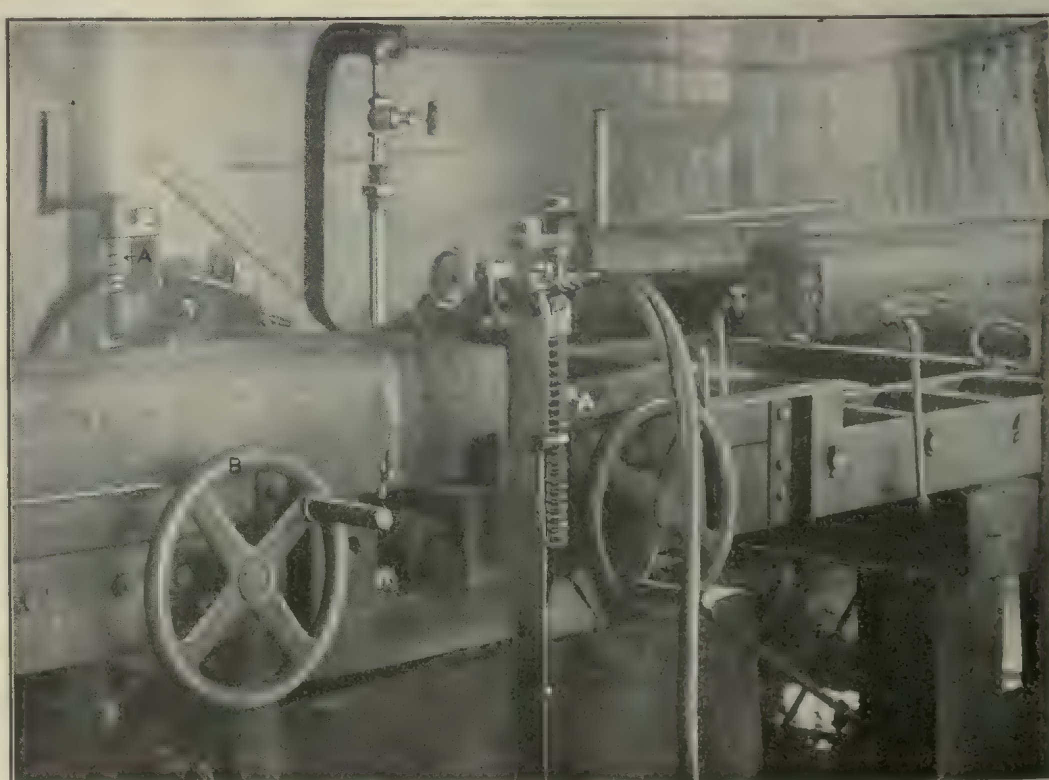


FIG. 3. OXYACETYLENE BAR-CUTTING MACHINE

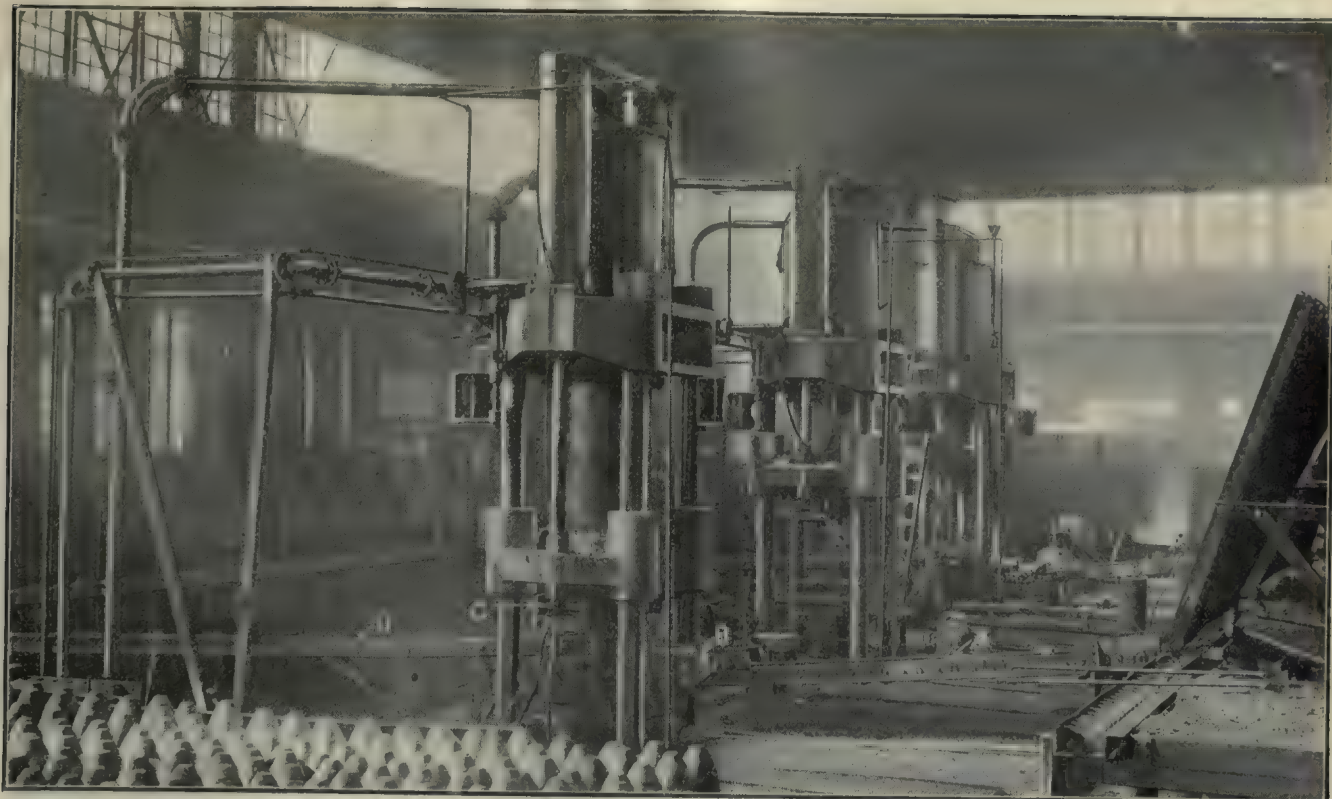


FIG. 6. GENERAL VIEW OF HYDRAULIC SHELL-FORGING PRESSES AND EQUIPMENT

FIG. 7. COOLING TUNNELS AND CONVEYOR

ping department, ready to be loaded on the cars. The first operation is heating. This is done in double-ended oil-fired furnaces, the blanks being fed into the furnaces at one end. As fast as a blank has reached the proper forging heat and is removed from the opposite end, a new blank is fed in at the other end and started through. In this way the furnaces are kept loaded to full capacity at all times, and maximum production is assured. As soon as a blank has reached the proper forging heat, it is drawn from the furnace, scaled and passed down the rollerway *A*, Fig. 6, until it reaches the elevating, or loading, device *B*, which tips the blank up and drops it, nose down, into the die under the hydraulic press. The first, or "slugging,"

punch forces it down into the die. The traveling head C, which carries the punches and stripper, is then moved over. The piercing punch makes the bore of the shell and at the same time causes the metal to flow up and around the piercing die, in much the same manner as clay flows out of a tile machine. The punches are now raised and returned to first position, and the knock-out pin in the bottom of the female die pushes the shell blank up. A workman catches it with a hook and tips it over into the rollerway D, and it passes down to the inspector, who tests it for concentricity of the bore with the outside. If it passes inspection, it is carried along the rollerway and into the cooling tunnels, shown in Fig. 7. These cooling tunnels are double ended and are supplied with air pipes and stacks to carry off the heat. Otherwise, with hundreds of white-hot shells cooling in the open shops, the temperature would become so high that the men would be unable to work. A gage for the length and shape of the shell nose is shown at A.

After cooling, the blanks are inspected for cracks and defects brought out in forging. They are again inspected for concentricity, on the motor-driven machine illustrated in Fig. 8. This machine consists of a rotating mandrel, with solid nose to fit the inside of the shell nose, and expanding fingers that grip the bore of the shell at the butt end. The wheels A press against the outside of the shell as it is rotated, and pointers at B show the eccentricity between the bore and the outside.

Shells failing to pass these last two inspections are sent to the hospital, and cracks and other defects are removed by grinding, as before described. Those that can be cleaned up without going so deep as to interfere with the final machining are again passed to the inspectors. Blanks that run out too much or show deep scars are taken to the turning department and placed on Root & Van Dervoort shell lathes, and a roughing cut is taken. If a sufficient cut for finishing is still possible the blanks are passed to the inspectors. It is remarkable that but about one per cent. of the shells are finally rejected by the inspectors.

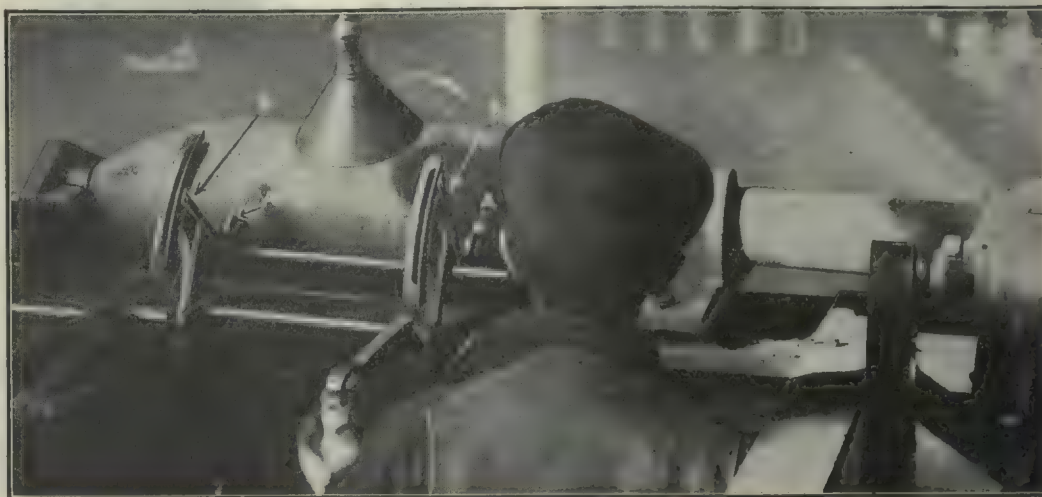


FIG. 8. TESTING THE SHELL FOR ECCENTRICITY

All shell blanks are given a final heat-treatment, which the manufacturers call "normalizing," in the furnaces shown in Fig. 9. The blanks are loaded on cars and passed into the furnaces at A, where they are heated to the proper temperature. As they reach the end of the furnace, they are passed back through a cooling tunnel B and cooled, after which they are ready for loading into cars for shipment. At D are tongs and an air lift used in loading and unloading shells from the small cars:

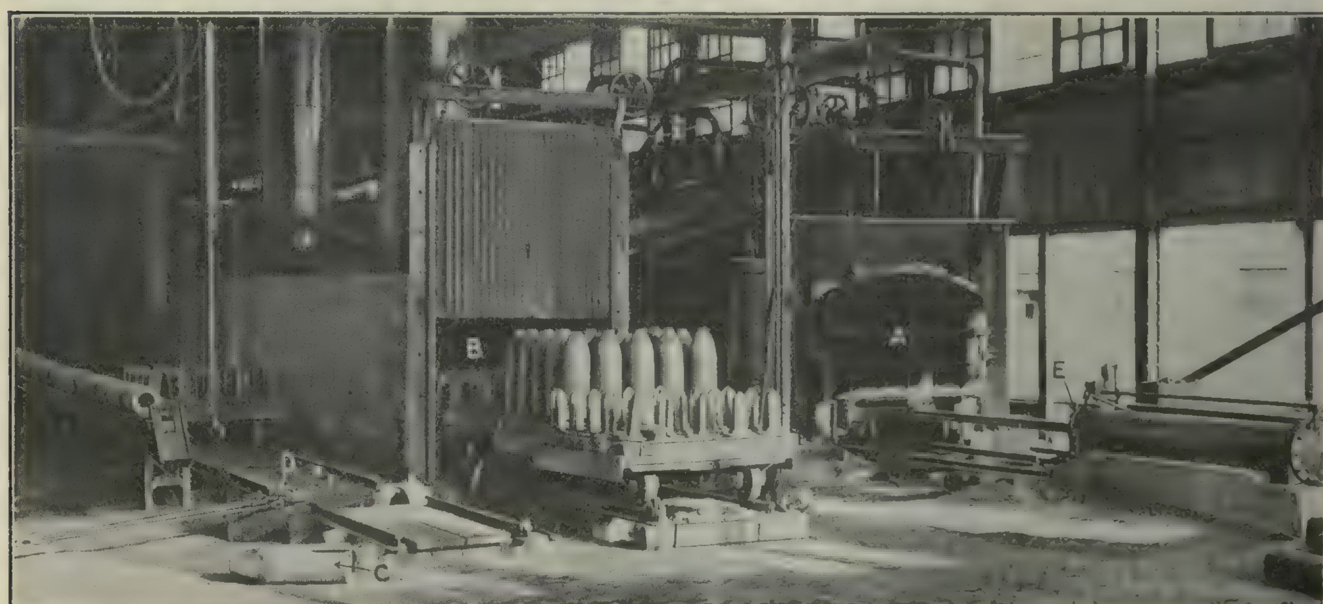


FIG. 9. THE NORMALIZING FURNACES, TRUCKS AND AIR APPARATUS

E shows another adaptation of the air lift, used to push the cars into the furnaces. At *C*, is a shell from which a test piece has been cut. As stated before, the analysis is handled at the foundry and mills, but the physical tests are made in the Curtis plant. The castings come in lots of about 130 pieces to the heat, and one shell out of each heat is given a physical test.

Fig. 10 shows the receiving and shipping sheds, where all material is handled with crane and with electromagnet lifts. It will also be noticed that, wherever possible, rollerways are provided, and these greatly facilitate the passing of material from one department to another. Wherever it is necessary to lift stock, air hoists are used. These are of the company's own manufacture; and as these hoists are subjected to extremely hard usage, it speaks well for the product.

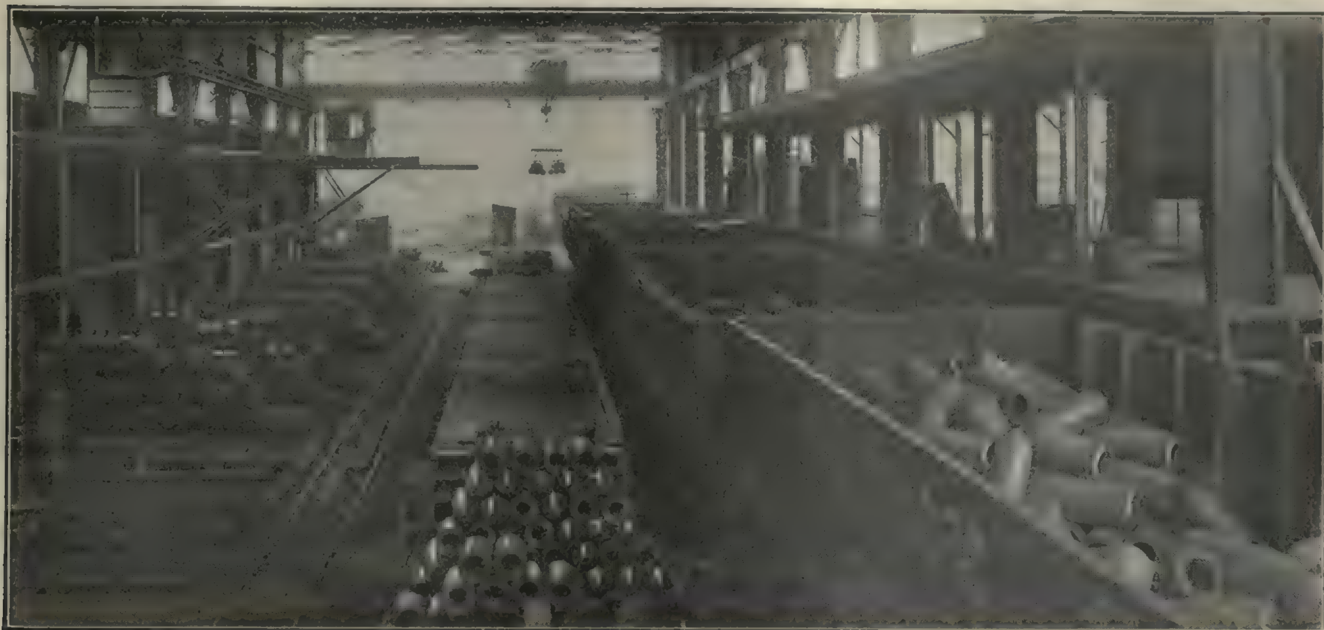


FIG. 10. RECEIVING AND SHIPPING SHEDS EQUIPPED WITH CRANES AND LIFTING MAGNETS

Designing To Suit the Shop

By William S. Ayars

How many draftsmen and designers, throughout the length and breadth of this continent, get "sore" every day at somebody out in the shop, who picked a lovely drawing all to bits because it did not suit the available tools? I can recall quite a few experiences of this sort in my early days at the board; but the lesson was learned before any considerable damage was done. It never does a draftsman any harm to go out into the shop once in a while to get a line on the equipment and what it will do.

I was once employed on boiler and engine design in a large shipbuilding plant. The noon hour in the shop and that in the office did not synchronize. This was most fortunate, as a draftsman could spend at least half an hour of his recess out in the shops, which were then at work.

Nothing is more fascinating than to watch something grow into completion that a few weeks before had been schemed out on a piece of paper. It is often interesting, and sometimes cruelly instructive, to listen to the comments of the man in overalls—especially if he does not know who fathered the job he is on at the time and addresses his criticism to the bashful designer as being the nearest listener. I even had the pleasure once of being taken all over the engine and boiler room of a small steamship by her chief engineer. Everything about her was carefully explained to me, as it would have been to any other interested passenger, when I myself had been responsible for the design of every bit of her equipment. I had to take the bitter with the sweet, but the chief never knew I had been head draftsman of the plant that built his craft.

I recall one mistake made on that very job. I had designed the bedplate of the engine, a four-cylinder triple, for bored seatings for the boxes instead of planed ones, because I had read somewhere that this was a cheaper way to machine them. Some time after the steel castings were in the shop, the foreman told me that he wished I had taken him more into my confidence on that job while it was still on paper, as he had no proper equipment with which to bore the seatings cheaply. He said he could have planed them very easily, however, the whole lot at one setting; and there were eight of them.

Every chief draftsman ought not merely to be on speaking terms, but as intimate as he can find time to be with the foreman. It happens in my own case that I have usually found the machine- and pattern-shop foremen the most useful; but any work around steel steamships brings out the need of knowing a lot about pipework, boilermaking and smithwork. In some shops the foremen want every little detail on a drawing; in others they like to have considerable left to their own discretion. This latter method takes quite a lot of responsibility off the designer's shoulders, but I think this responsibility belongs to the designer; and he has no business to shift it onto the foreman, whether the latter wants it or not.

If you mark a flange to be "drilled for $1\frac{1}{4}$-in. studs," how large a drill should be used? It would seem better to mark it "$1\frac{5}{16}$-in. drill for $1\frac{1}{4}$-in. studs," provided that

gives the necessary clearance for this particular job. And furthermore, in the second case, nobody in the shop needs to exercise judgment, and the man on the drill press does not need to hunt around for the boss in order to find out how big a drill he should use for 1¼-in. studs.

Draftsmen are prone to roving, and methods that suit perfectly in one shop do not always transplant readily. Some shops have things beautifully standardized; and others run, sometimes quite prosperously, on the "b'guess and b'gosh system." But the standards in well-standardized shops are not always made known to the newcomer, and he gets into trouble accordingly. I once spent considerable time figuring out and designing a triple butt-riveted joint for a boiler, only to be told later by the chief, "Oh I forgot to tell you we have all those riveted joints standardized, and you must always use our standard joints." He then dug out a crumpled blueprint from his desk and handed it to me with strict injunctions not to lose it or let it get out in any way. Later I found that it was merely a copy of the standards given out gratis by the Hartford Boiler Insurance people and to be found in almost any catalog of reputable boiler manufacturers.

Another Problem of the Designer

Another thing a good designer must look out for is specifying something which is new to the shop and which is not thoroughly well known to himself.

Many good workmen of the "show-me" type are also of the "it-can't-be-done" type. Nobody would expect an architect to go up on a scaffold and show a bricklayer or a stone mason just how to do a bit of difficult work at his trade, but a good machine designer is not expected to call for any piece of hand or machine work if he cannot at least show the workmen how to go about it. I shall never forget the joy with which I once tackled a job in the shop that required some difficult hand-clipping of oil grooves. I had designed the whole bearing, which was for the trunnions of the air-pump beams, or "levers," of a triple marine engine, and happened to walk through the shop just as a "fitter" was putting it together. He was cutting the grooves wrong, and I made bold to tell him so. "Well, then, perhaps you can show me how!" was his rather contemptuous retort.

I had cut some miles of those grooves in the preceding four years, so I took his tools and started in. After cutting a few inches, he reached for them and said he was convinced, remarking that I had "called the bluff." Always, thereafter, he was one of my stanchest friends.

Style of the Shop Important

Another thing a draftsman must notice carefully when he starts to work with a new employer is the style of the output. I mean "style" in the same sense that it is applied to clothes. I have known locomotive men who could look at a locomotive some distance away and tell by its style just who built it. It is a rare schoolboy today who cannot tell at a glance the maker of any automobile as it flashes past.

Only last summer a machinist in Bethlehem, Penn., remarked of a certain machine tool that it was a "bear for work, but had no style about it." No designer can afford to introduce novelties or even improvements into the design of a standard and well-known product unless somebody a great deal higher up authorizes him to do so, if these changes are going to cause any noticeable departure from the style of the product. On this point, as on a great many others, one of the best men to consult is the sales manager.

In conclusion I can offer to designers in general these points on designing to suit your own shop:

1. Study the machine-shop equipment until you have a good idea of the maximum sizes of single pieces that each tool can handle.
2. On any job where you can alter the design one way or another without affecting its strength or usefulness, design it for machining on the tool which will do it best and quickest. This is pretty sure to be cheapest.
3. On small odd pieces not apt to be called for more than two or three times, a simple forging or building up from structural shapes is often much cheaper than a casting.
4. Beware of calling for any hand or machine operation that may be novel or difficult unless you either know there is a man in the shop who can do the work or are prepared to go out there and show someone how to do it yourself.
5. Look out for any change or improvement in a standardized product that will alter its general style.
6. Always, and everywhere, design for an absolute minimum of handwork on everything.

I might add as a postscript that every designer, at the outset of a new plan, should have a clear idea whether the machine to be manufactured is wanted in small, medium, large or continuous quantity, as this will radically affect the design and the manufacturing equipment necessary for the most economical production.

Relative Accuracy

By Joseph R. Sheppard

Referring to an article by William S. Ayers, on page 457, advocating a method of denoting relative accuracy by the dimensions, I will give a very good and yet simple scheme that I adopted while employed by a large manufacturing concern that made thousands of dollars' worth of tools yearly. The decimal system was used exclusively, and the details were dimensioned as follows:

	Variation Allowed + or —	Manner of Dimensioning
Pattern dimensions	0.1	8.5 or 7.0
Pattern and rough machined dimensions	0.01	8.52 or 7.00
Machined dimensions	0.001	8.523 or 7.000
Machined dimensions	0.0001	8.5237 or 7.0000

These dimensions applied to the tools and fixtures only, as the manufactured parts were dimensioned with limits in the usual way, denoting the accuracy required, except the dimensions that did not require such accuracy, which were dimensioned in the same manner as the first two cases in the table.

Cutting Short Rods to Length

By A. E. Holaday

Several hundred round rods ¼ in. in diameter and 3 in. long were to be squared off to $2\frac{1}{8}$ in. long. A piece of brass tubing was procured about 1¾ in. inside diameter, ⅛ in. thick and 2 in. long, and this was cut once lengthwise and filled full of the rods. The tube was then placed in a four-jawed chuck and the rods were cut to length in a very short time.

The Human Potential in Industry*

By Otto Geier

SYNOPSIS—In this article Dr. Geier, whose experience and study of the subject make him an authority, points out the means of increasing the industrial human potential by means of proper medical care. Dr. Geier presents some very conclusive arguments and cites many interesting examples that show the dollars and cents return of proper shop medical supervision.

For the past three years history has been writing the terrible story of the human potential in modern war. As a result of a long period of peace, we Americans had looked upon war as a most removed possibility, attested to most strikingly by our present state of utter unpreparedness.

It was rather our subconscious minds that recognized the great sea power of England or the militaristic spirit of Germany. Our real attention was focused, not on the plans and intrigues of governments, but rather on the national characteristics of their peoples. When we traveled in Germany, we admired her order and cleanliness, her *Gemuthlichkeit*. The world paid homage to her philosophers, revered her musicians, studied and copied her educational systems and longed for her thoroughness and scientific capacity.

Perhaps for the first time since the Civil War, we are thinking together. Our national consciousness has been reborn. The pettiness in us is disappearing, and true Americanism is coming to the foreground. And what tasks has our entering the war brought to industry? Huge production? Yes! But is that all? Have not old truths as to the value of the conservatism of labor taken new form, new emphasis? Has not the human potential in industry in the nations abroad finally been the measure of their potential on the battlefield? Has the interdependence of man ever been more fully demonstrated? Has the mutual dependence of labor and capital ever been so strikingly proved?

The Present Question

The question that presents itself is this: Can we keep pace with other nations in war, and will we keep pace industrially after the war? Can we stand this new type of competition unless we likewise enter upon the program of the new social order? Will not the programs of our National Association of Employers, chiefly defensive in the past, necessarily become socially constructive? Will not labor have to seek leadership capable of best adjusting itself to these forward-looking steps?

War has lifted the discussion of the human potential in industry out of the realms of philosophy and has used it as the foundation stone of a national economic policy. The Council of National Defense has appointed a Committee on the Conservation of the Health and Welfare of the Worker, and, in the interest of the health and productiveness of labor proposes to establish definite standards of plant operation. The human potential of the nation is needed at its maximum, for the country cannot afford the usual labor losses due to accident, disease or fatigue and industrial poisoning.

A right-minded, forward-looking man does not wait for compulsory legislation to develop his business organization to the highest degree of efficiency. This type of man, for years, has developed not only the administrative and technical divisions of his plant, but when most successful, has given a great deal of thought to the human equation—the giving of happiness and meting out justice to his employees. To him it was apparent that by intensively studying the health of his workers he was establishing some splendid new points of contact between himself and his men and in so doing narrowed the gulf that has always existed between capital and labor.

Industry must find a substitute for the valuable relationship of master and man, which passed with the coming of greater industrial concentration. Master and man worked elbow to elbow. The master largely molded the thought and living of the man. Then they had real personality for each other. Now in too many instances the pay envelope expresses the only bond between the two.

Some years ago, industry began to recognize its social obligation. It saw the economic advantage of substituting fine, light, well-ventilated buildings for the dark, unsanitary workshops of the good old days. It was at about the same period that many abortive attempts on purely paternalistic lines at so-called welfare work were started, which in most instances failed to make any real contribution to the better understanding of labor and capital. It would indeed be a foolhardy individual who should attempt to interest the members of labor organizations in that kind of welfare work.

Health Work Most Important

The activities of the human service department should be founded on intensive health work. Health is our most vital possession. Healthy bodies promote right thinking, right living, good habits, and it is upon such factors that intelligence, stability and loyalty are engendered. The point of approach to the human potential had best, therefore, be through the industrial dispensary. Under a high-grade physician it will be the great melting pot of the human experiences of your men. Here the virtues and the weaknesses of the men will be most apparent. The physician will also be confessor, adviser, priest. Through him the employee may learn that it pays to be healthy, steady and of good habits. He does not hesitate to preach the "sober first" campaign.

Your industrial dispensary, with a dental clinic as its adjunct, will advertise itself. It will come in daily contact with 5 per cent. of your force, the equivalent of the whole force each month. To respond to all the possible services that grow out of these frequent contacts, it will require one full-time physician to every 750 employees.

Your men will first use this department for their slight cuts and accidents; next, they will begin to call the doctor's attention to some surgical defect with which they have been suffering. They will want to know what to do about their ruptures, whether it is necessary, for instance, to have their hemorrhoids removed. A little later the doctor begins to get the history of their chronic rheumatic

*Extracts from an address delivered before the joint session of the American Society of Mechanical Engineers and the National Machine Tool Builders Association at Cincinnati.

conditions, gastric conditions, constipation, headaches, neuralgias.

I recall the case of an Italian watchmaker with five children. His complexion was pale and pasty. He seemed anxious to please his foreman, but his work, like his skin, remained rather pale. He had a bad record for absence and lateness. His average earnings amounted to $13 per week. Investigation showed that he had been suffering with hemorrhoids for 20 years and had been repeatedly advised against an operation. He had enough confidence in the plant physician to undergo the operation. As a result, his physical efficiency was raised, so that now his premium earnings are nearly as great as his weekly wages formerly were. In other words, the operation has practically doubled his wages. An inefficient man, an active candidate for the human scrap heap, one whose family had been on the poverty line for years, had been converted into a happy, productive citizen.

In your industrial all-day dispensary your men will frequently learn that, while they have been treated for rheumatism on the outside they are actually suffering from broken arches. Again and again men will be found who are continually taking headache dope for headaches due either to gastric conditions or eye-strain. Untold numbers of your men will be found whose working capacity has been below normal; whom you have always felt more or less sorry for and therefore did not discharge, because they seemed anxious to make good, but they never quite "reached." Quite a lot of these will be found suffering with chronic intestinal toxæmia, while fully as many will be discovered whose lowered vitality has been induced by years of bad mouth hygiene, abscessed roots and pyorrhea. I am thinking just now of such a man who had been treated for rheumatism for years and who never was able to get out of the subnormal class of workers. A careful checking up showed pyorrhea of the teeth to be responsible. With six months' supervision and care, that man increased his earning capacity by nearly 100 per cent.

Another Mistake in Diagnosing

While we are speaking of mouth conditions, let me recall a case of a man who for three weeks suffered excruciating neuralgia of the face and head. He was the type of man that puts off going to a physician until the last moment. Examination showed that he had a very dirty mouth, a number of snags and some pyorrhea; X-ray showed an unerupted cuspid tooth lying horizontally, the pressure therefrom causing the pain. Twenty-four hours after the removal of the unerupted tooth and the old snags, all pain disappeared. If the plant dentist had been an average dentist, no X-ray would have been called for and the man would, for weeks, have lost sleep and time from work and have considerably reduced his vitality and working capacity.

In passing, we might mention one other case where the man was losing a day or two each week as a result of nausea, sleepy, draggy feeling, practically no ambition for work and gradual loss of weight. Physical examination showed nothing unusual, except that the teeth were bad. Cleaning up the mouth and pulling out the old snags were followed by immediate improvement. The stomach trouble disappeared. In six weeks he gained seven pounds and had a new bite for work.

The plant dispensary, with the economic pressure back of it to get results, will go farther to establish a diagnosis than the family physician. It sees the financial advantage to the patient and to the company to spend a few dollars for consultation or for X-ray. If the employee cannot pay for the consultation, the plant physician can always place his hand upon some consultant on the outside who will do the work for nothing. There is a drive behind the plant physician to get a quick result.

Here is another typical example: A man returning to work reported to the plant physician on account of his two weeks' absence, saying that he had been treated by his family physician for neuralgia. Examination showed that he still had temperature as well as pain over one of the bony cavities of his head. He was immediately referred to a specialist, who drained the antrum of pus, the pressure of which was the cause of the pain that he had been suffering. He was immediately relieved.

Physical Examinations Valuable

Too much cannot be said for physical examinations of employees. No one knows how many cases of incipient tuberculosis are present in his shop force. There are any number of men whose appetites are variable, who tire easily, but who have no cough or symptoms that would make them consult a physician; are perhaps merely irritable and have a draggy feeling and no "pep." They attribute their weariness to the job. In so many cases of an early diagnosis of incipient tuberculosis, an enforced rest of a month or two will put these men on their feet again.

It is equally difficult to say how many cases of Brights' disease are to be found in the average plant. It is an insidious disease that may be quite advanced before showing any symptoms. Only recently a young coöperative student from the university was given the required physical examination on entering this course. He was surprised to learn from the plant physician that he had an advanced case of Brights' disease. He was immediately laid off and sent to his family physician for treatment. He died within the month.

Anyone who has ever had any personal experience with an irritated and irritating appendix will recognize the value of being without an appendix. There are a number of men working in our plant, whose families, we believe, would have been minus their bread-winner, had it not been for the prompt removal of the vermiform appendage. You will, I believe, be interested in two cases that show the superior advantage of the industrial clinic and the opportunities that it presents for close observation. A man came in early one morning complaining of stomach ache. It seemed like a simple case of cramps. An hour later he returned again saying that he felt worse. A second examination revealed that he had now developed the typical symptoms of acute appendicitis. He was minus his appendix at noon, out of the hospital in two weeks and returned to work at the end of the third. This man's attendance card showed a bad record for the eight months preceding the operation, undoubtedly due to chronic appendicitis.

The other case is interesting from another point of view. This man was taken ill with cramps in the evening after working hours; he consulted the neighborhood physician, who, as was later proved, prescribed morphine to quiet the pain. The man stayed at home the next day and returned the day after. He left his place at the machine to report his absence to the plant physician. He

explained that he felt all right and, shaking the bottle, said that he was taking this medicine. In spite of the fact that he was 6 ft. 3 in. tall and weighed 200 lb., he did not look all right to the plant physician. On examination the latter found that the workman had a temperature of 102½ and a pulse of 140. The pain in the abdomen, however, was dangerously masked by the morphine. Under great protest he was taken to the hospital and operated on immediately. A very much swollen appendix, ready to burst, was removed. The initial signs of peritonitis already existed. A life is said to be worth $5000 to the community. It would be difficult for the company to fix the value of keeping alive this very efficient employee.

I have interpolated these few cases as examples of the real conservation of the human element that takes place within an organization of industrial medical service.

The Narrow-Visioned Employer

The development of the human potential with all its mutual and economic advantages will not be introduced in industry where the employer does not possess some social vision. I am thinking just now of one narrow-visioned employer, who was recently interviewed by someone who was anxious to gain a consensus of opinion as to the value of employees' service departments. The total human equation in this particular industry, employing some 1100 men, was represented by a mutual aid to which the company contributed annually the large sum of $100 (less than 9c. per man). It was necessary for that association at its annual picnics, given for the purpose of raising money, to invite the employees of a number of other smaller concerns. In other words, for the sake of a few dollars raised by inviting outsiders, this company blindly encouraged the undermining of any good feelings of fellowship that might have been encouraged among its employees by this one annual getting together. The same employer boasted that the efficiency plan of wages greatly reduced the cost of production, returning $10 for each dollar put into that system.

In discussing his men he spoke only of their lack of loyalty and the lack of loyalty on the part of the foremen. With an injured air he told that petitions for the unionizing of the employees had been in circulation in his shop for two weeks with the full knowledge of the foremen before he discovered that fact. The result is, he says, that "the shop is fully organized and the union has his company under its thumb." It seems that it had been the custom of this company to entertain the foremen once a month with a dinner and smoker and that one of these entertainments was held the night before the discovery of the petitions. With stupid satisfaction he said that thereafter foremen's meetings ceased. It is not surprising to note in passing that the labor turnover in this plant is 305 per month. This man, who gives the whole sum of $100 toward the sole coöperative effort on the part of the men to care for themselves in times of illness loses $100,000 per year in excessive labor turnover.

If I were called upon to make a diagnosis of that employer, I would venture to say that he has an aggravated case of mental strabismus, or mental crossed-eye. He does not realize that the sound-minded industrial procession is passing him.

To you men who are seriously at work solving the problem of the human potential in industry, permit me to say that most of you are overlooking the possibilities for service that the socially minded physician may render you and your employees. The proper place has not yet been accorded him. You have not given him an opportunity to make one for himself. It does not count for much if you but employ surgeons in your plant to care for the injured. The surgeon is in just the same relation to your business and your employees as is your electrical repairman who replaces the fuse and looks after your short-circuits. What you need is a doctor, a combination general repair and safety engineer, to look after your human machinery, to study stresses and strains on it, to give warning of a probable breakdown, to advise easing up on the load until the human mechanism has been readjusted, to do the hundred and one things that make for comfort of mind and body.

When we are told by investigators that only one industrial worker in five in need of a physician calls one, you may know what this shortsightedness in them is costing you in lost time. You may also know what great service the industrial dispensary may render.

These figures lead us to understand the impressive number of chronic invalids, the great number of casually employed, the number of unemployables. They account for the millions of dollars spent by these unfortunates in quack medicine in an effort to doctor themselves back to employability.

The loss of wages to the worker on account of preventable illness runs annually to the billion-dollar mark. To the employers the loss must surely be twice that amount, when we remember what a large part bad health plays in inefficiency, in irregularity of attendance, with its consequent poverty and low standard of living, in its frequent shifting from job to job, in its undermining of character and stability, in inducing alcoholism and other vices. The man struggling against a physical defect uses up every ounce of energy and loyalty to support his family. Can he have any loyalty left for you? Is it human to expect it?

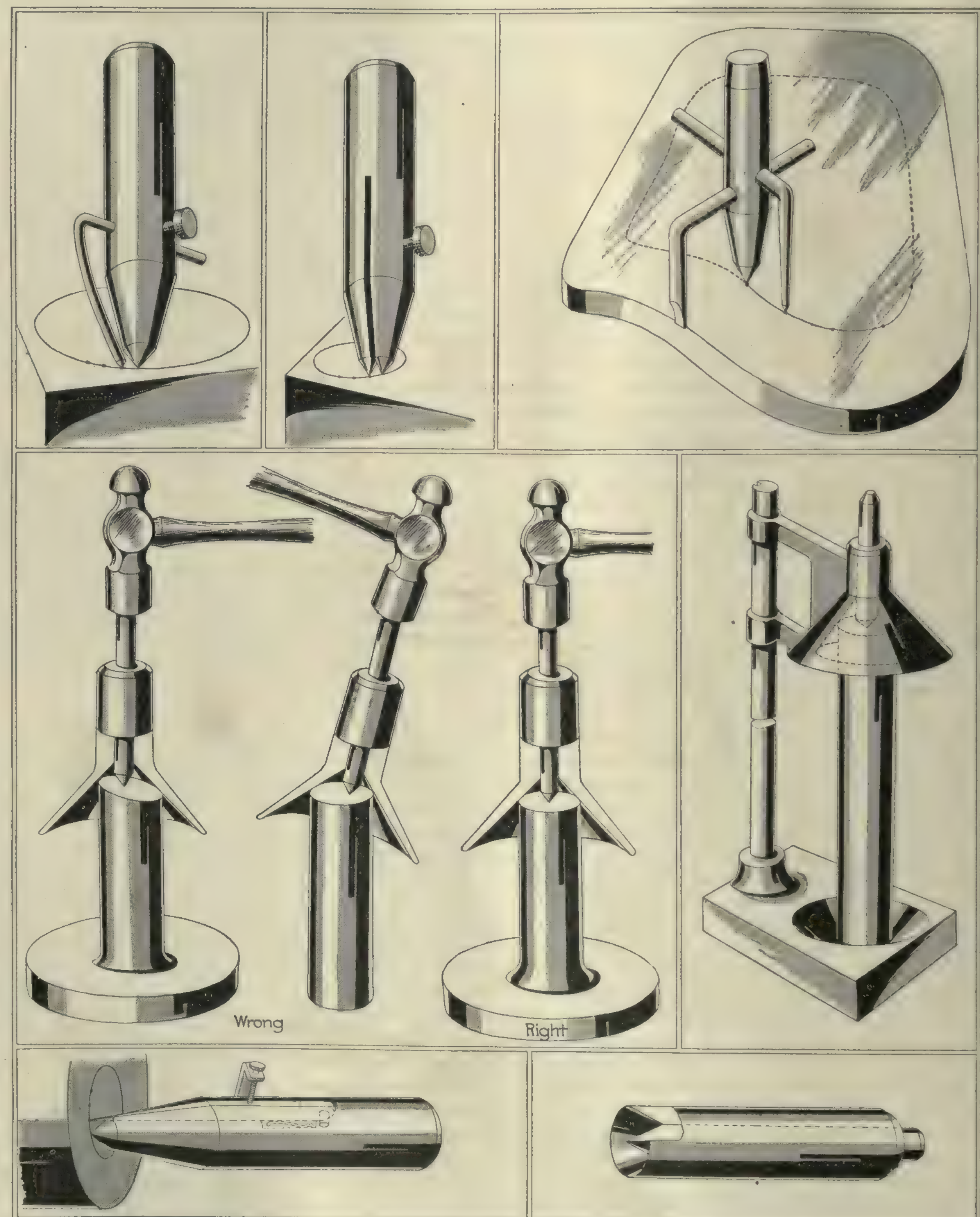
Value of the Industrial Dispensary

The industrial dispensary will lessen disease, increase the number of working days as well as working capacity and thereby increase the purchasing power for adequate medical service for the families of the workers. Medical care in industry is not a charity. It pays you the best dividends of any department in your business. It secures a new arm to the health department and makes possible preventive medicine on a scale yet undreamed of. Witness the reduction of 75 per cent. of the lost time on account of illness in those employees of the Norton Co. who use the medical department. In attacking directly such problems as personal hygiene, bad housing and living conditions, alcoholism and venereal disease, it will make a real contribution to health and social welfare.

Thus in a feeble way have I attempted to give you a glimpse of the contribution which the physician in industry may make toward increasing the human potential in industry. If it has served to awaken your interest and later investigation, it will not have been in vain. The problem is yours. Of this I am certain: The industrial dispensary can be made the great human laboratory that will help to refine out the dross and hasten the day of industrial betterment, the ultimate day of a better understanding.

From a Small-Shop Notebook

By J. A. Lucas



VARIOUS CENTERPUNCHING KINKS

VARIOUS WAYS OF PULLING KEYS

The Original Mechanic

By Berton Braley

When the universe weltered in chaos,
  With everything running askew
(A sight that would vastly dismay us,
  If we had been there for the view),
The Lord called his angels together.
  "This formlessness irks me," he said,
"And I have been wondering whether
  We cannot have order instead."

Then out stepped an angel all gritty
  And grimy of fingers and face.
"Great Master," he cried, "it's a pity,
  This fearful confusion in space,
This wastage of forces titanic
  Throughout all the boundless expanse;
The universe needs a mechanic.
  Dear Lord, won't You give me a chance?"

And when the Lord nodded permission,
  The angel, with visage alight,
Went forth to fulfill his ambition
  Of putting disorder to flight.
He geared up the stars in their courses,
  He sweated and figured and toiled,
Until all the natural forces
  Were working like engines well oiled.

And then, when the job was all running
  More nearly the way that it should,
The angel won praise for his cunning,
  The Lord said his labors were good.
And being impressed with his science,
  The Lord made one specialized clan
Of men to be mankind's reliance,
  To dream and to scheme and to plan.

And so, when the grimy mechanic
  Brings order, efficiency, calm,
From aimless confusion and panic,
  Remember his lineage from
That angel who tinkered with chaos
  And stopped all the suns playing hob,
And who—lest disorder dismay us—
  Is still keeping on with his job!

United States Common Shrapnel and Common Steel Shells, 3.8, 4.7 and 6 In.*

The following specifications and operation lists for the different projectiles shown, taken together with those already published for the 3-in. sizes, will give manufacturers and shopmen something definite to work from in deciding on the capacity of their shops in the production of munitions of this character.

The 3.8-In. Common Shrapnel (30 Lb.)

Fig. 1 shows the dimensioned forging for the 3.8-in. common shrapnel; Fig. 2 is the dimensioned finished case, while Fig. 3 illustrates the complete projectile.

Operations on the Case (Forging)

OPERATION 1. CENTERING

Tools and Fixtures—No. 42 combination center drill; chuck and arbor.

OPERATION 2. TURN BODY

Tools and Fixtures—Special arbor; right-hand lathe turning tool and arbor press. Gages—Combination maximum and minimum snap for diameter of body; maximum and minimum ring rear of band; length from base to bourrelet.

OPERATION 3. FINISH EXTERIOR

Tools and Fixtures—Set of eight chuck pads; facing tool; circular form tool; circular form tool holder; knurling tool; knurling-tool holder. Gages—Combination minimum and maximum band seat; maximum and minimum width and depth of band seat; position of band seat and grooves; thickness of base and test piece; length over all.

OPERATION 4. FINISH INTERIOR, ROUGH-TURN BOURRELET, ROUGH-TURN OGIVE

Tools—Set of chuck pads; diaphragm-seat finishing cutter; diaphragm-seat cutter bar; tap; ogive cutter; right-hand rough-turning tool. Gages—Maximum and minimum diameter of diaphragm seat; depth of diaphragm seat; maximum and minimum thread plug gage; maximum and minimum diameter of powder chamber; maximum and minimum root of thread.

OPERATION 5. ASSEMBLE HEADS

Tools—Special wrench.

OPERATION 6. FINISH-TURN HEAD AND BOURRELET

Tools—Right-hand turning tool; form; rear of cross-slide follower; special chuck; revolving center. Gages—maximum and minimum ring gage; diameter of bourrelet; ogive profile gage; diameter of nose thread plug.

OPERATION 7. DISASSEMBLE HEAD

Tools—Special wrench.

OPERATION 8. HYDRAULIC TEST

Special Fixtures—Test fixture.

OPERATION 9. ASSEMBLE BAND

Equipment Used—Set of banding dies; pair of tongs; gas furnace.

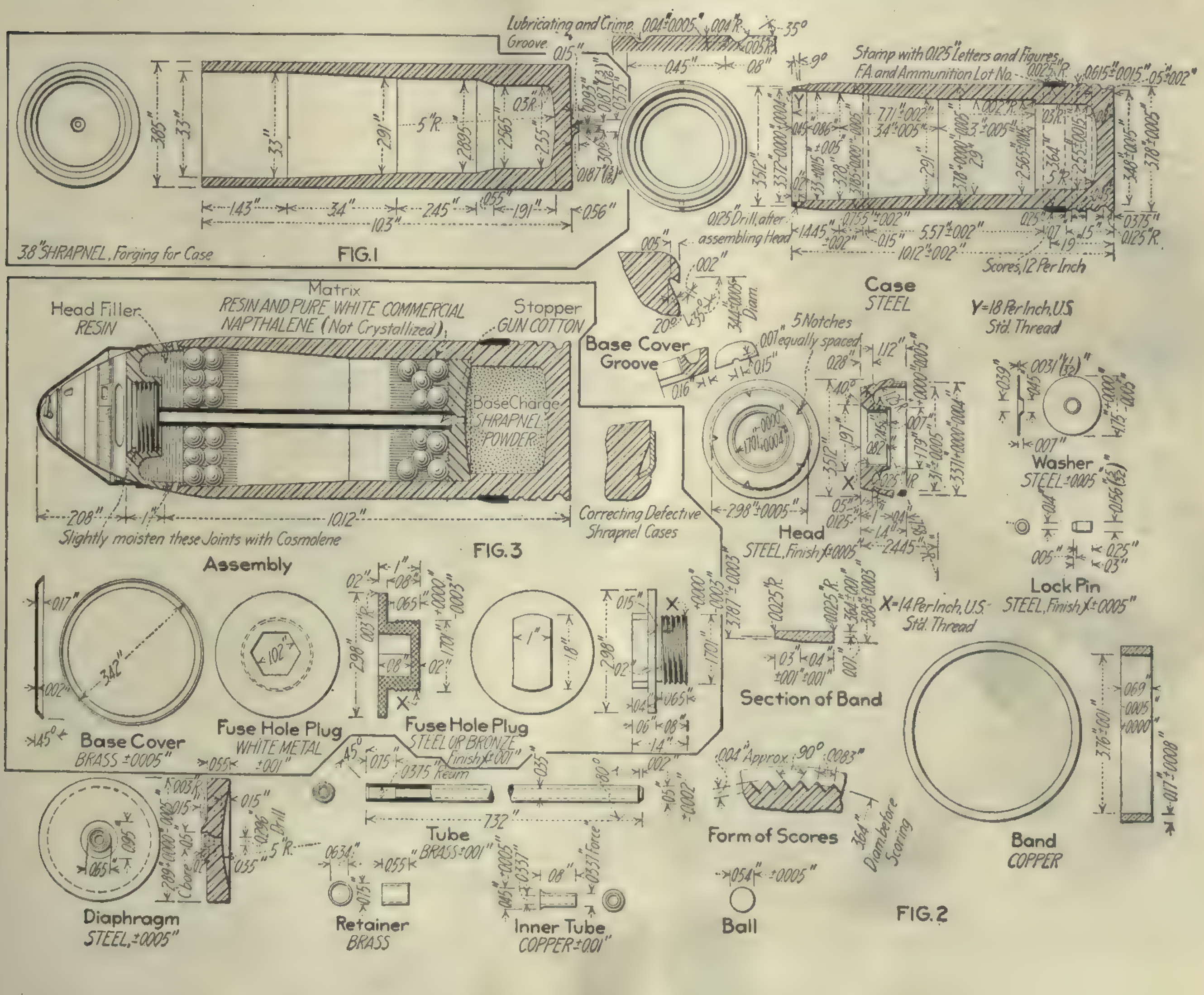
OPERATION 10. TURN BANDS

Tools—Special chuck; steadyrest; form; rear of cross-slide follower; facing tool; band-turning tool; special stop; tool-post holder rear of cross-slide. Gages—Maximum and minimum ring gage diameter of band; profile and position of band.

OPERATION 11. WASH IN HOT SODA

Equipment Used—Pair of tongs.

OPERATION 12. PAINT INSIDE



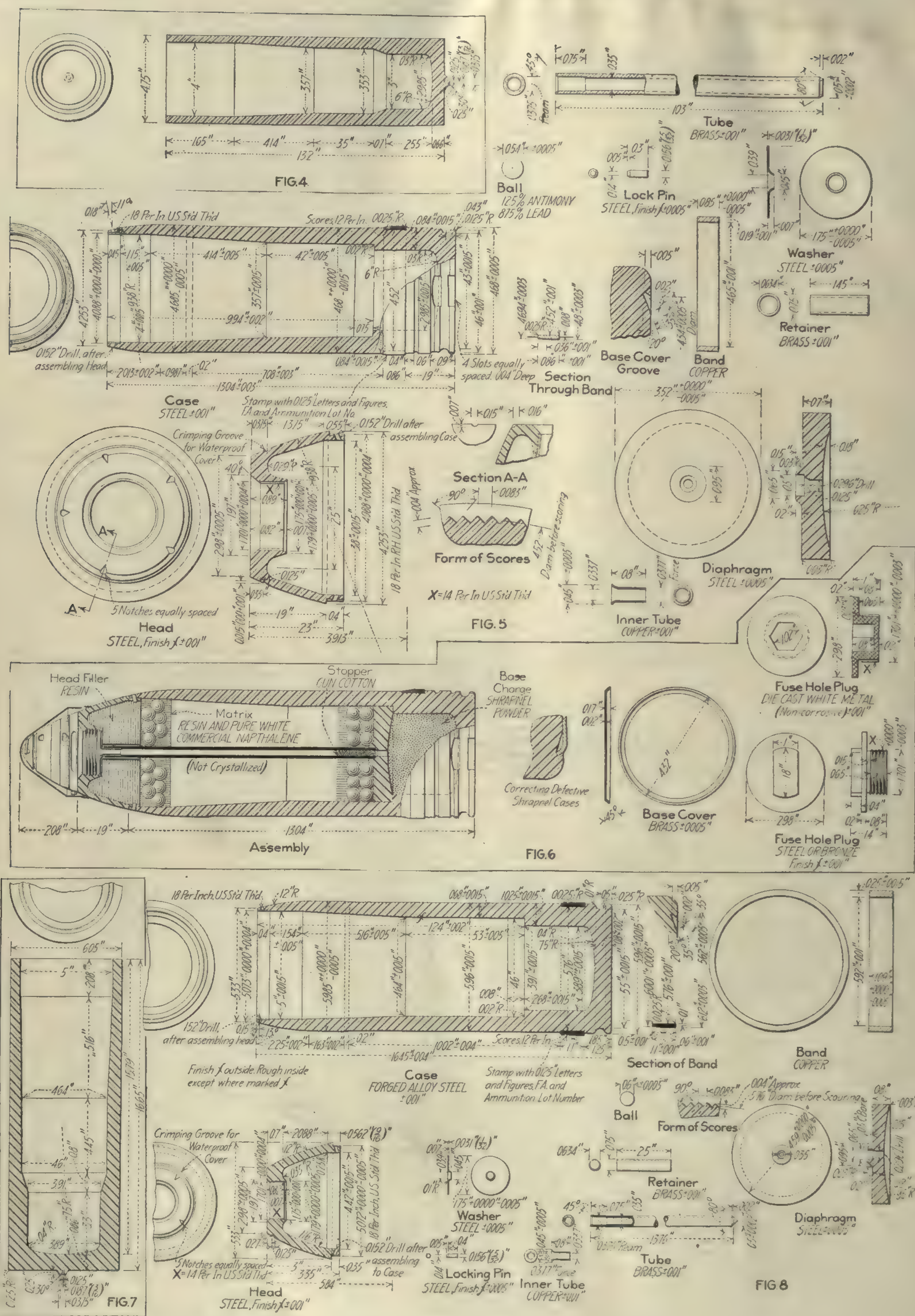


FIG.4
Ball
125% ANTIMONY
875% LEAD
Lock Pin
STEEL, Finish ✗ ±0005"
Tube
BRASS ±001"
Washer
STEEL ±0005"
Retainer
BRASS ±001"
18 Per In US Std Thd
Scores 12 Per In.
0152" Drill after assembling Head
Case
STEEL ±001"
Base Cover Groove
Band
COPPER
Section Through Band
4 Slots equally spaced .004" Deep
Stamp with 0125" Letters and Figures, F.A. and Ammunition Lot No.
Crimping Groove for Waterproof Cover
0152" Drill after assembling Case
Section A-A
Form of Scores
18 Per In RH US Std Thd
X=14 Per In US Std Thd
5 Notches equally spaced
Head
STEEL, Finish ✗ ±001"
FIG.5
Inner Tube
COPPER ±001"
Diaphragm
STEEL ±0005"
Fuse Hole Plug
DIE CAST WHITE METAL
Head Filler
RESIN
Stopper
GUN COTTON
Matrix
RESIN AND PURE WHITE COMMERCIAL NAPTHALENE
(Not Crystallized)
Base Charge
SHRAPNEL POWDER
Correcting Defective Shrapnel Cases
Base Cover
BRASS ±0005"
Assembly
FIG.6
Fuse Hole Plug
STEEL OR BRONZE
Finish ✗ ±001"
18 Per Inch US Std Thd
152" Drill, after assembling head
Scores 12 Per In
Finish ✗ outside. Rough inside except where marked ✗
Case
FORGED ALLOY STEEL ±001"
Stamp with 0125" Letters and Figures, F.A. and Ammunition Lot Number
Section of Band
Band
COPPER
Ball
Form of Scores
Diaphragm
Crimping Groove for Waterproof Cover
5 Notches equally spaced
X=14 Per In US Std Thd
18 Per Inch US Std Thd
0152" Drill after assembling to Case
Head
STEEL, Finish ✗ ±001"
Washer
STEEL ±0005"
Locking Pin
STEEL, Finish ✗ ±0005"
Retainer
Inner Tube
COPPER ±001"
Tube
BRASS ±001"
FIG.7
FIG.8

Operations on the Head

After the head has been rough-machined, it is assembled to the case, as the fifth operation on the case. The head and bourrelet are then finish-turned.

OPERATION 1. MACHINE FROM BAR

Tools and Fixtures—Set of chuck pads and bushings; feed shell pads and bushings; stop; twist drill; drill holder; set rough grooving tools; set rough combination grooving tools; holder; set finish grooving tools; combination counterbore and reamer; collapsible tap and chasers; double-end flat forming tool; cutting-off tool and suitable holders. Gages—Length and diameter of thread; length from front to thread; inside diameter of crimping wall; maximum and minimum thread plug; depth of groove; length over all.

OPERATION 2. COUNTERSINKING

Tools—Chuck; beveling tool. Gages—Diameter and profile of fuse-seat bevel; minimum diameter of fuse seat and fuse-seat thread.

OPERATION 3. THREAD AND CRIMP IN STEEL WASHER

Tools—Chuck; crimping tool; circular thread cutter; leader and follower. Gages—Maximum and minimum thread ring.

Inner Tube

OPERATION 1. MACHINE

Tools—Stop; 60-deg. countersinks; belling tool; chamfering tool; cutoff tool. Gages—Combination length and diameter of bell.

Central Tube

OPERATION 1. MACHINE

Tools—Reamers for inner-tube seat; 90-deg. countersinks; cutoff tool; chamfered tool. Gages—Length; combination depth and diameter; inner-tube seat.

Washer

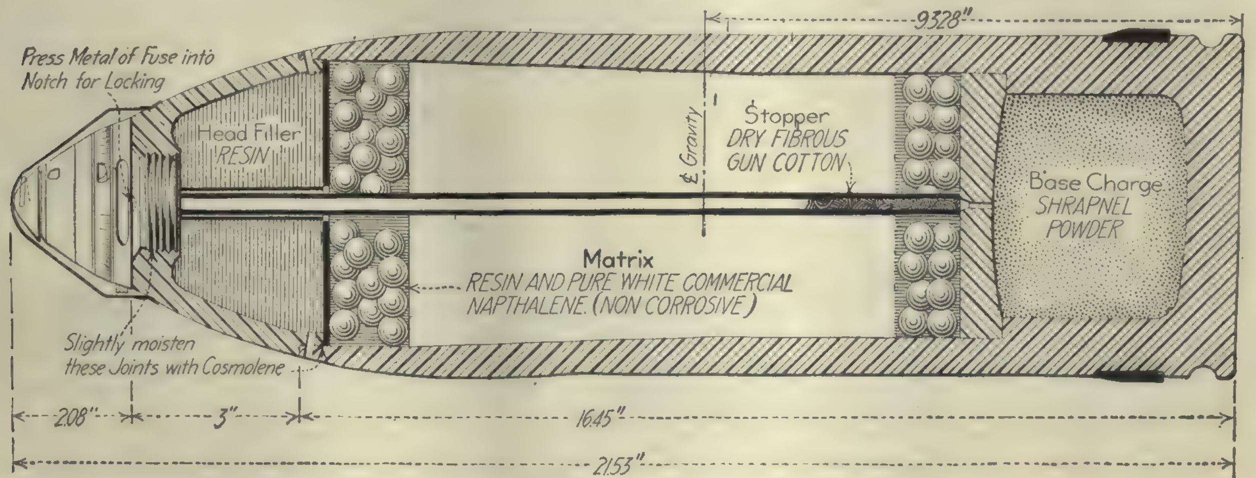
OPERATION 1. PUNCH

Tools—Punch and die.

Diaphragm

OPERATION 1. DRILL AND COUNTERBORE

Tools—Special chuck; twist drill; counterbore; countersink and holders. Gages—Maximum and minimum plug; diameter of counterbore; depth gage for counterbore; maximum and minimum ring; outside diameter.



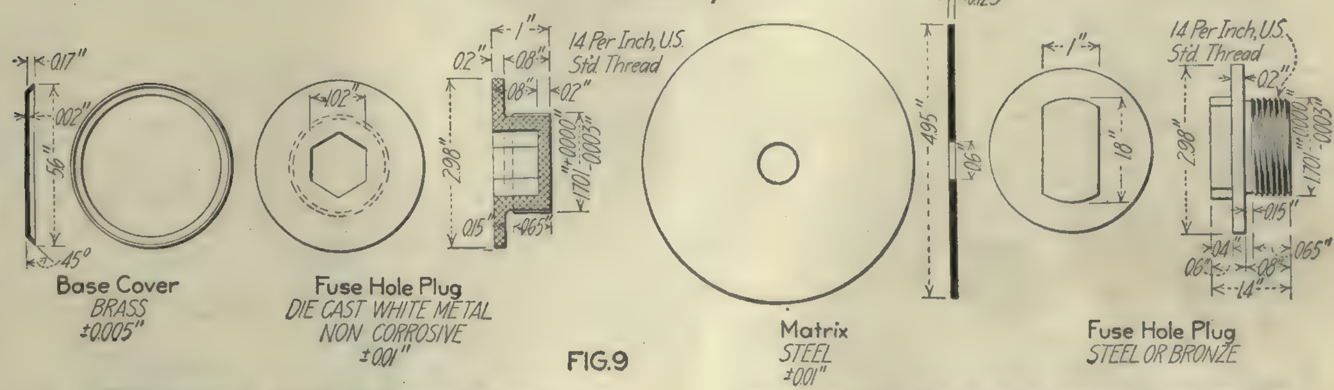


FIG. 9

OPERATION 4. MILL NOTCHES IN HEAD

Special Fixtures—Milling cutter and arbor.

OPERATION 5. GROOVE FOR WATERPROOF COVER

Tools—Screw chuck; special lathe tool. Gages—Waterproof-cover scratch gage; position of waterproof-cover groove.

OPERATION 6. PAINT INSIDE HEAD

OPERATION 7. PUT IN RETAINER AND FILL HEAD

OPERATION 8. CUT OUT SURPLUS RESIN

Tools—Special chuck and right-hand side-facing tool.

OPERATION 9. COAT THREADS WITH COSMOLINE

OPERATION 10. REASSEMBLE HEAD TO CASE

Tools—Special wrench.

OPERATION 10-A. INSERT INNER TUBE

Tools—Punch.

OPERATION 11. PIN HEAD TO CASE

Tools—Drill chuck; twist drill; fixture for holding case.

OPERATION 12. FINAL INSPECTION

Locking Pins (Bar Stock)

OPERATION 1. MACHINE

Tools—Stop; cutoff tool; form tool. Gages—Length.

Retainer

OPERATION 1. MACHINE

Tools—Stop; cutoff; chamfer tool. Gages—Length.

OPERATION 2. HEAT-TREATMENT, 1600 DEG. F.

OPERATION 2-A. PLACE IN COTTONSEED-OIL BATH

OPERATION 2-B. RUMBLE IN HOT SALT TO REMOVE SCALE

OPERATION 2-C. HOT SALTPETER BATH, 900 DEG. F.

OPERATION 3. REMOVE SCALE FROM COUNTERBORE

OPERATION 4. GRIND BASE

OPERATION 5. PAINT BASE

OPERATION 6. ASSEMBLE TUBE

Special Fixtures—Centering fixture. Gages—Length.

Loading

OPERATION 1. INSERT DIAPHRAGM IN TUBE

OPERATION 2. FILL CASE

OPERATION 3. COMPRESS BALLS

OPERATION 4. CUT OUT SURPLUS RESIN

Tools—Universal chuck; steady-rest; resin cutter. Gages-Depth.

The 4.7-In. Common Shrapnel (60 Lb.)

A dimensioned forging of the 4.7-in. common shrapnel is shown in Fig. 4, and a dimensioned case is given in Fig. 5. The complete projectile is illustrated in Fig. 6.

The operations, tools and gages are of practically the same type as for the 3.8-in. size.

The 6-In. Common Shrapnel (120 Lb.)

In Fig. 7 is a dimensioned forging of the 6-in. common shrapnel. A dimensioned case is shown in Fig. 8, and the complete projectile is illustrated in Fig. 9. The operations, tools and gages are of the same type as for the preceding sizes.

The 3.8-In. Common Steel Shell, Model 1905

Fig. 10 shows a dimensioned forging of the 3.8-in. common steel shell, and a dimensioned case is presented in Fig. 11. The operations are practically the same as for the 4.7-in. shell.

The 4.7-In. Common Steel Shell, Model of 1905

From Fig. 12 may be obtained the dimensions of the forging for the 4.7-in. common steel shell, while Fig. 13 shows a dimensioned case.

OPERATION 1. ROUGH-TURN BODY

Tools—Universal chuck; revolving center; right-hand lathe turning tool.

OPERATION 2. MACHINE INTERIOR AND EXTERIOR OF BASE AND FINISH-TURN BODY

Tools—Chuck pads; combination counterbore and reamer; recessing tool; circular form tool; knurling tool; right-hand lathe turning tool and holders. Gages—Depth of cavity and warp; base plug flange seat; maximum and minimum ring diameter rear of band; combination snap diameter band seat; position of band seat and crimping grooves; combination snap diameter of body; position of grooves; length of base to bourrelet.

OPERATION 3. FINISH-TURN POINT AND ROUGH-TURN BOURRELET

Tools—Special chuck; steady-rest; left-hand lathe turning tool; former rear of cross-slide; extension bracket and roller; form for point; follower. Gages—Combination snap maximum and minimum rough diameter of bourrelet; projectile profile; profile of point.

OPERATION 4. MILL THREADS IN BASE

Tools—Thread milling cutter; arbor; spring chuck. Gages—Maximum thread plug; minimum thread plug and eccentricity of counterbore.

OPERATION 5. MACHINE BASE-COVER GROOVES

Tools—Toolholder (fixed spindle); four roughing tools; toolholder; fixture on cross-slide with finishing tools; finishing toolholder and two tools. Gages—Inside diameter working gage; diameter depth and width.

OPERATION 6. HEAT-TREATMENT

(A) Heat in furnace; (B) cottonseed-oil bath; (C) heat in lead furnace.

OPERATION 7. FINISH-GRIND BOURRELET

Tools—Electric grinder; special chuck; steady-rest. Gages—Maximum and minimum ring diameter of bourrelet.

OPERATION 8. ASSEMBLE BANDS

Tools—Banding dies; tongs; gas furnace.

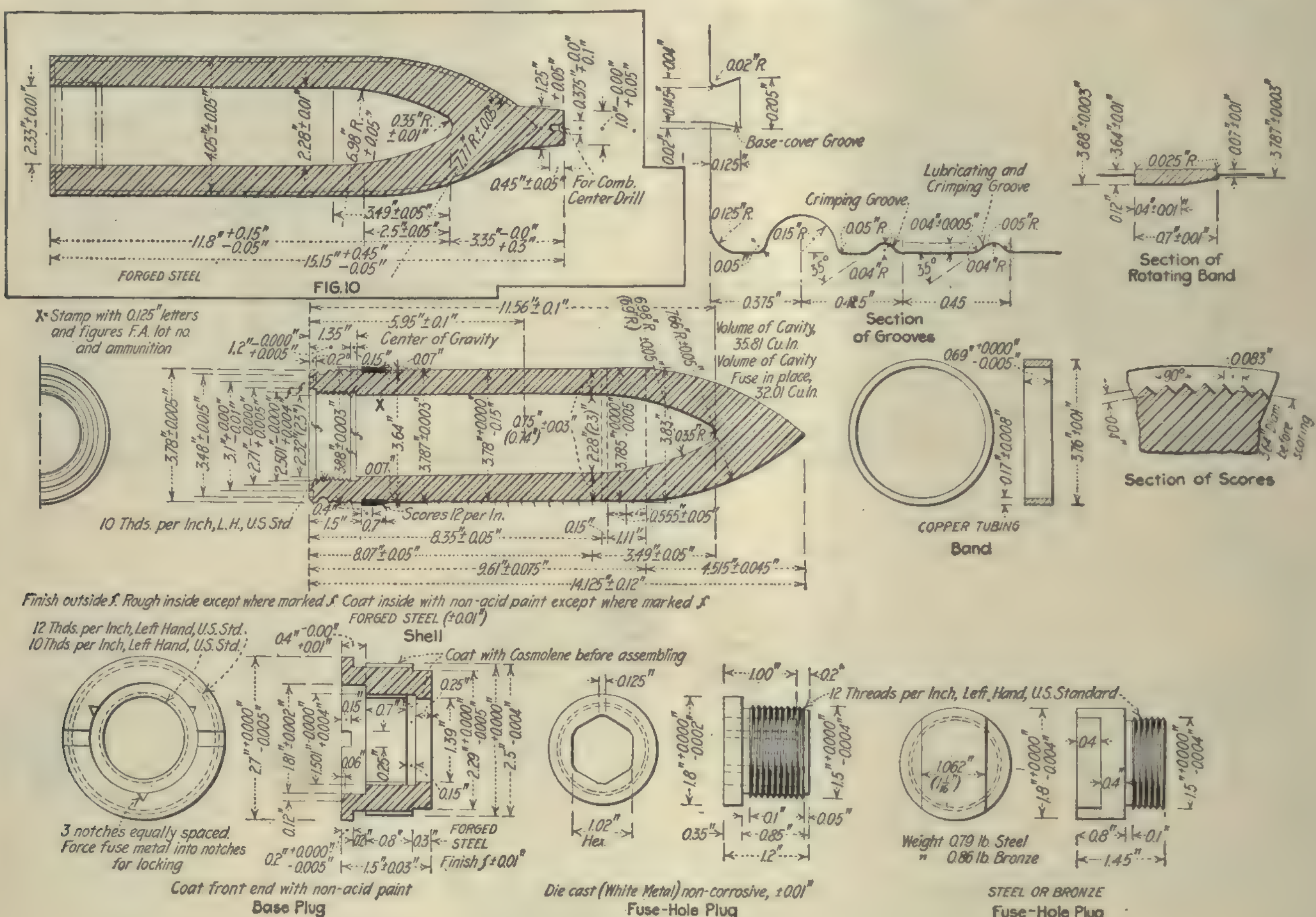


FIG.10

FIG.11

OPERATION 9. TURN BANDS

Tools—Special chuck; steady-rest; right-hand side-facing tools; band-turning tool; special stop; form and follower rear of cross-slide. Gages—Maximum and minimum ring diameter of band; position and profile of band.

OPERATION 10. HYDRAULIC TEST

Equipment Used—1500-ton heading press with pressure pump; testing fixture; triplex chain drop.

Base Plugs

OPERATION 1. MACHINE FROM BAR

Tools—Stock stop; two twist drills; two drill holders; combination floating counterbore and reamer; forming tool; facing tool; cutting-off tool; chuck pads; feeding finger pads and toolholders. Gages—Maximum and minimum plug diameter of small hole; depth and diameter of counterbore; maximum and minimum diameter of flange; maximum and minimum snap diameter of thread; overall length of base; plug and width of flange; length of thread.

OPERATION 2. MILLING INTERNAL THREAD

Tools—Combination milling arbor and cutter; spring chuck. Gages—Maximum and minimum thread plug.

OPERATION 3. CUTTING EXTERNAL THREAD ON TURRET LATHE

Tools—Threading attachment; chuck; screw for chuck; circular thread cutter; chamfering tool. Gages—Maximum and minimum thread ring.

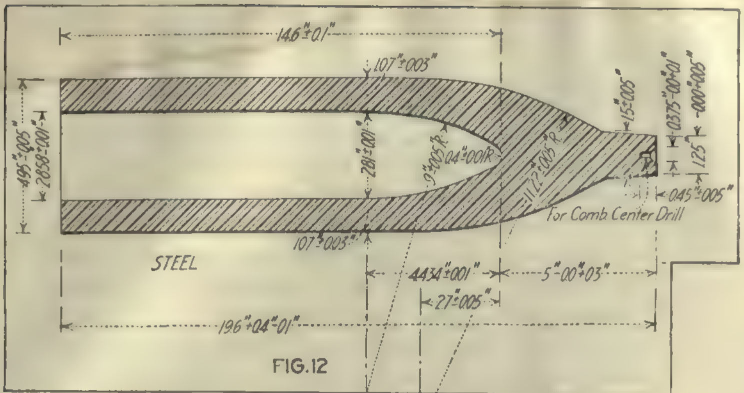
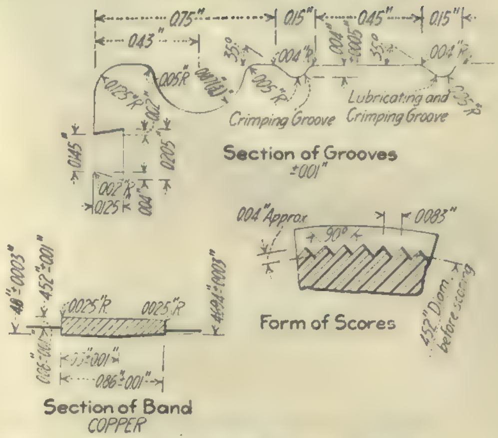


FIG. 12



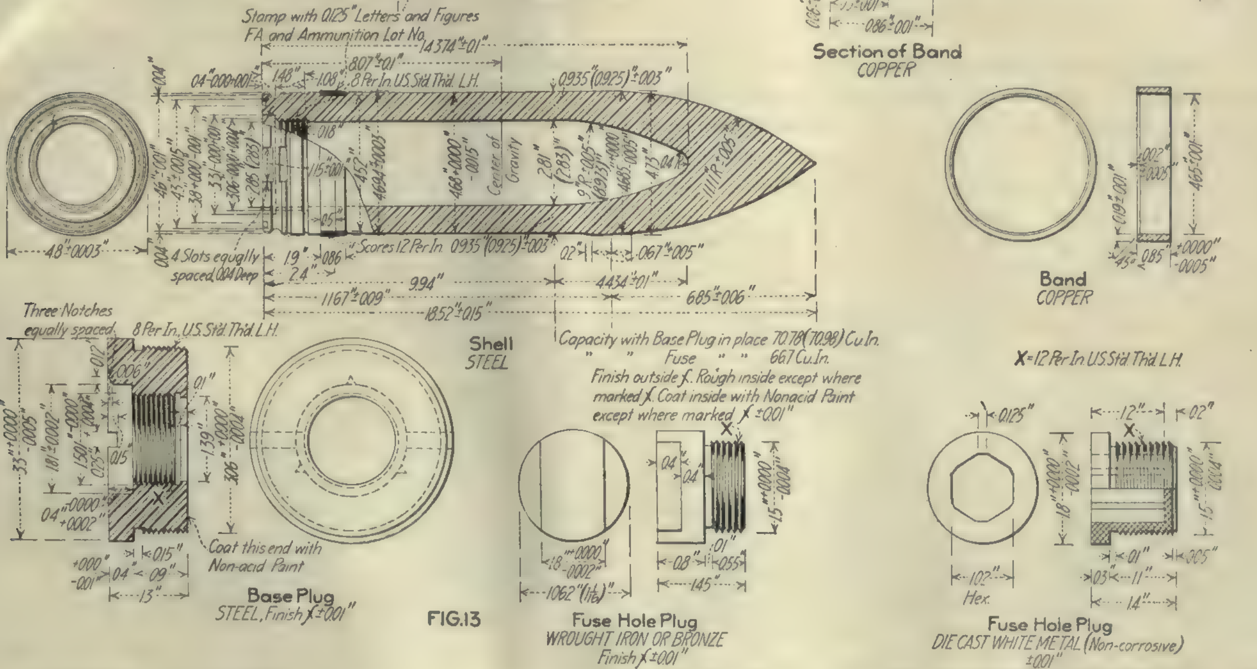


FIG. 13

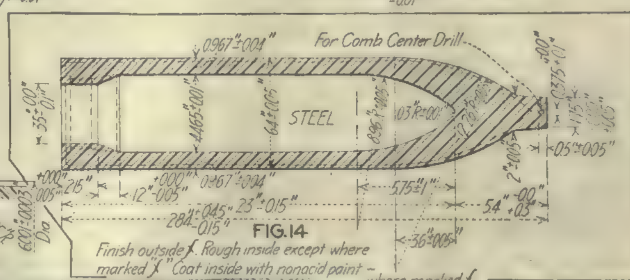


FIG. 14

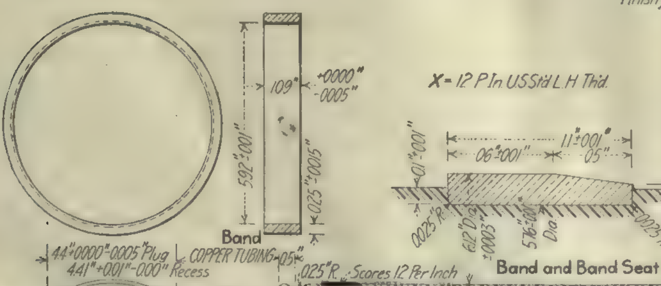
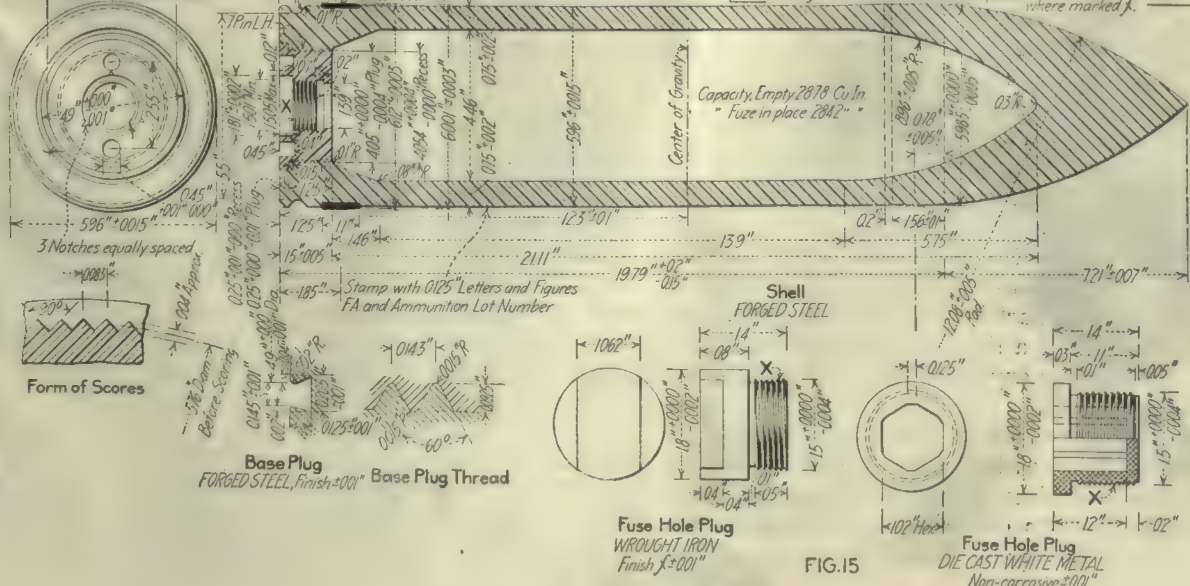



FIG. 15

OPERATION 3. CUTTING EXTERNAL THREAD ON THREAD MILLER

Tools—Thread milling cutter; arbor for cutter; spring chuck. Gages—Maximum and minimum thread.

OPERATION 4. NOTCH BASE

Tools—Fixture; milling cutter; arbor.

OPERATION 5. MILLING WRENCH SLOTS

The 6-In. Common Steel Shell

A dimensioned case of the 6-in. common steel shell is shown in Fig. 14. The operations on this shell are practically the same as for the 4.7-in. size.

Why Preparedness?

By Elmer A. Braden

The article by L. I. Yeomans, page 548, entitled "Why Preparedness?" seems to the writer to contain a needless amount of undue criticism for the owners of various factories and machine shops over the country who have in good faith offered their plants to the United States Government to be used as it may see fit.

The fact that an automobile plant is not fitted for the making of 16-in. naval guns does not hinder it from being used for many other purposes equally important. Our soldier does not take a 16-in. gun under his arm and make a charge from one trench to another; neither do our submarine chasers carry 16-in. guns; and furthermore, the machine gun, which is a valuable war implement, is not a 16-in. gun.

There are a thousand and one things that are absolutely necessary in war times that could be made either wholly or in part in any modern shop. For instance, ammunition wagons, ambulances, trucks, tractors, gun mounts, cartridge cases, small-caliber shells, torpedoes, small-arm parts, harness, field glasses, range guides, bomb-dropping apparatus, bombs and hand grenades, sights, airplane engines and parts for airplanes, parts for submarines, auxiliary machinery for ships, and hundreds of articles that could be named with a little more thought. Now, must a factory be equipped to work 16-in. naval guns before we will allow it to make these articles?

Changes Necessary

In regard to the "uncomplicated changes" mentioned by our worthy writer, I want to mention a few instances as follows: An experienced hammer man can drive rivets into the hull of a submarine just as tightly as he can into a locomotive boiler, and they are not required to withstand any more strain in proportion.

A press equipped with the proper dies can press out cartridge cases just as easily as it can press out hub caps, brake drums, etc., for automobiles (it makes no difference to the press).

A miller will mill out the small pieces of army rifles, torpedoes, etc., just as easily as it will mill out the small parts of magnetos, self-starters, etc., of automobiles.

A lathe will turn up a shell just as easily as it will turn up a crankshaft or any other part of an automobile or locomotive.

The same machinery used to forge the axles of automobiles could also be used to forge shells, it would seem. Automatic screw machines can make screws, nuts and bolts and intricate parts of guns as well as any other products. Practically the only thing that cannot be done in the average factory with the present equipment is boring and rifling the barrels of guns, which should be left to the arsenals.

When completed, the parts made in different factories could be sent to the place where they would be required. This system can be put into practice without question, as it is done today by almost every automobile factory, as very few of them make in their own shops every part of their completed product.

It is useless to argue that our mechanics cannot do this work, for it has been demonstrated in Europe that women without previous machine-shop experience can do it. Equip our mechanics with the necessary jigs and fixtures, and they will be able to make anything within reason. Our mechanics are accustomed to working to thousandths and ten-thousandths of an inch, and this should be close enough for the average war material.

The Tiffany shops could probably be used very nicely, if need be, for making gun sights, small-range finders, bomb droppers, field glasses and many other instruments of precision used in modern warfare.

The writer has been informed that there is at least one typewriter factory in the United States now making shrapnel shells for the armies of Europe. There is also a well-known watch factory making speedometers for the automobile trade. One automobile concern that uses an aviation motor in its car has formally agreed to cease receiving orders for its cars for six months, in order that the company making its motors may make them for the United States aëro service instead.

In view of these radical changes and many more equally radical, I see no reason why a properly equipped manual-training school could not make shrapnel shells, when furnished with the rough forgings.

Offers Should Not Be Laughed At

Even though these factories cannot make war material as fast as their regular lines, shall we laugh at them and refuse their well-meant offers and send our soldiers to war with clubs and bricks? Suppose a man desires to enlist in the army; shall we direct him to go home and hoe potatoes, just because he is not an experienced soldier?

The writer understands that the submarine referred to by Mr. Ford was of the "mosquito" type, about 25 ft. in length, requiring probably about 125 hp. to drive it, and to be used for coast defense. We take it from Mr. Ford's past record that he knows pretty well what he can do in mechanics. But on the other hand, if he could only make the machinery for such craft, would it not be a great help? Or if he could only make half that amount, or one-fourth, should we turn his offer down on that account?

In regard to the buying of factories, the writer knows of one man who runs a machine shop that is equipped with a good class of machines. This man could have sold his entire equipment to a munitions manufacturer (after five or six years' use) for more than he paid for it. If these machines could not be used, why buy them?

It seems to the writer that it is high time the United States was getting prepared; and I see no reason for turning down or laughing at any offer of help we get, even though we cannot use it. Criticizing any such offer tends to lessen coöperation of the people, which was recognized as such a valuable asset to our forefathers when they exclaimed, "United we stand, divided we fall."

Electric-Welding Operations at the Studebaker Plant

SPECIAL CORRESPONDENCE

SYNOPSIS—In this article are shown some operations that are performed with the spot welder on automobile parts. One example is an oil pan on which a reinforcement is welded along the flange so as to strengthen it. Tote boxes, which are useful accessories in machine shops, are now being made by this method. Two examples of manufacturing operations that are simplified by means of the welder are also shown and described.

The Studebaker Corporation, Detroit, Mich., is using the electric spot welder to advantage in making various elements for its automobiles. By this process difficult machining operations can be either avoided or simplified. The time for making these parts is also reduced, and yet the finished product is proving strong in service. The machines used for this work at the Studebaker plant are Toledo, Winfield and Detroit spot welders.

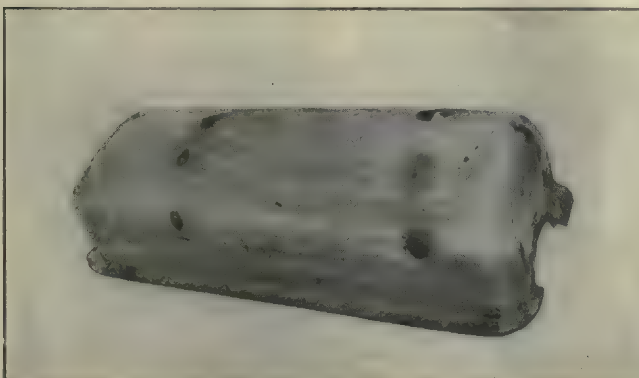


FIG. 1. WELDED OIL PAN

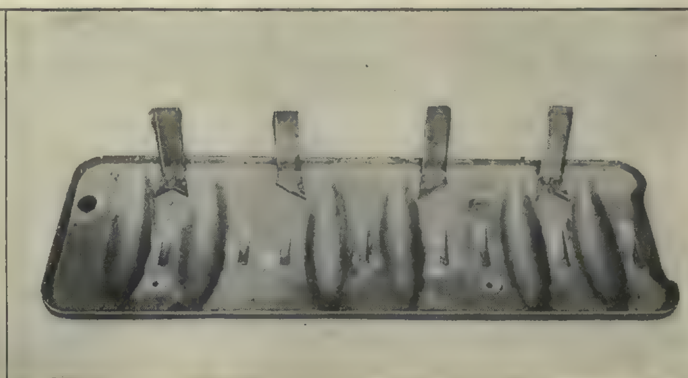


FIG. 2. WELDED DRIP PAN

In Fig. 1 is shown an oil-pan body around the flange of which a steel stiffening strap is welded. The body of the pan is of 0.0625-in. (No. 16 gage) steel, and the stiffener is $\frac{1}{8}$ in. thick. The two are united along the flange by means of 24 welds, and the average time required is 3 min. By this method a light pan can be made with a flange of sufficient thickness to meet designing requirements.

A drip pan used on the automobile has four straps welded to it, as shown in Fig. 2. The pan is of 0.0375-in. (No. 20 gage) steel, and the straps are of 0.0625-in. (No. 16 gage) steel. Three spot welds are required for each strap, or 12 welds for each drip pan. The average time for the operation is $1\frac{1}{4}$ minutes.

In Fig. 3 is illustrated the loop end of the gas-tank strap that is formed with the spot welder. The metal is 0.0625 in. (No. 16 gage) thick, and the end is first bent over to form the loop. For the welding operation five spot welds are made, and the rate of production is three per minute. The strap is neat and strong and, as can be seen by the time given, it is quickly completed.

Among the convenient accessories of a machine shop are tote boxes for keeping pieces together either for storage or for conveying from one part of the shop to another. At the Studebaker factory a number of tote boxes are now manufactured with the spot welder. In Fig. 4 is shown one of these tote boxes. It is made from 0.0625-in. (No. 16 gage) steel, and the band iron that is welded to fit is $\frac{1}{8}$ in. thick. In building up this tote box 103 spot welds were used, and the time necessary was 5 minutes.

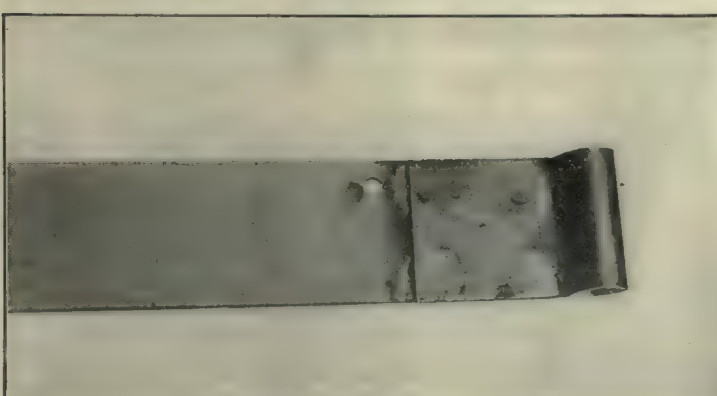


FIG. 3. WELDED END OF GAS-TANK STRAP

FIG. 4. WELDED TOTE BOX

The spot welder also aids in simplifying manufacturing operations. An article thus treated is illustrated in Fig. 5. This piece is a generator coupling that is made in two parts, a sheet-metal disk A and a forging B. The disk, which is of 0.0375-in. (No. 20 gage) sheet steel, is blanked

to the shape shown. The forging is turned on the shank to fit the hole in the disk. The shoulder is faced, the hole bored and a keyway machined. The machined forging is then slid into the disk and united to it with six welds, as shown by the assembled piece at the right of the illustration. The production for this welding operation is six per minute.

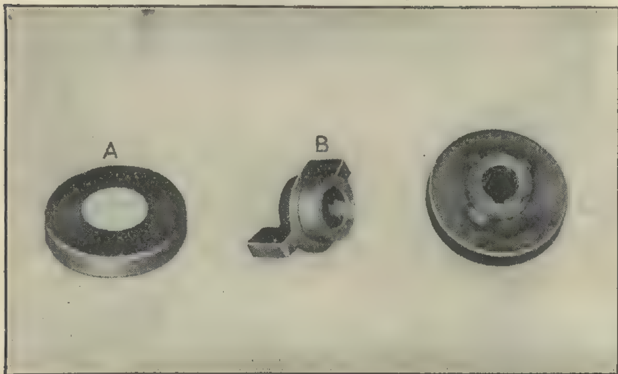


FIG. 5. WELDED GENERATOR COUPLING

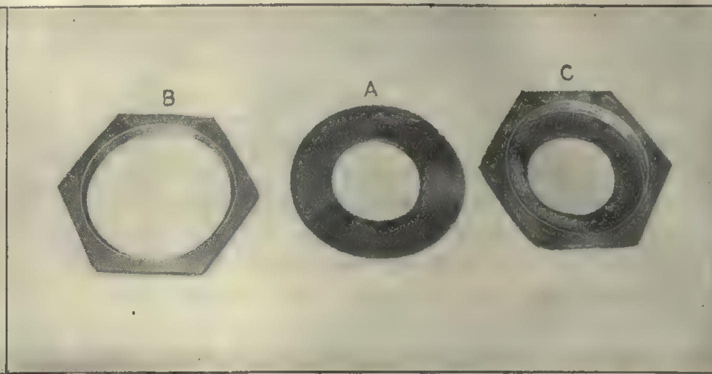


FIG. 6. WELDED AXLE-COUPLING NUT

In Fig. 6 is shown an axle-coupling nut that is also built up with the spot welder. The nut is made from a washer A, 0.0625 in. (No. 16 gage) thick, and a hexagonal nut B, which is $\frac{5}{16}$ in. thick. The washer is then attached to the nut with six spot welds to form the part shown at C. The time necessary for the operation is $\frac{1}{2}$ minute.

Hydraulic Tests of Welded and Screwed Pipe Connections*

The tests here described were conducted in the machine construction laboratory of the University of Kansas and had for their purpose the determination of the relative strength of welded and screwed connections in steel pipe of various sizes when subjected to internal hydraulic pressure.

The pipe samples, which were cut from standard black steel pipe, were from the same stock and hence probably of uniform quality. The welded specimens were made by operators of the Oxweld Acetylene Co., Chicago. The screwed connections were made up with malleable-iron couplings and tees by expert pipe fitters. The pieces for the butt welds were cut at an angle of about 60 deg. in a pipe-cutting machine to get the necessary V-groove for welding. The T-welds were made by cutting a hole in the run and butting the outlet against the run. The ends of all the specimens were sealed by welding in plugs or disks made from boiler-plate punchings. Two of these disks are shown at the bottom of the illustration, Fig. 3.

*These tests were made by F. H. Sibley, Professor of Mechanical Engineering, University of Kansas, assisted by Messrs. Naris, Ruth, Schooley, Jesperson and Dryden.

The specimens were subjected to pressure by means of a small hydraulic-pressure pump, Fig. 1, which was made especially for this work. The specimen under test was placed about 25 ft. from the pump and connected to it by means of a $\frac{1}{2}$-in. copper tube. A pressure gage with a check valve opening toward the gage was placed between the pump and the specimen. The check valve was necessary to steady the pressure in order that satisfactory readings could be obtained, because some of the samples carried pressures greater than 5000 lb. per sq.in. before

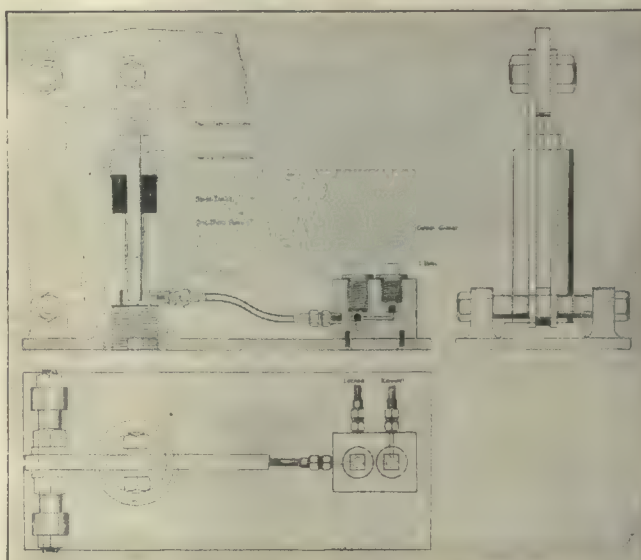
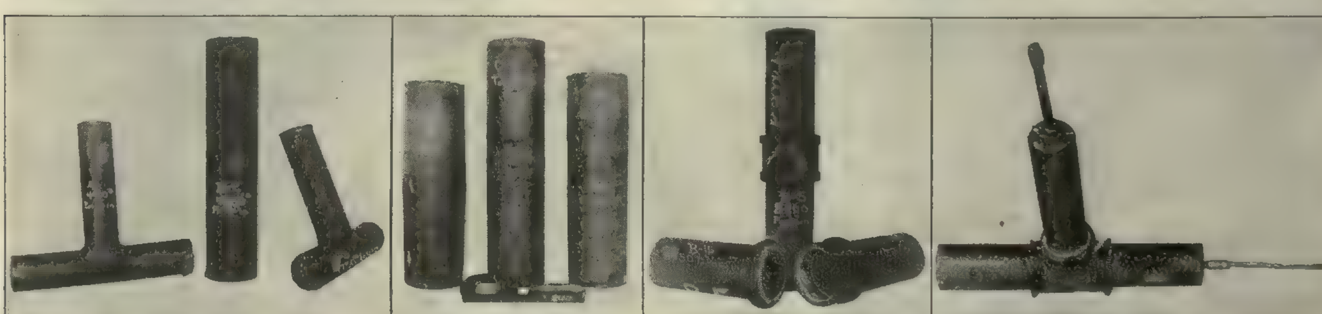


FIG. 1. DETAILS OF THE HYDRAULIC PUMP USED



FIGS. 2, 3, 4 AND 5. SAMPLES OF OXYACETYLENE-WELDED AND SCREWED PIPE TESTED TO FAILURE BY HYDRAULIC PRESSURE

failing. The illustrations show several of the specimens tested and their modes of failure.

Welded 2- and 3-in. specimens are shown in Fig. 2. These failed by splitting along the longitudinal seams of the pipe, the split stopping at the welded section. The 4-in. welded specimens in Fig. 3 bulged under the high pressure, but did not fail in either the weld or the seam.

The modes of failure of two of the screwed connections are shown in Fig. 4. The bursting pressures for the screwed connections were way below that of the welded specimens, and all failed in the fitting. Great difficulty was experienced in testing the specimens made up with screwed fittings because sand holes developed and the water leaked through the castings to such an extent that it was almost impossible to reach the point of rupture. Fig. 5 shows one of the screwed T-specimens under test and illustrates clearly the leaky condition just mentioned.

Examination of the data given in the table shows that in only one case was there failure in the weld, and that was merely a leak which did not develop until 3850 lb.

Size Pipe, In.	Type Joint	Pressure at Failure, Lb. Per Sq. In.	Maximum Pressure, Lb. Per Sq. In.	Nature of Failure	Condition of Weld
2	Welded T	4,400	4,400	Tube seam split	O. K.
2	Welded T	2,200	2,200	Leak in tube seam	O. K.
2	Welded T	4,750	4,750	Tube seam split	O. K.
2	Screwed T	2,350	2,750	Sand holes in fitting	.....
2	Screwed T	500	2,000	Sand holes in fitting	.....
3	Butt weld	.....	5,300	....	O. K.
3	Butt weld	4,950	4,950	Tube seam split	O. K.
3	Butt weld	.....	4,250	....	O. K.
3	Coupling	3,950	3,950	Coupling split	.....
3	Coupling	3,400	4,400	Leak in coupling	.....
3	Welded T	.....	3,500	....	O. K.
3	Welded T	.....	4,250	....	O. K.
3	Welded T	.....	3,505	....	O. K.
3	Screwed T	350	2,700	Sand holes in fitting	.....
3	Screwed T	300	3,100	Sand holes in fitting	.....
4	Butt weld	.....	5,100	Pipe bulged	O. K.
4	Butt weld	.....	3,250	....	O. K.
4	Coupling	300	3,000	Leak at threads	.....
4	Coupling	750	2,600	Leak at threads	.....
4	Welded T	3,850	5,100	Leak in weld	Leaked
4	Screwed T	1,000	1,950	Sand hole in fitting	.....

per sq.in. pressure was applied. This brings out the point that, while leaks are much less likely to occur in welded than in screwed connections, they are the principal cause of difficulty. Therefore, pipe lines that are to be subjected to high pressure, if properly tested for leaks when installed, should give no trouble under service. The results of these tests bear out the conclusions that:

A. The strength of a welded pipe connection is practically the same as that of unwelded pipe. By slightly building up the weld it can be made stronger.

B. The strength of the welded pipe connection is very much greater than that of the malleable iron screwed fittings.

C. Although a careless or inexperienced operator might produce a leaky joint, nevertheless, if the pipe line is tested for leaks when installed, it should give no difficulty in service.

Industrial Exposition and Export Conference

The Industrial Exposition and Export Conference is being held in Springfield, Mass., June 23 to 30. An exposition showing all classes of manufactured articles from steel to knit goods has been arranged as well as an interesting program.

Saturday, June 23, was opening day; Monday, paper day; Tuesday, textile day; Wednesday, leather and rubber-goods day; Thursday, metals day; Friday, office-appliance day; Saturday, chemical day.

Aircraft- and Motor-Car Engine Design*

At a period when the management and equipment of aircraft corps is attracting public attention throughout the length and breadth of the land, as well as in the theaters of war, more than ordinary interest attaches to the paper of Louis Coatalen, delivered to the members of the Aëronautical Society of Great Britain on this subject, in that he stands in the unique position of being a signally successful designer and constructor of both types of engines. Mr. Coatalen was the only motor-car manufacturer in Great Britain who had ready and standardized at the time war broke out more than one model of aircraft engine of original design and of sufficient power to be of use for the needs of the Air Services during the war. During the course of the war he has also evolved, at the request of the authorities, a wider variety of practical standardized models.

Mr. Coatalen opened by saying that the national habit of decrying English achievements and praising that of foreigners, notably the Germans, was never more in evidence than in the case of the aircraft-engine problem: nor was it ever less justified. The case of the latest six-cylinder Mercedes engine to be captured by the Allies might be taken by way of illustration. Without water and radiator it weighed $3\frac{1}{2}$ lb. per horsepower; whereas the latest British water-cooled aircraft engine in the same condition weighed 1 lb. less per horsepower. He pointed out that the belief which appears to obtain in some quarters to the effect that the design and production of an aircraft engine is akin to that of a motor-car engine is erroneous. Flexibility, silence and cost of production are governing factors in designing a motor-car engine; they are practically of no consequence in the case of an aircraft engine. On the other hand, weight, a very high brake mean effective pressure, the capability to work at full power for long periods and comparative great horsepower output—reckoned in terms of hundreds instead of tens—are of prime importance in aircraft-engine construction and of comparative unimportance in motor-car engine design and production.

The aircraft-engine proposition calls, notably, for the exploitation of new methods of achieving lubrication, in that the system that suffices for a car proves inefficient for aircraft engines of high output, which are alone useful in warfare today. The lubricant becomes too hot, therefore too fluid, resulting in the reduction of pressure to the main bearings, hence the evolution of the dry-sump system for lubricating aircraft engines.

Value of Racing Experience

He held that there was a closer analogy between the motor-car engine designed and built specially for racing before the war and the wartime aircraft engine, than there was between either that type of car engine and the standardized car motor; or, again, the standardized car motor and the aircraft engine of today. For instance, the racing-car engine resembles the latest aviation types in that a very high mean effective pressure has to be obtained with it. As the problem in both cases is power for weight and engine volume, and not silence and low cost, great freedom is allowed the designer of a racing-car engine as regards piston clearances, valve timing, compression, largeness of valve area, strength of

*Extracts from a paper read by Louis Coatalen at the ninth meeting of the 1917 session of the Aëronautical Society of Great Britain.

valve springs and so forth, the particulars in this connection approximating much more to aviation than to standard car practice.

The chief desiderata in designing aircraft engines are light weight, low fuel and oil consumption per horsepower and reliability. Minor desiderata, which have already been largely realized, embrace simplification to the utmost, in view of the fact that aircraft engines are placed, for the most part, in the hands of semi-skilled talent, whether as regards actually using or merely maintaining them. Hence the demand for that quality which is generally called "foolproof." Accessibility, particularly during war times, renders it necessary on occasions to replace the most vital parts. Suitability of exterior form, so that the power plant may be accommodated conveniently in the aircraft and occasion the minimum displacement, is also an essential.

Varieties of Engine Types

There are strict limits to the sizes which are practicable for radial engines, whether of the rotary or stationary types. In regard to either vertical or V-type engines, the nature of the particular service to which each individual machine is to be put likewise imposes certain limits on design. Sometimes this may concern the overall length of the engine, particularly when in waging war in the air it is essential to lose the minimum time in altering the attitude of the machine from a diving position to a very steep climbing one. Again, some series of aircraft call for the minimum head resistance, but are less imperative as to overall length. Hence six-cylinder types would be suitable for such service, whereas V-shaped varieties might not be in some cases.

At this period it is impossible to lay down any arbitrary rules as to any one type of aircraft engine being suitable for the needs of all aircraft service. Those needs are almost as various as are the demands for special varieties of steel and alloys. Moreover, they are likely to multiply with the lapse of time. Aircraft-engine design resembles motor-car engine production in this particular, that it is all the time a question of compromise. The most successful designer is he who exercises the soundest judgment in weighing a hundred and one factors of the hour and who makes the shrewdest estimate of the value of each.

Continuing, Mr. Coatalen said that in the circumstance of being in mid-campaign it was not possible to state definitely the size of aircraft engine which would most likely be adopted as standard in the near future. Experience gained by aviators at the beginning of the war, together with the demands for the engineer to meet their ever-growing needs, have called for continuous evolution in the design of aircraft, which has inspired corresponding enterprise in regard to engine construction and production.

For short flights the rotary type of engine generally, and the air-cooled varieties, have shown up to advantage, though with them the consumption of fuel and lubricating oil may be comparatively high; this is offset by the relative lightness of their starting weight. But for longer flights, in connection with which petrol and oil consumption have to be reckoned with as part of the engine weight, water-cooled stationary-type engines have proved most suitable.

Speaking broadly, as regards weight per horsepower, progress in the design of the ordinary water-cooled type of aircraft engine has been very marked. In the brief period of two years Sunbeam-Coatalen aircraft engines of this type have been reduced in weight from 4.3 lb. per horsepower to 2.6 lb. per horsepower. The design of the engine head, cylinders, the valves and the valve gear is one of the cardinal features of successful aircraft-engine production. For water-cooled aircraft engines Mr. Coatalen favors two overhead exhaust and two overhead inlet valves per cylinder, a conclusion which would appear to be justified by the horsepower obtained from engines designed and standardized on this principle. Incidentally, it allows of the best sparking plug position—namely, in the center of the cylinder head in the vertical position. Three valves per cylinder—one inlet and two exhaust valves—have been found practicable for certain varieties of work. He holds that more than four valves per cylinder is an undesirable scheme as it seems hardly possible to place them so as to leave an even jacket all round each valve without the employment of complicated gear. We have an example of this in the Maybach (German) aircraft engine, which has three exhaust and two inlet valves per cylinder. In this little water space is provided between the valve seats, while the sparking plug is, besides, set horizontally on the side of the cylinder barrel.

Much improvement has been made in the cast iron available for cylinders. Aluminum alloys employed with knowledge and skill for that purpose have been found, besides, of great advantage in reducing the weight per horsepower to an extraordinary extent. Though we are merely on the threshold of realizing the possibilities of aluminum alloys for cylinder castings, it cannot be doubted that within a very brief period they will be recognized as the standard materials for this work. For two years Mr. Coatalen has standardized aluminum alloy pistons.

Cooling and Carburation

It is to be noted, further, that air-cooling is coming into favor increasingly. The introduction of aluminum alloy in the manufacture of the cylinders has exercised a marked effect in regard to this tendency. In the near future air-cooled engines of greater power may be expected to materialize. Tests on Sunbeam-Coatalen aircraft engines have shown the petrol consumption of 0.52 pint per horsepower per hour and the oil consumption of 0.022 pint per horsepower per hour, representing a distinct advantage in consumption by engines using ordinary type carburetors so recently as at the beginning of the war. Nevertheless, there is room for much improvement yet. Whereas at the beginning of the war the maximum mean effective pressure was 106.135 lb., today it has been increased to 134 lb. per square inch, measured from the brake horsepower and, in some cases, actually through the reduction gear. In regard to methods of engine rating, Mr. Coatalen wishes to propose that the horsepower per unit capacity obtained from any given engine should be taken as the standard for preparing the different "duties" of aircraft engines. The capacity taken would be the capacity per cylinder multiplied by the number of cylinders, and by the number of complete cycles per minute. To serve the aim in view, the horsepower per liter engine capacity per thousand cycles, otherwise per two thousand crankshaft revolutions per minute, is proposed.

United States Munitions*

The Springfield Model 1903 Service Rifle

Making the Stock—III

SYNOPSIS—The operations here presented complete those required on the stock.

Following the finish turning for the bands, the surplus stock between is removed in a similar type of lathe, Fig. 2028. Cutters wide enough for each unturned strip are used, and the work is completed in one revolution, the feeding being done by hand as in the previous operation. No gages are needed, care being used not to turn below the band cuts, to allow for the scraping and sanding.

The hole for the upper-band screw is bored in the machine illustrated in Fig. 2031, the work being held in the fixture shown in Fig. 2032. Two grasping grooves are cut, one on each side of the stock. They are intended

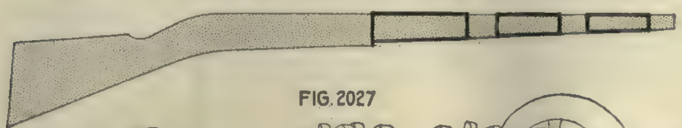


FIG. 2027

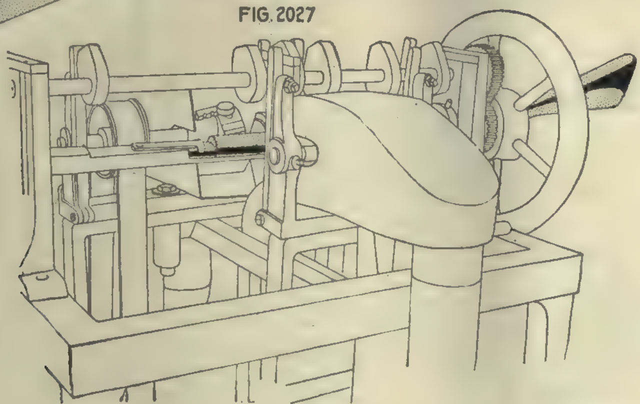
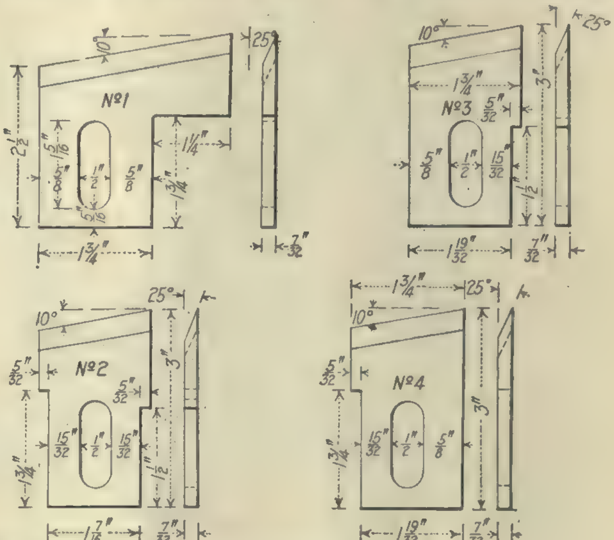


FIG. 2028



OPERATION 16

FIG. 2029

FIG. 2030

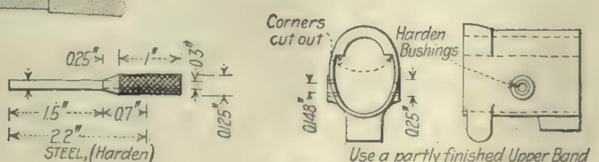


FIG. 2034

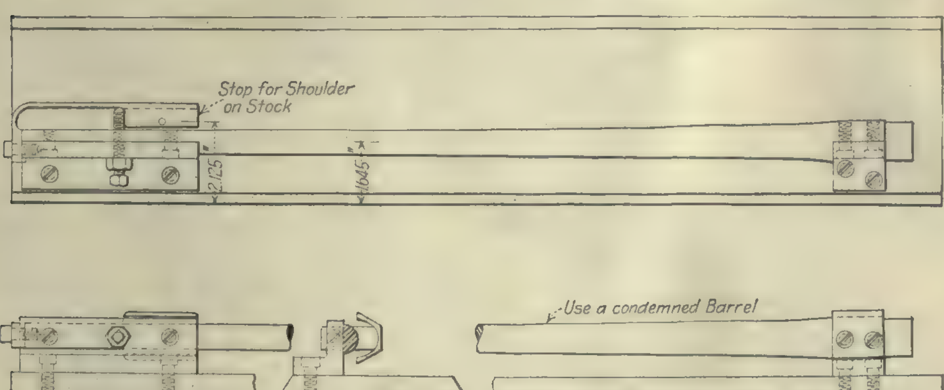


FIG. 2032

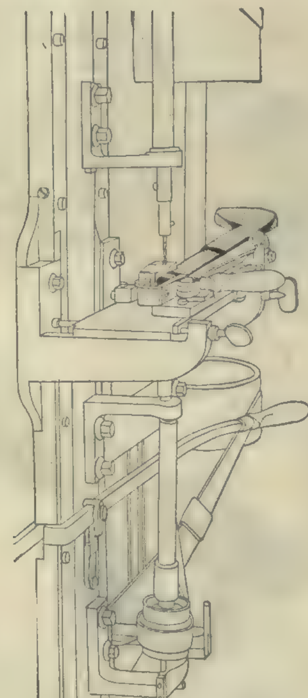


FIG. 2031

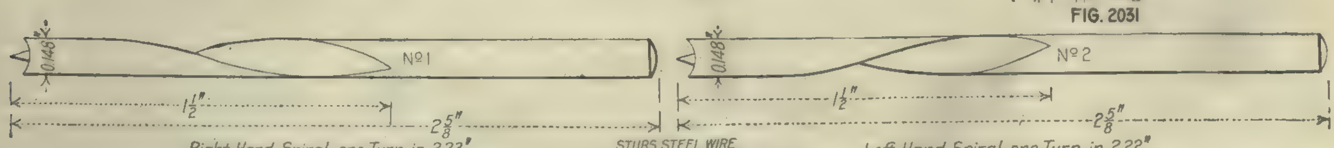


FIG. 2033

OPERATION 20

to give a good grip for the left hand. These grooves are cut in the wood shaper, Fig. 1943, using the work holder and form, Fig. 2036.

The bedding machine, Fig. 2040, is used to cut for the guard, bore guard screw holes and cut the trigger slot. Master forms guide the cutters as in a regular profiling machine. The holding fixture, Fig. 2042, and gages, Fig. 2043, are used.

The hole and slot for the lower-band spring are made in the machine shown in Figs. 2045 and 2045-A. The hole is first bored, then the slot is sawed out. Following this, the hand tool, Fig. 2048, is used to finish the spring seat to exact size and shape. Rounding the edge under the upper band is a hand operation with a spoke shave.

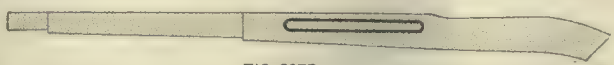


FIG. 2035

FIG. 2038

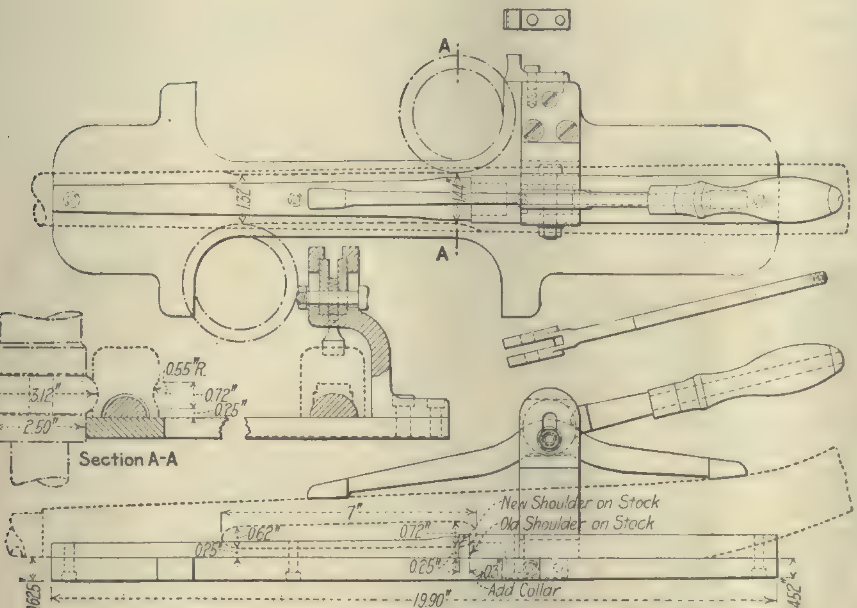


FIG. 2036 OPERATION 18

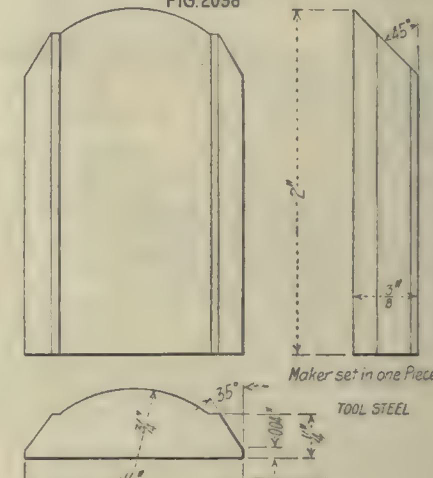


FIG. 2037

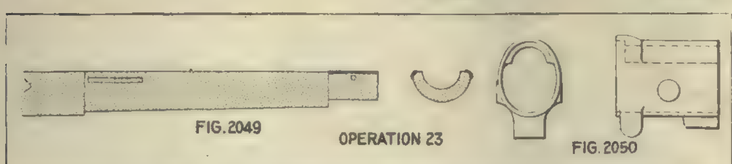


FIG. 2049 OPERATION 23 FIG. 2050

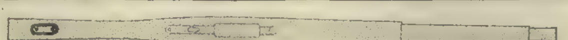
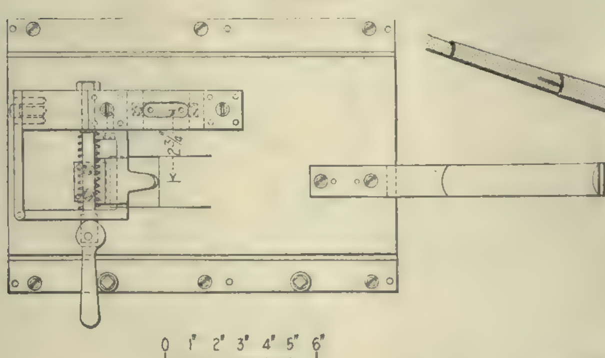


FIG. 2051



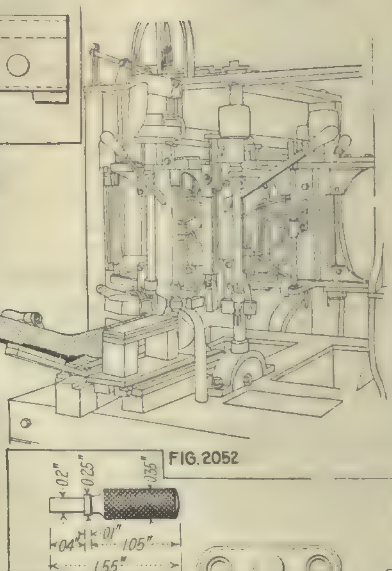


FIG. 2052

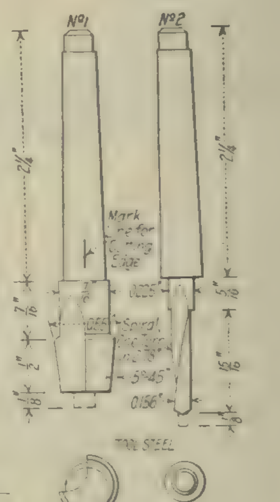


FIG 2053

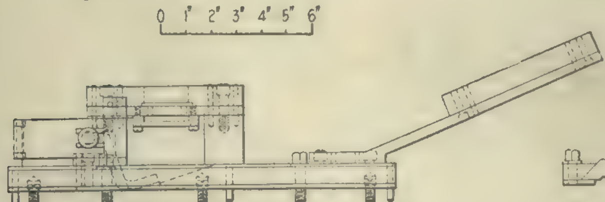
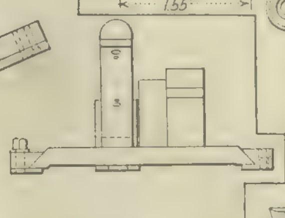


FIG. 2053A



OPERATION 19

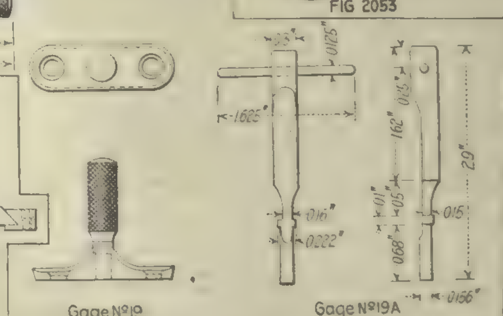


FIG. 2054

OPERATION 16. TURN BETWEEN BANDS

Transformation—Fig. 2027. Machine Used—Modified Blanchard lathe, Fig. 2028. Number of Operators per Machine—One. Cutting Tools—Fig. 2029. Number of Cuts—Three at once. Cut Data—Heads run about 4000 r.p.m. Production—748 per 8-hr. day. Note—Hand feed, according to grain; operator is careful not to turn below band cuts.

OPERATION 20. BORE FOR UPPER BAND SCREW

Transformation—Fig. 2030. Machine Used—Special drilling machine, Fig. 2031. Number of Operators per Machine—One. Work-Holding Devices—Fig. 2032. Cutting Tools—Fig. 2033. Cut Data—4000 r.p.m. Gages—Fig. 2034. Production—2200 per 8 hr.

OPERATION 18. CUT GRASPING GROOVE

Transformation—Fig. 2035. Machine Used—Wood shaper, Fig. 1943. Number of Operators per Machine—One. Work-Holding Devices—Fig. 2036. Cutting Tools—Fig. 2037. Cut Data—Spindle runs 5000 r.p.m. Gages—Fig. 2038. Production—1210 per 8 hr.

OPERATION 17. CUT FOR GUARD, BORE GUARD SCREW HOLES AND TRIGGER SLOT

Transformation—Fig. 2039. Machine Used—Bedding machine, Fig. 2040. Number of Operators per Machine—One. Tool-Holding Devices—Five-tool turret. Cutting Tools—Fig. 2041. Cut Data—Spindle runs 7000 r.p.m. Special Fixtures—Fig. 2042. Gages—Fig. 2043. Production—517 per 8-hr. day.

OPERATION 21. CUT FOR LOWER BAND SPRING

Transformation—Fig. 2044. Machine Used—Special machine, Figs. 2045 and 2045-A. Number of Operators per Machine—One. Cutting Tools—Fig. 2046. Cut Data—Drill and saw run about 5000 r.p.m. Gages—Fig. 2047. Production—1452 per 8 hr. Note—Pin hole is first drilled with vertical spindle, then slot is sawed out, after which the tool in Fig. 2048 is used by hand.

OPERATION 23. ROUND EDGE UNDER UPPER BAND

Transformation—Fig. 2049. Number of Operators—One. Description of Operation—Operator puts stock in padded vise and rounds edges indicated with spoke shave. Gages—Fig. 2050. Production—1210 per 8 hr.

FIG. 2039

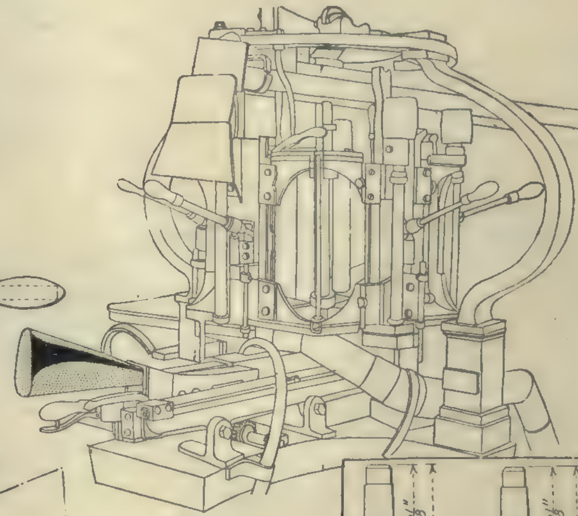


FIG. 2040

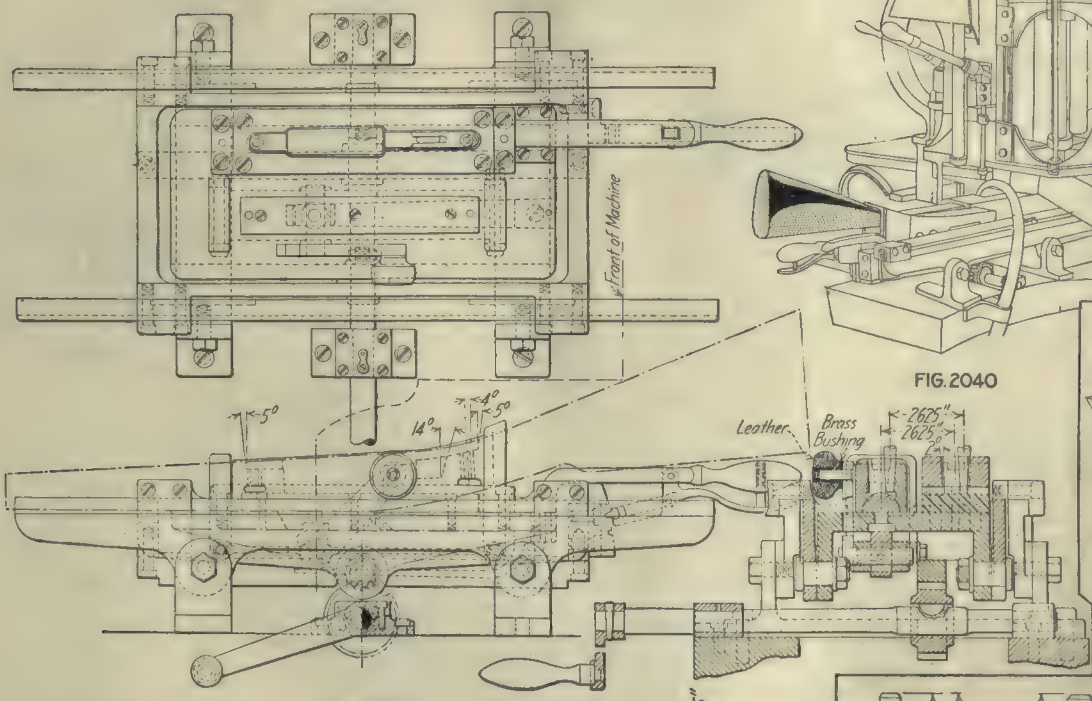


FIG. 2042

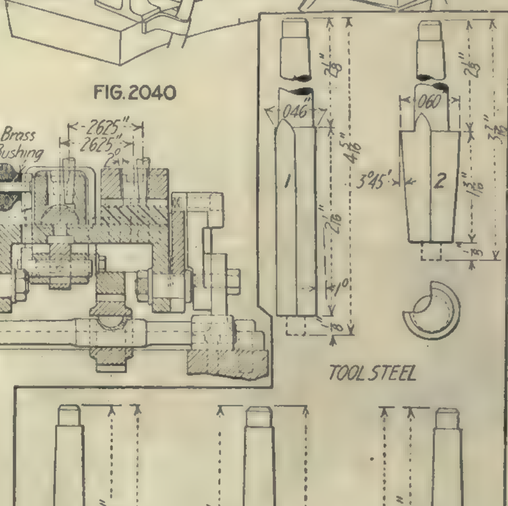
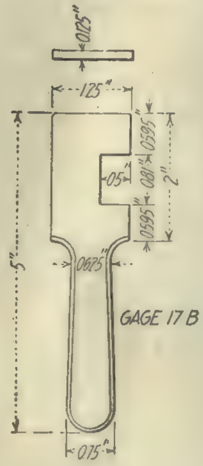


FIG. 2041

OPERATION 17



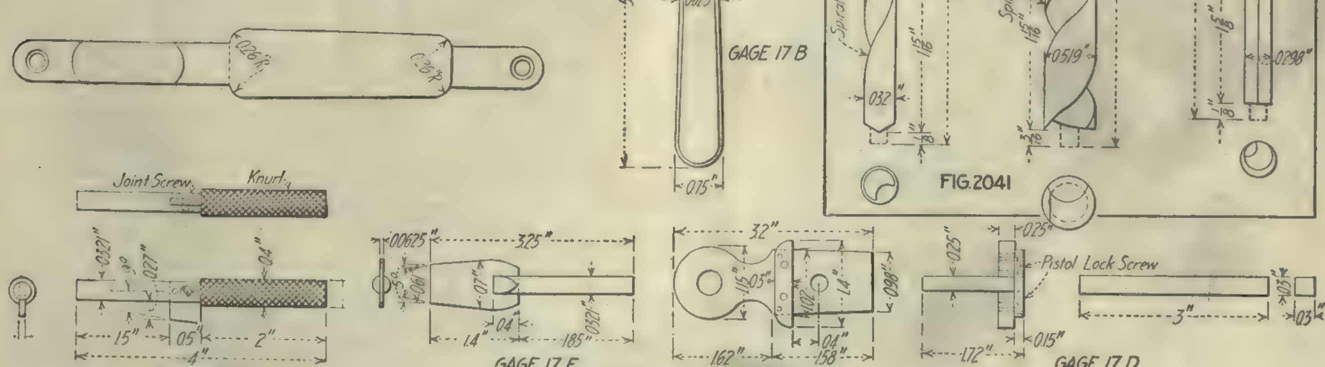


FIG. 2043

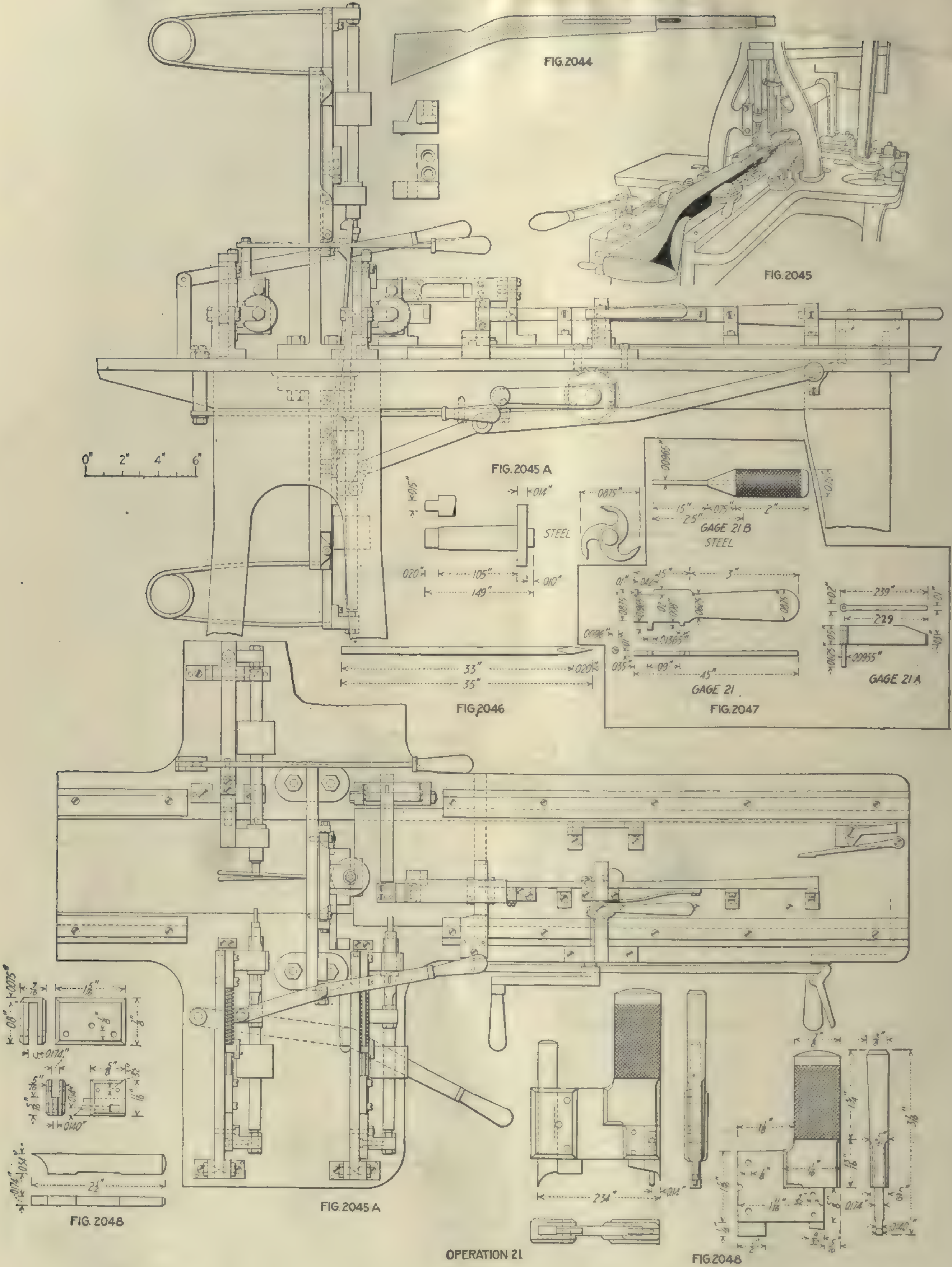


FIG. 2044

FIG. 2045

FIG. 2045 A

FIG. 2046

FIG. 2047

FIG. 2048

FIG. 2045 A

FIG. 2048

OPERATION 19. CUT FOR SWIVEL PLATE AND BORE SCREW HOLES

Transformation—Fig. 2051. Machine Used—Special bedding machine, Fig. 2052. Number of Operators per Machine—One. Cutting Tools—Fig. 2053. Special Fixtures—Master form and work holder, Fig. 2053-A. Gages—Fig. 2054. Production—1210 per 8 hr.

OPERATION 24. FIT RECEIVER TO PLACE IN END OF STOCK

Transformation—Fig. 2055. Description of Operation—With the stock held in a padded vise, the workman fits in the master form or gage by cutting away the wood where necessary with chisels, gouges or scrapers. Gages—Fig. 2056. Production—280 per 8 hr.

FIG. 2055

FIG. 2056

OPERATION 24

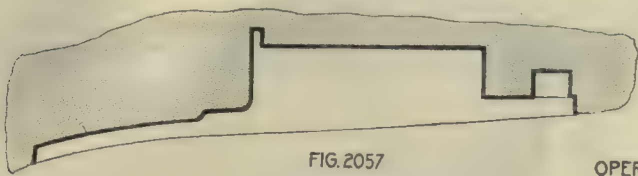


FIG. 2057

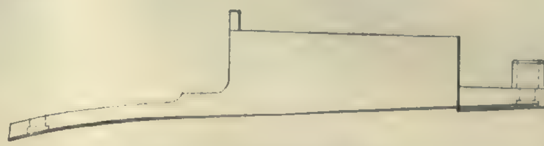


FIG. 2058

OPERATION 25

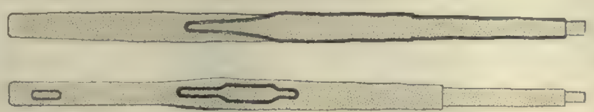


FIG. 2059

FIG. 2060

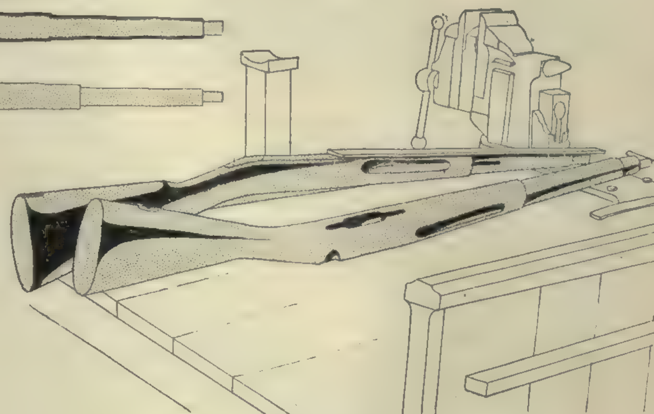


FIG. 2061

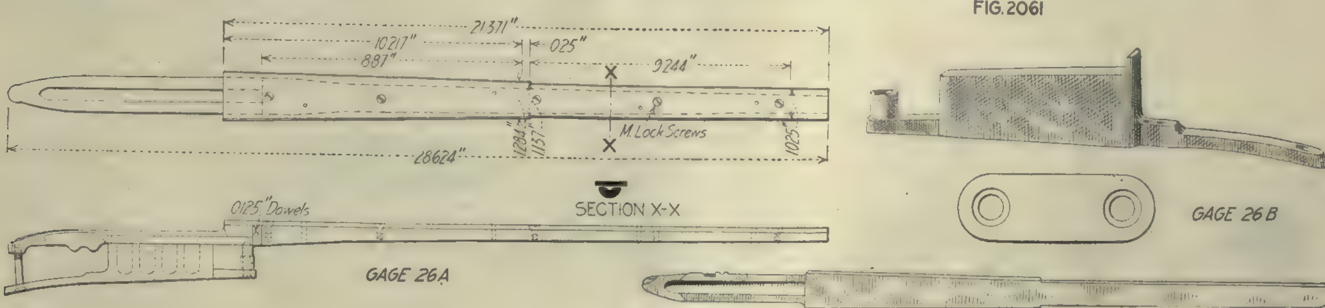


FIG. 2062. OPERATION 26

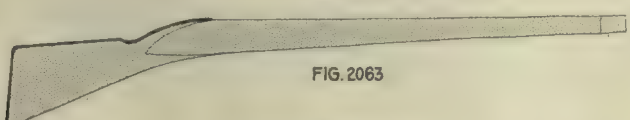


FIG. 2063

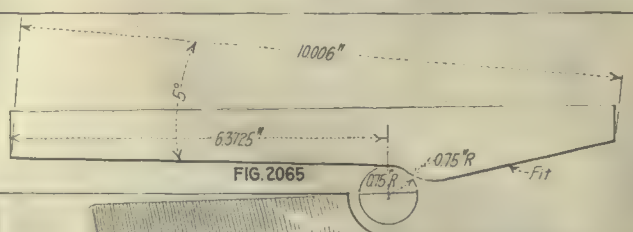


FIG. 2065

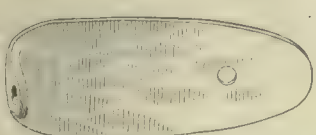


FIG. 2065 OPERATION 27

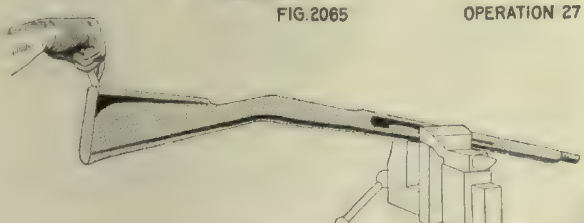


FIG. 2064

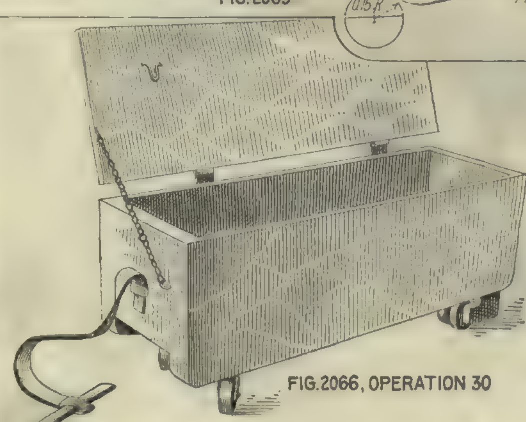


FIG. 2066, OPERATION 30

OPERATION 25. FIT GUARD

Transformation—Fig. 2057. Description of Operation—With stock in padded vise, operator fits in gage and shaves wood level with outside edges. Gages—Fig. 2058. Production—220 per 8 hr.

OPERATION 26. SHAPE TO TANG OF RECEIVER, EDGES OF BARREL GROOVE TO HAND GUARD, AND TO GUARD AND SWIVEL PLATE

Transformation—Fig. 2059. Number of Operators—One. Description of Operation—Operator puts the receiver templet in the barrel groove and the receiver templet in place, then screws the two together and with spoke shave trims wood to templet edges; he also shaves to match edges of swivel plate; these shaved edges serve as guides for the subsequent scraping and sanding operations; the method of working is shown in Fig. 2060. Apparatus and Equipment Used—Bench vise with wooden jaws and support for butt, Fig. 2061. Gages—Fig. 2062. Production—137 per 8 hr.

OPERATION 27. SHAPE TO BUTT PLATE AND SAND TO FINISH

Transformation—Fig. 2063. Number of Operators—One. Description of Operation—Operator holds work as shown in Fig. 2064; shaves butt to edges of butt plate and top to form templet, then scrapes and sandpapers all over to finish. Apparatus and Equipment Used—Set of spoke shaves, scrapers and sandpaper Nos. 1, 0, 00 and 000 used, according to grain of wood and finish. Gages—Fig. 2065. Production—22 per 8 hr.

OPERATION 30. OIL (BOILED LINSEED)

Number of Operators—One. Description of Operation—Operator dips stock in boiled linseed oil, lets it drain and then places it in a rack to dry over night. Apparatus and Equipment Used—One tank, 48 in. long, 16 in. wide and 16 in. deep, Fig. 2066. Production—150 per hr.

OPERATION 28. BORING FOR OILER AND THONG CASE AND TO LIGHTEN STOCK

Transformation—Fig. 2067. Machine Used—Special horizontal boring machine, Fig. 2068. Number of Operators per Machine—One. Cutting Tools—Two drills, Fig. 2069; one slotting tool, 0.655 in. in diameter. Average Life of Tool Between Grindings—2500 pieces. Special Fixtures—Fig. 2070. Gages—Fig. 2071. Production—528 per 8 hr., with three changes of tools.

OPERATION 29. FIT LOWER BAND SPRING

Description of Operation—Operator presses band spring into its seat as slotted in operation 21 and sees that it seats and works properly. Production—1540 per day.

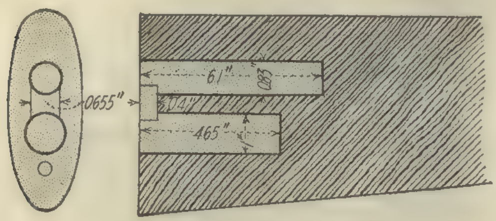


FIG. 2067

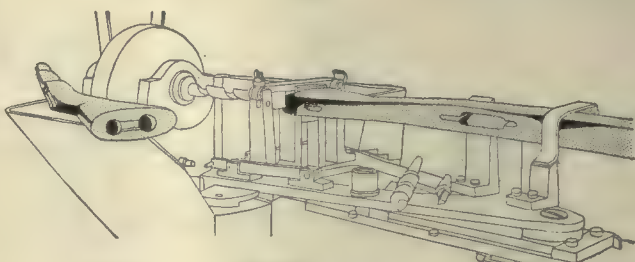


FIG. 2068

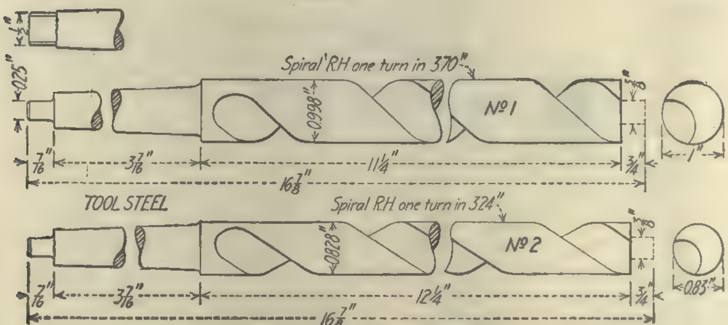


FIG. 2069

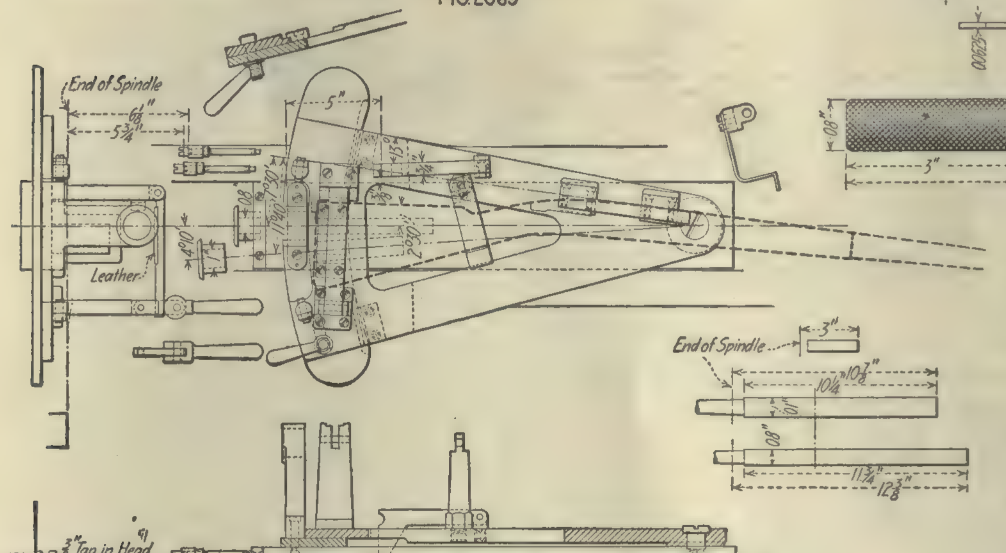


FIG. 2070 OPERATION 28

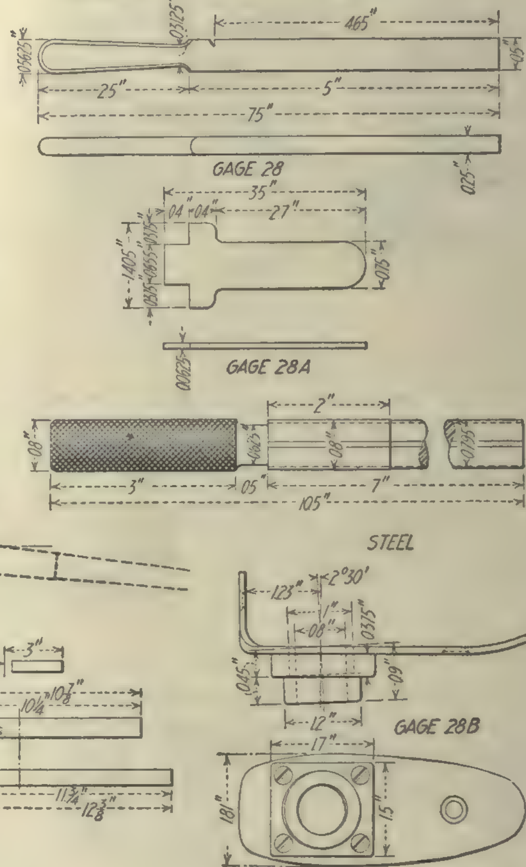


FIG. 2071

OPERATION 32. DRILLING FOR STOCK SCREW

Transformation—Fig. 2072. Machine Used—Two-spindle opposed drilling machine, Fig. 2073. Number of Operators per Machine—One. Cutting Tools—Fig. 2074. Cut Data—Drills run about 3500 r.p.m. Gages—Fig. 2075. Production—1100 per 8 hr.

OPERATION 33. ASSEMBLING WITH STOCK SCREW

Transformation—Fig. 2076. Number of Operators—One. Description of Operation—Operator puts in screw, screws down nut and smooths with file or sandpaper, if necessary. Apparatus and Equipment Used—Forked screwdriver. Production—550 per 8 hr.

OPERATION 34. OIL WITH COSMOLINE

Number of Operators—One. Description of Operation—Operator brushes cosmoline on parts of stock where barrel and metal parts contact. Production—1100 per 8 hr.

OPERATION 35. BORING FOR SPARE-PARTS CONTAINER

Transformation—Fig. 2077. Machine Used—Horizontal drilling machine, Fig. 2078. Number of Operators per Machine—One. Cutting Tools—Drill, 0.33 in. in diameter. Average Life of Tool Between Grindings—500 pieces. Special Fixtures—Grooved plug to guide drill, which is a part of the holding fixture. Gages—Fig. 2079. Production—150 per hr.

The special bedding machine, Fig. 2052, is for making the cut for the swivel plate and boring the screw holes. Fig. 2053-A shows the master form and work holder in detail.

Fitting the receiver is entirely a hand operation, as the workman fits in a master gage or receiver by means of chisels, gages and scrapers. The guard is also fitted in the same way.

The shaping of the tang of the receiver, the edges of the barrel groove to the hand guard and to the guard and swivel plate is done by placing the master forms or templets in position and then cutting away the wood even with the templets by using spoke shaves.

The butt end is next shaped to a master plate in the same way. These shaved edges and surfaces are used as guides for the workman as he scrapes and sandpapers the rest of the stock to a final finish.

The oiling of the stock is effected by dipping it into a tank of boiled linseed oil. It is then drained for a few minutes and next placed in a rack to dry for several hours—usually over night.

Boring for the oiler and thong case is done in a special machine, Fig. 2068. The two holes are drilled, then the web in between the two is partly cut out with a slotting tool to lighten the stock. The lower-band spring is next fitted in by hand, and then the hole for the stock screw is drilled through, after which the screw is put in and smoothed down with file and sandpaper.

All parts where metal contacts with the stock are brushed with cosmoline, then the hole for the spare-parts container is bored. This is done in a horizontal drilling machine, Fig. 2078. The drill used is guided by a grooved plug that fits into a large hole in the butt. The work is tested by a gage, Fig. 2079.

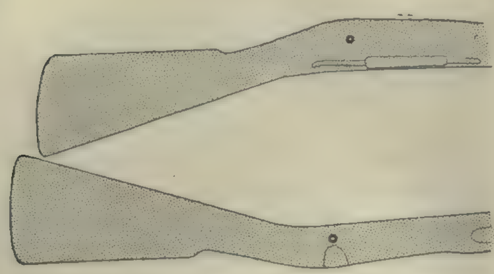


FIG. 2072

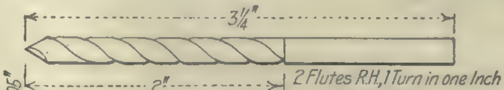


FIG. 2074

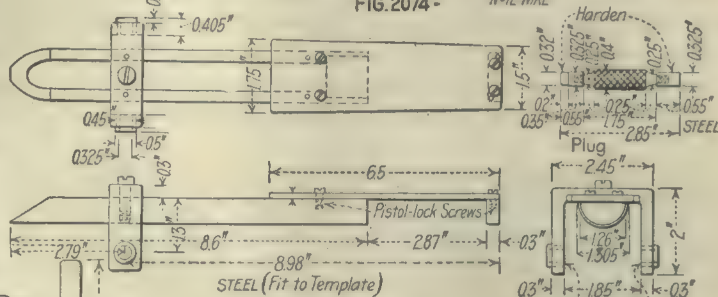


FIG. 2075

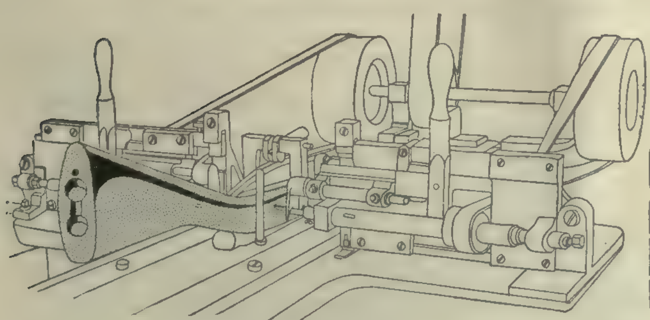


FIG. 2073

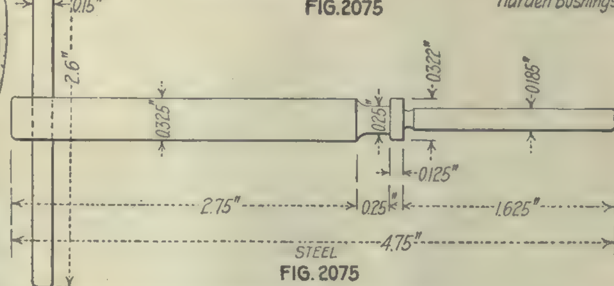


FIG. 2075

FIG. 2076

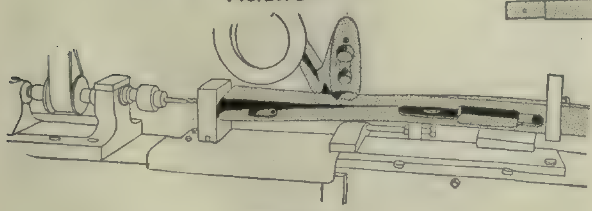


FIG. 2078

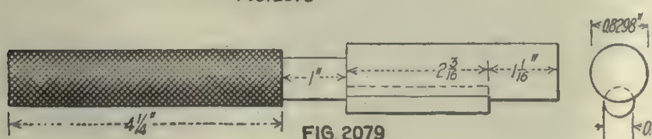


FIG. 2079

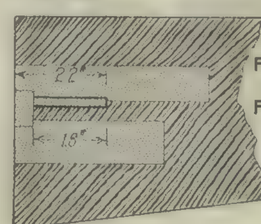


FIG. 2077

FIG. 2072, 2073, 2074 & 2075 OPERATION 32
FIG. 2076 OPERATION 33
FIG. 2077, 2078 & 2079 OPERATION 35

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Defects of Decimal Arithmetic

By F. A. Halsey*

We have all seen our decimal arithmetic referred to repeatedly as very unsatisfactory; and some have, no doubt, seen the true statement that, of all even numbers

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below 20, ten is, with the single exception of 14, the worst possible choice for a system of arithmetical notation. Without specific and concrete illustrations, such statements make but little impression on most of us. With lifelong acquaintance with decimal arithmetic, it has come to seem natural and almost inevitable. Few, indeed, can think in any other system (except that all can and do think in dozens), and we are apt to think of the objections to the decimal system as philosophical only, the more so as it seems to do all that we ask of it; and we are prone to conclude that its faults do not concern us.

The object of this article is to make plain how unfortunate a thing it is that those ancient Arabs who, according to tradition, founded the decimal system, did not omit their thumbs when counting. They provided a character for each finger (including thumbs) until they reached the last one, which they denoted by repeating the first character and adding a cipher, giving the expression 10, while for two tens they wrote 20, for three tens, 30, etc.

As a method of writing numbers, it was a brilliant conception, one of the most brilliant in the history of mankind, but there was no necessary reason why they should have written 10 for ten, and it is most unfortunate that they did. Suppose they had left out their thumbs and provided characters for seven fingers only, and then added the cipher. They would then have written 10 for eight, 20 for two eights, 30 for three eights, etc. For such a system of arithmetic the name octimal has been suggested, and let us see what some of its advantages would have been.

Since the beginning of measurements, mankind throughout the world has, with one accord, divided units of measurement by successive halvings, giving the familiar binary fractions—halves, quarters, eighths, etc.—of our measuring scales and the half and quarter pound and ounce of the grocer and druggist. It is fully understood by the well informed that there is plenty of good reason for this method of division, which, as a basis of sizes, is one of the few perfect things in this world; but it is not necessary here to enlarge upon these reasons.

The Defect of the Decimal System

The leading defect of the decimal system of arithmetic is that it does not harmonize with this method of division, and it is the leading merit of the octimal system that it does harmonize perfectly. For multiplication the decimal system answers all requirements, as, indeed, any system would do. The operation of multiplication having come, historically, far in advance of that of division, with its conception of fractions, is perhaps the reason why the merit of the octimal system was overlooked. So far as multiplication goes, there is not much advantage in any particular base except as it affects the multiplication table. A multiplication table based on eight would be far simpler and more easily learned than the present one, but with the table once learned, the decimal system answers well enough so far as multiplication goes.

It is when we consider division that the faults of decimal arithmetic become serious; and to realize this and the advantages of the octimal system, it is only necessary to compare the expressions for binary sizes given by the two systems.

To make the matter clear to those who have given it no previous thought, let me explain more at length that just as, in the decimal system 10 stands for ten and 100 for ten tens, so in the octimal system 10 would stand for eight and 100 for eight eights, or what we now call 64. So, likewise, 0.1, which now stands for one-tenth, would stand for one-eighth, and 0.01 for one-sixty-fourth. With this explanation, the accompanying table will be clear. In the first column we have binary

EQUIVALENT EXPRESSIONS IN BINARY, OCTIMAL AND DECIMAL FRACTIONS

Binary Fractions	Octimal Fractions	Decimal Fractions	Binary Fractions	Octimal Fractions	Decimal Fractions
$\frac{1}{2}$	0.4	0.5	$\frac{1}{32}$	0.02	0.03125
$\frac{1}{4}$	0.2	0.25	$\frac{1}{64}$	0.01	0.015625
$\frac{1}{8}$	0.1	0.125	$\frac{3}{64}$	0.03	0.046875
$\frac{1}{16}$	0.04	0.0625	$\frac{7}{64}$	0.07	0.109375

fractions as now written; in the second, those fractions as they would be written in octimal arithmetic; and in the third column, the familiar decimal equivalents.

The second and third columns show the comparative merits of the octimal and decimal systems as applied to binary sizes. Of course, the decimal system expresses decimal sizes with equal simplicity, but no one wants decimal sizes. The difference is this: In spite of the badness of the decimal equivalents, we continue to use the binary sizes for construction, ignoring the decimal sizes and their simple expressions.

Is not that second column enough to make a draftsman's or a machinist's mouth water? Imagine our tables of decimal equivalents relegated to the limbo of forgotten things!

The large lesson to be learned from this table is that the merit of the decimal system is the merit of a form of expression only, having no necessary connection with the divisions with which it is accidentally associated, and that it might be and could have been much better associated with a different set of divisions. It would have been so associated, had those ancient Arabs omitted their thumbs when counting.

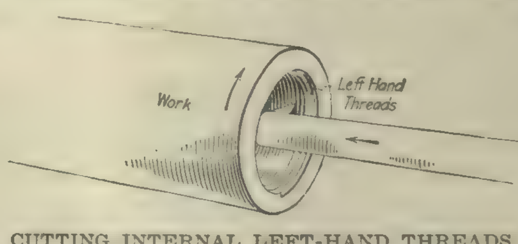
And now does some decimal enthusiast rise up and say that I am advocating a far more difficult change than that to the metric system? Not so. No one knows better than I that such a change, desirable as it is, is impossible. I am here to do nothing more than call attention to another application of the old couplet:

Of all sad words of tongue or pen,
The saddest are these—It might have been.

Cutting Internal Left-Hand Threads

By Harry F. Pearson

By observing the following directions threads can be started from the outside when grinding internal left-hand threads: Gear the lathe for cutting a left-hand



CUTTING INTERNAL LEFT-HAND THREADS

thread in the usual manner. Set the cutting edge of the threading tool facing the back of the hole to be threaded, so that it will cut when the lathe is turned backward. Run the lathe backward to cut the thread.

IDEAS FROM PRACTICAL MEN

Variable-Speed Drive

By C. F. Meyer

An interesting and practical belt drive for two speeds is shown in Figs. 1 and 2. Only one belt is used, on three pulleys of the same size. The arrangement, which is employed on a certain kind of textile machinery, is as follows:

The three pulleys *L*, *K* and *M* are attached to the shaft *A* in such a way that *L* is fastened securely to the shaft *A* by setscrews. *K* and *M* are revolving loosely about *A* and are held in place by a suitable collar. The hub of the pulley *M* has an extension which is turned off and to which the driving pinion *I* is keyed, so that the latter revolves with *M*.

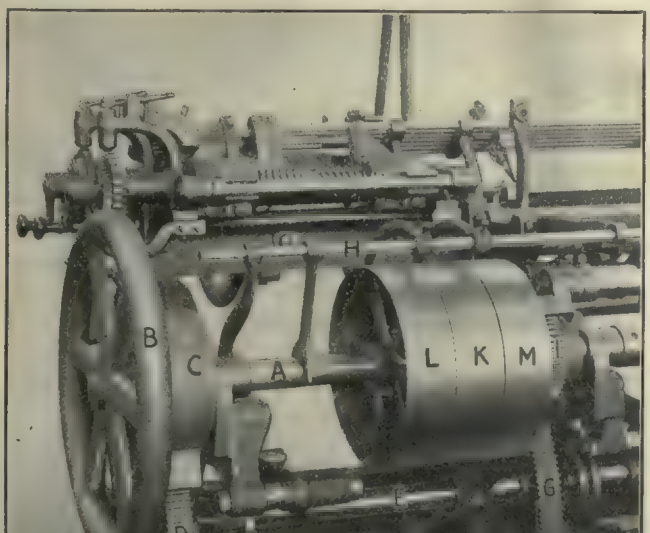


FIG. 1. VARIABLE-SPEED DRIVE

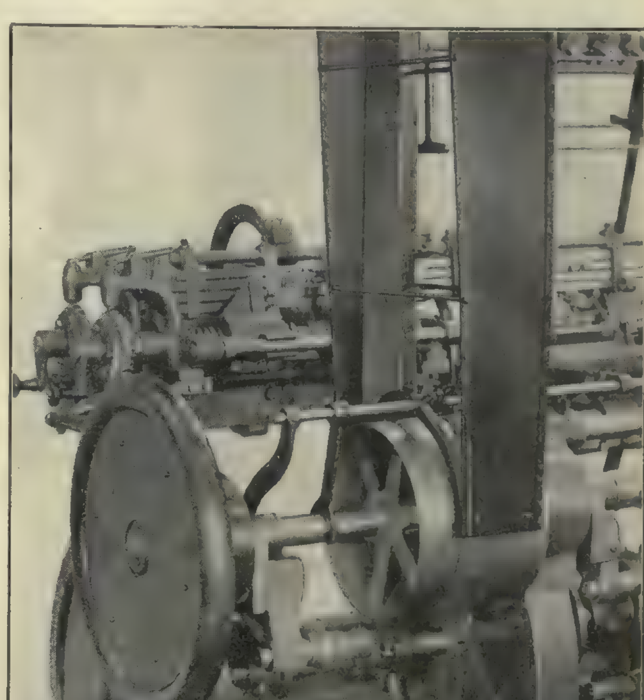


FIG. 2. DRIVE WITH GUARDS IN PLACE

The shaft *A* is provided with a pinion and guard *C* and a flywheel *B*. The pinion *C* meshes with *D*, which is keyed to the mainshaft *E*. Another gear *G*, keyed to the same shaft, is in mesh with the pinion *I*. The ratio between the gears *D* and *G* and the pinions *C* and *I* respectively is, of course, different in each case.

So long as the belt shifter *H* holds the belt on the loose pulley *K* none of the pinions will revolve. If the belt is shifted to *L*, the pinion *C* will revolve the gear *D* and the shaft *E*. The gear *G* on the latter will revolve *I* and also *M*, which is loose about the shaft *A*.

If the belt is shifted to *M*, the latter will revolve the gear *G*, by means of the pinion *I*, at a speed corresponding to the ratio of these gears. The gear *D* will take *C*, the shaft *A* and the pulley *L* along with it, so that in this case the speed of the driving pulley (rather the number of revolutions) is different from that of the driving shaft.

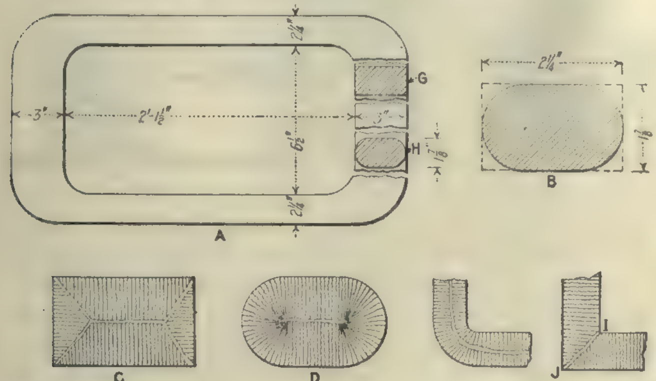
Fig. 1 shows the drive without safety devices while Fig. 2 has all of these in place. The drive is used often and gives good results.

Reducing a Part To Make It Stronger

By M. E. Duggan

On page 472, E. W. Wrigley tells how parts of machinery are made stronger by reducing the cross-section. The cast-steel link, shown at *A* and cross-sec-

tioned at G, broke. A pattern was wanted for a new casting. Existing conditions would not permit enlarging the side members of the casting, so I made the new pattern a duplicate of the original casting. This was rejected by the master mechanic and was returned to the pattern shop with instructions to strengthen the side



WHY THE LINK WAS STRONGER THOUGH LIGHTER

members by reducing the cross-section as shown in the sketch at H. The side member is shown in full in the section B.

Castings cool from the outside inward, forming crystals perpendicular to the face, as shown at C and D. Now, if the casting has a right angle as at E, there will evidently be a weak place along the line IJ; but if the angle be eased by a curve, the crystallization takes place as shown, and the line of weakness is avoided. In making patterns for parts of a machine, the patternmaker will very often make the corners square. He does this to simplify the work and keep down the cost of the pattern. Rounding the corners and filleting the angles is, on a great many jobs, more work for the patternmaker than making the rest of the pattern.

Multiple Tooling in the Lathe

By A. Towler

The Robbins & Myers Co., Springfield, Ohio, has developed and is employing an interesting method of machining small shafts in the lathe. These shafts are approximately 14 in. in length and are made from 1½-in. 0.30-carbon steel. It will be seen by referring to Fig. 1, which is the first turning operation, that the fixture holds four tools spaced so that the various surfaces machined will be finished at the same time. A useful feature of

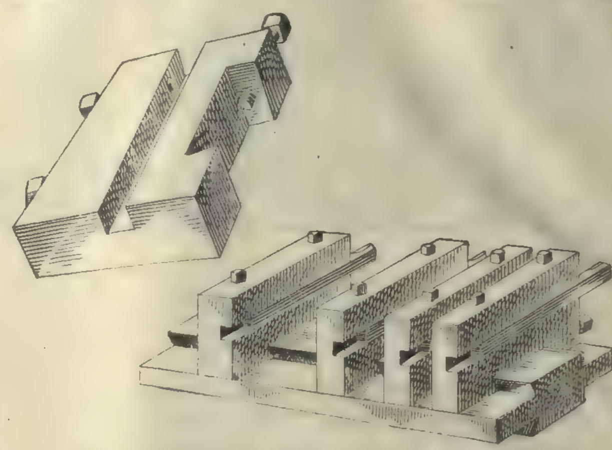


FIG. 2. LAYOUT OF TOOLING—FIRST AND SECOND OPERATIONS

the fixture is the provision for adjustment provided by the dovetail base. With this arrangement the various holders for the tools may be set to suit various lengths of shoulders to be machined.

The shaft is then reversed and the turning operation repeated. The speed at which the work revolves is 160

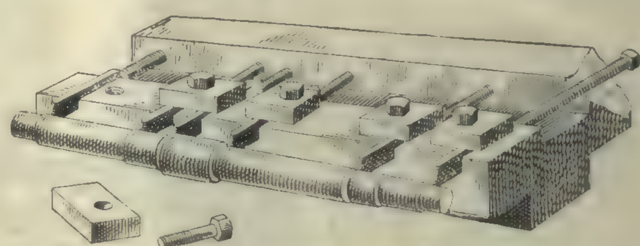


FIG. 4. LAYOUT OF TOOLING—NICKING OPERATION

ft. per min., or 543 r.p.m. The feed is 0.015 in. per revolution, allowing 0.012 in. for grinding. A layout of the tooling operation for the first and second machining is shown in Fig. 2. A similar arrangement of tooling is used when nicking the shoulders prior to the grinding operation. A view of the machine performing the nicking operation described is shown in the illustration, Fig. 3.

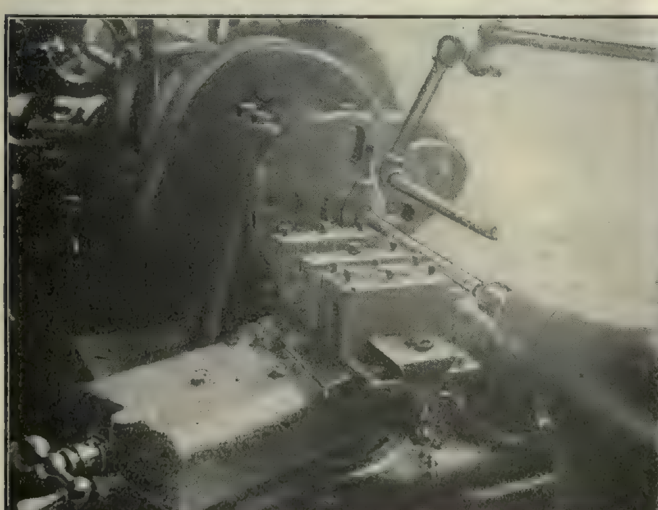


FIG. 1. FIRST AND SECOND TURNING OPERATIONS

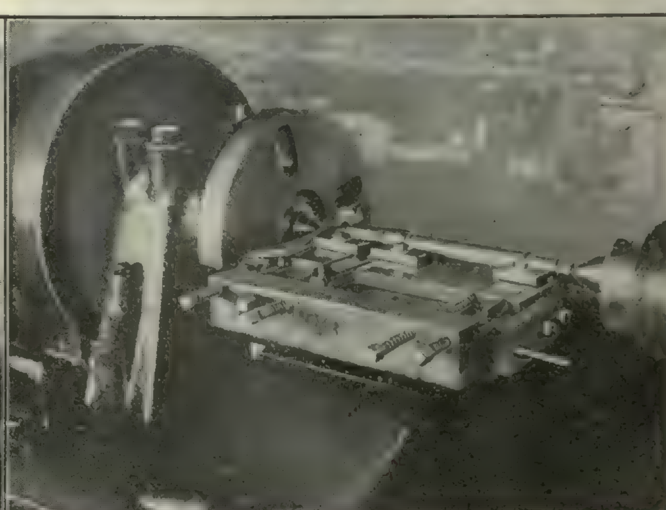


FIG. 3. NICKING THE SHOULDERS

The tools are ⅛ in. thick and are held securely in the fixture by means of clamps placed near the cutting edge, as may be observed by referring to the illustration. A layout of the fixture and tools for the nicking, or third, operation is shown in Fig. 4. The shafts are then ground to size in the conventional manner.

Critical Speeds of Rotors Resting on Two Bearings

By Paul Hoffman

Referring to the article on page 97, a few remarks suggest themselves regarding the example given there of the graphical method of determining the critical speed for a 500-kw. turbine rotor.

While I fully agree with Professor Rautenstrauch that approximate results are, as a rule, entirely sufficient for practical purposes and that the expenditure of too much time on details, in either analytical or graphical methods, is usually not warranted, there is, on the other hand, some danger in simplifying assumptions, which can easily lead to considerable errors.

In the case under consideration (see Fig. 1, which is a reprint of Fig. 10, page 100), the assumption was made that the shaft sections *A, B* and *C* (*A* representing the journal of the generator shaft, *B* the generator shaft end and *C* the turbine shaft end connected by a sleeve coupling) should be replaced by the same length of a straight,

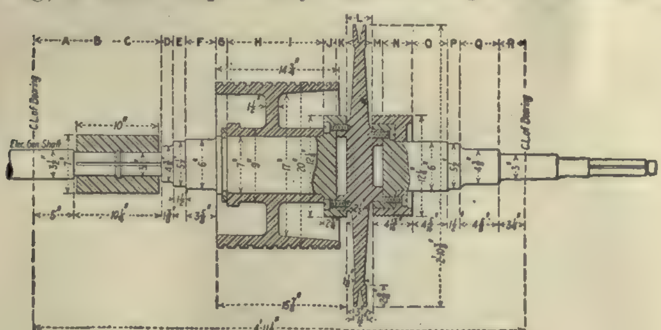


FIG. 1. DETAIL OF TURBINE SHAFT

uninterrupted piece of shafting 3 in. in diameter. The load due to the coupling weight was neglected, to compensate for which no reinforcement by the coupling was taken into account, the contention being that "one way or the other the critical speeds resulting will not be noticeably different." The graphical determination was then carried through and, in the end, the curve of the shaft deflection was obtained.

In examining this curve (also shown in my Figs. 2 and 3), the suspicion arises, however, that the magnitude of the deflection is determined precisely by this length of weak shaft introduced by Professor Rautenstrauch, the strong curvature of the shaft occurring in the sections *A, B* and *C* only, and the maximum deflections obtaining in the center of *C*.

I want to investigate, in the following, how much this suspicion is justified and just what effect the simplifying assumption regarding the coupling has on the final result, by means of a revised computation of the deflections based on what I consider the actual premises of the problem.

My opinion is that the reinforcing influence of the coupling on the shaft is quite considerable and in no way negligible; it is founded on the actual practical requirements for a design such as the one illustrated, which will only operate successfully with a "force fit" of the coupling on both shaft ends. But this means that the bending moment in *B* and *C*, transmitted from one shaft end to the other through the coupling, will be resisted by the coupling with its full momentum of inertia. No deformation of the neutral axis of the shaft can take place unless the coupling bends along with the shaft; and it is the coupling, clearly, which carries the shaft, while the latter, interrupted in the middle of the coupling, does not contribute at all to the strength of the elements *B* and *C*. Therefore, in considering this part of the shaft, a cross-section of 7-in. outside diameter and 3-in. bore must be figured with, both as regards the construction

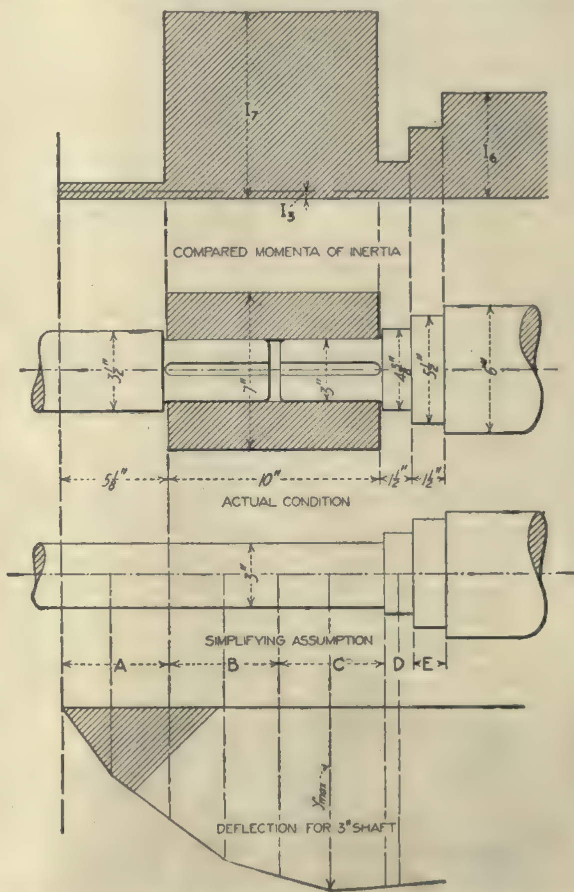


FIG. 2. DIAGRAMS OF SHAFT AND DEFLECTION CURVE

of the bending-moment diagram and that of the modified bending moment.

Fig. 2 shows the resulting increase in the strength of the shaft expressed through the increase of the momentum of inertia, in the sections *B* and *C*. This increase is in the ratio of the fourth power of the diameters, or as $7^4/3^4 = 29.5$ (in reality about 28.5 only, on account of the inactive 3-in. bore in the coupling).

At the same time, it may be pointed out that there is no reason for weakening the section *A* of the shaft 3½ to 3 in. in diameter, as was done for simplifying purposes. I shall figure on 3½ in. and thereby gain in strength in the ratio of $3.5^4/3^4 = 1.85$.

On the basis of these new assumptions, the graphical determination of the shaft deflections has been renewed (see Fig. 2), the result differing considerably, as will be seen, from Professor Rautenstrauch's. The change affects first the loading diagram, by the addition, on

sections B and C, of the coupling weight, which is 90 lb. in round figures. This increase of load, it will be remarked, produces only a slight alteration of the first vector polygon and, as a consequence, of the diagram of the bending moments. This has been shown by drawing both the original diagram, in dot and dash lines, and the revised one, in full lines, side by side.

In the next operation, however, which is to determine the modified bending moments, a radical change takes place with regard to sections A, B and C. Owing to the increase of the momenta of inertia, dealt with above, the new modified moments are entirely different from the original ones (see Fig. 2). Likewise, the second vector diagram is thoroughly changed, the two dominating large loads, owing to the modified bending moments on B and C, having disappeared almost completely. The angles of the vectors have changed accordingly, and if the deflection curve is now constructed in the usual way, by drawing parallels to the vectors from center to center of each shaft section, the outcome, as shown in Fig. 2, is a very much flatter curve with a maximum deflection only about one-third of the original value, or about 0.00225 in. Since the same scale was used for the determination of this new value, as it appeared on Fig. 11 in the original article, no great degree of accuracy is claimed for this result, the intention being merely to establish approximately the extent of the discrepancy. For the same reason, it will not be necessary to use any exact method for computing the critical speed from the deflection curve, but an approximate, shorter way of proceeding will be sufficient. I will use a simple semiempirical formula, which gives the critical speed as a function of the maximum deflection alone and is derived in analogy with the formula for a weightless shaft with a concentrated load, namely:

$$n = 205\sqrt{\frac{1}{y\ max.}}$$

the factor 205 replacing the constant 187.7 in the formula for concentrated load, and being the resulting average of numerous graphical determinations. Using this formula we find:

$$n = 205\sqrt{\frac{1}{0.00225}} = 4340\ r.p.m.$$

If we apply the same formula, for checking purposes, to the maximum deflection obtained in Professor Rautenstrauch's computation, we find:

$$n' = 205\sqrt{\frac{1}{0.00673}} = 2500\ r.p.m.$$

as compared with 2760 r.p.m., obtained somewhat elaborately by more accurate methods.

The agreement between the two latter results is quite satisfactory and shows by inference that the value of 4340 r.p.m., found for the critical speed according to our revised assumptions, may be considered correct, probably inside 10 per cent. limits.

The conclusion of the foregoing, therefore, is that in the considered example, by neglecting the reinforcing influence of the coupling on the shaft, a result had been reached that differs about 75 per cent. from the real value for the critical speed. Instead of being at about 2500 r.p.m., the critical speed is around 4300 r.p.m., so that the shaft, which very likely runs at a working speed of 3500 r.p.m., is rigid, and not flexible as would have appeared from the first computation.

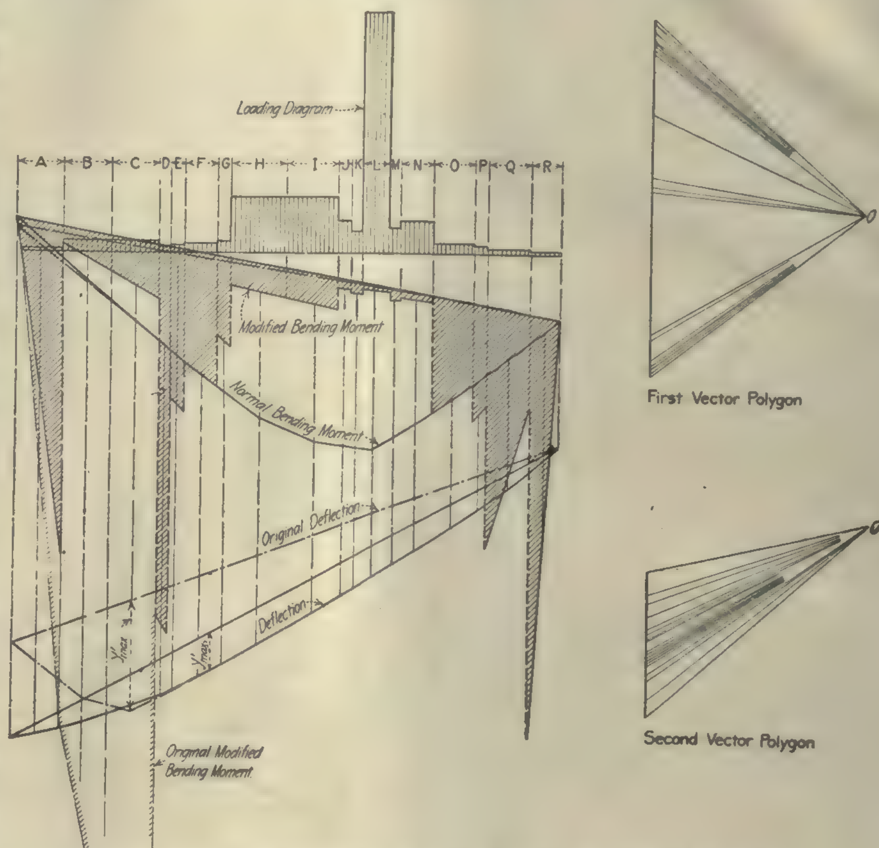


FIG. 3. CRITICAL SPEED DIAGRAMS FOR TURBINE SHAFT

If it be argued that the fit of the coupling, on which rests this whole discussion, is essentially a question of viewpoint, and would probably be answered differently by different investigators, then, at least, the inherent uncertainty should have been pointed out and the weakness of the theoretical method admitted.

In this connection and in order to strengthen our own assumptions an example cited by Dr. Stodola in the fourth edition of his "Steam Turbines," page 303 and 304, might usefully be recalled. The critical speed of a generator rotor had been figured to 1000 r.p.m., while it turned out to be, at the practical test, between 2600 and 2900 r.p.m. This seemed inexplicable, until the shaft was refigured, taking into account the reinforcing action of the armature and commutator, mounted on the shaft with a tight fit.

My final conclusion, therefore, is that in any case the results of graphical or analytical determination of the critical speed of a shaft must be weighed very carefully before practical conclusions are based upon them, and that, even if the utmost accuracy be used in the calculations proper, a wide margin of safety must be allowed.

Editorials

The Economy of a Huge Airplane Squadron

The experience of our allies, particularly on the western front, where the final decision seems likely to be obtained, points conclusively to the great importance of aircraft as the deciding factor in all the great battles of the war. There is very little open fighting in the present war, contrary to the methods pursued in former wars. Men are hidden in trenches, and they are armed with rifles, machine guns, smoke bombs and other missiles, to prevent their capture by the enemy. Open attack means death to practically every man.

The artillerymen on each side are in hiding far behind the first line of trenches, and they endeavor to blow enemy trenches to pieces by subjecting them to a rain of tons of high explosive shells. Then an attack is launched, and, if the preparation has been complete, the trench is captured. To make such a bombardment successful, the gunner must know exactly where to shoot, and he must be kept informed how his shots are being placed. This can only be done from the air. High above, nearly three miles according to the present practice, the spotting airplane, upon which the gunner depends for his information, patrols the air and sends wireless messages. These give the location of the enemy's guns and also direct the demolition of the trenches. With this information, the gunners can train their enormous guns and work deadly havoc eight or ten miles away and never see the target at which they are shooting. Without the spotter in the air the gunner is comparatively helpless, the observation balloon playing a part of diminishing importance in the present struggle.

But the spotter does not have things all his own way if the enemy has a fleet of fighting airplanes, whose duty it is to drive down the spotter and prevent him from sending information to his gunners. This makes it clear that the army whose fliers can dominate the air, who can observe the enemy and direct the gunfire of their own batteries and at the same time prevent the enemy fliers from serving their own army in the same way, can pound its adversary to pieces and drive it from place to place. The destruction of trenches and fortifications can be accomplished so thoroughly by artillery that resistance becomes hopeless, the men become disheartened, and their positions can be carried by the attackers with the loss of very few men.

We can do no more important service at this time than to devote our energies and our money to adding to the aircraft equipment at the earliest possible moment. Even ten thousand airplanes (though do not let us stop at this number) added to those now in use would so completely dominate the air as to blind the German batteries and make the evacuation of France and Belgium a matter of necessity. Ten thousand airplanes, with aviators and mechanics to man them, would be of far greater value than a hundred thousand men in the trenches at this time. More than this, the "winged cavalry" would become far more of an actual fighting force in attacking fortified towns, in raiding supply depots behind the lines and in carrying demoralization to the hostile army.

The Aircraft Production Board has given this matter the most careful attention, and great progress has been made toward securing rapid and rational production. Designs are being standardized, based on the best foreign practice, and the manufacturing capacity of the country in the automobile field, which has developed quantity production to a higher state than any other industry, has been enlisted in the good work. Engineers are now in France studying the problems there at first hand, so as to leave no stone unturned to secure the best machines for all purposes.

But before we can enter into the production of an overwhelming fleet of airplanes, we must impress Congress with the absolute necessity of such a movement. The work will require a tremendous appropriation, but it promises, from every point of view, to be the most economical expenditure we can make. Howard E. Coffin, chairman of the Aircraft Production Board, estimates that the appropriation should be $600,000,000, in order to insure the success of the plan. While this seems, and is, a tremendous sum of money, it is comparatively little as war costs go, being less than it is costing Great Britain every month. If by this expenditure we can hasten the ending of hostilities, as we undoubtedly can, and at the same time save thousands of lives, which also seems to be an undisputed probability, there should be no hesitation in passing such an appropriation.

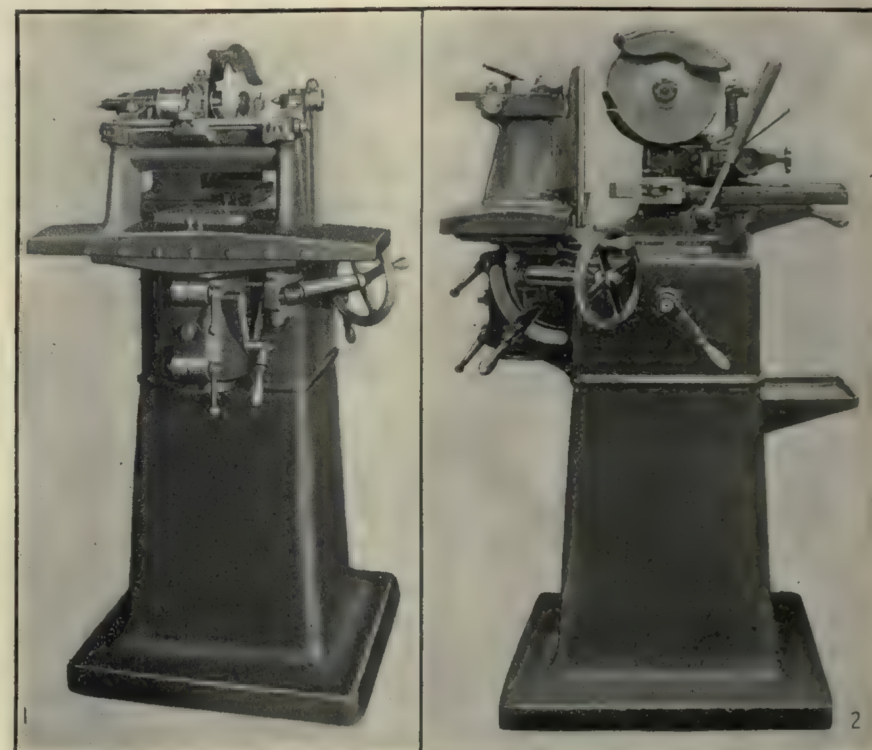
Another similar air fleet operating over the ocean in the localities infested by submarines would probably be more efficient than any other means of combating that very serious menace. Acting as eyes for the destroyers and chasers, as well as taking a hand in attacking by bombs and other devices, the airplane would aid greatly in making life on the enemy's submarines even less enjoyable than it is at present. Then, too, a sufficient number of airplanes would make a formidable attacking squadron on submarine bases, and so assist greatly in destroying the submarines at their source, which is far more effective than to build ships faster than they can be sunk.

The airplane points the way in which we can be of the greatest service in doing our part in the present struggle. It is also particularly fitting that the country which made possible the navigation of the air, and by so doing revolutionized the methods of warfare, should exert its energies to make its contribution in this line so overwhelming that it would compel the cessation of hostilities. By all means give us an air fleet which can so dominate the skies as not only to blind the enemy's gunners, but to carry demoralization to those who have so long ridden roughshod over the rights of all who opposed their desire for world conquest and domination. Let us willingly spend our millions for machines which will enable us to save the lives of thousands of our own men and hasten the ending of hostilities.

Shop Equipment News

Cutter Grinder

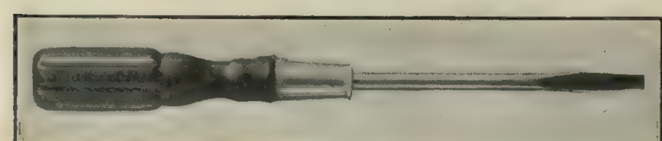
The cutter grinder illustrated is now being marketed by Elmer Sacrey, 1001 Diamond St., Philadelphia, Penn. It is intended for sharpening milling cutters of either the profile or the inserted-tooth variety. Fig. 1 shows the front of the machine, while Fig. 2 is a side view. The spindle is 1$\frac{1}{16}$ in. in diameter, is hardened and ground and runs in split taper bronze bearings. Dustproof oil cups are provided, and the exposed wearing parts are protected from emery dust. A strip of felt is attached to the emery-wheel slide bearings, metal strips are used on the ways, and a dust hood covers the elevating worm. All adjusting wheels have micrometer dials, and extended clamp levers make wrenches unnecessary. Cutters may be held either between centers or on the flat auxiliary table. The diamond-wheel truing device, which is incorporated in the machine, may be seen projecting at an angle in the upper left corner of Fig. 2. When the work is such that the use of a master form is necessary, four adjustable socket-type clamps are used. The machine is of sufficient size to permit work being done on cutters up to 9 in. long and 9 in. in diameter. Two 10-in. Aloxite wheels are used with faces $\frac{1}{8}$ and $\frac{1}{2}$ in. wide. The dimensions of the front and rear bearings are 1$\frac{1}{16}$ x 4 in. and 1$\frac{1}{16}$ x 2$\frac{3}{4}$ in. respectively, and the spindle speed is 2100 r.p.m. A work-setting device is included in the equipment. The net weight of the machine is 1200 lb., and the height over all is 57 inches.



FIGS. 1 AND 2. GRINDER FOR MILLING CUTTERS

Screwdriver with Fluted Wooden Handle

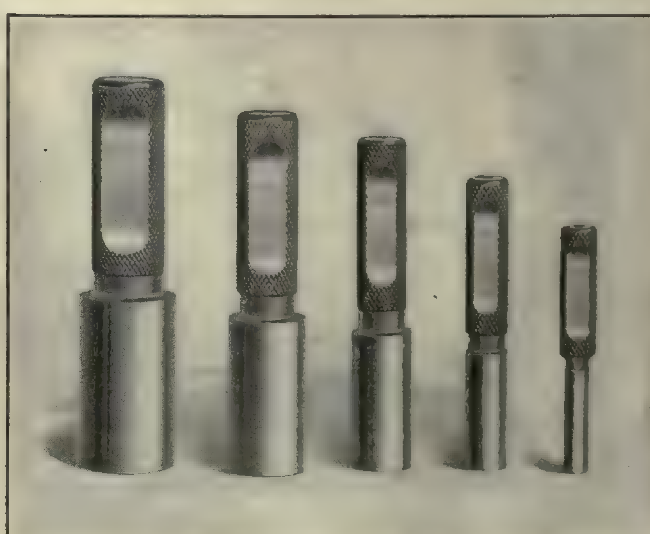
The screwdriver illustrated is the latest product of the Peck, Stow & Wilcox Co., Cleveland, Ohio, and Southington, Conn. It is equipped with a round blade forged from special steel, hardened and tempered. Both the blade and the ferrule are polished. They are held in a handle of generous size, fluted and given a black polished rubberoid finish.


SCREWDRIVER WITH LARGE HANDLE

Plug Gages

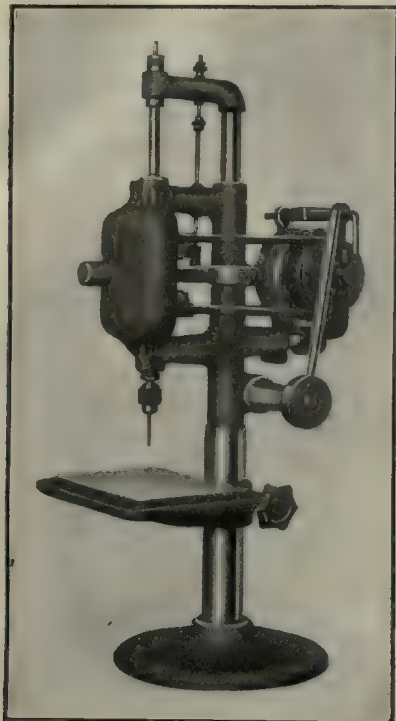
The Simplex Tool Co., Woonsocket, R. I., is now marketing a standard line of plug gages, a few of which, of several different sizes, are shown in the illustration.

At present the gages are made in sizes varying by $\frac{1}{32}$ in. from $\frac{1}{8}$ to 1 in. They are of tool steel, hardened, ground and lapped to size, and are claimed to be accurate to within 0.0001 in. The handles provide a good hold.


STANDARD PLUG GAGES

Tapping Machine

The tapping machine shown has a capacity up to $\frac{3}{16}$ in. in steel and up to $\frac{1}{4}$ in. in brass. It is made in either the bench or the floor type. One of its more important features from an operating viewpoint is the automatic reversing mechanism, which causes the spindle to reverse its direction at any predetermined depth. The spindle is of the floating type and is double splined to insure correct balance at high speeds. It is carried in a feed yoke operated by either a foot or a hand lever. A $\frac{3}{8}$-in. round belt is used for driving the spindle. A bracket at the back of the machine column carries the driving and an idler pulley, and proper tension in the round belt is maintained by a forward or backward movement of this bracket. The clutch is mounted between the spindle driving pulleys and is thrown into forward or reverse by means of a snap fork. The depth stop on the yoke governs the time of the throw, and a catch is provided for the belt shipper.



BENCH TAPPING MACHINE

Height, 31 in.; table, $6\frac{1}{2}$ x 9 in.; distance chuck to table, up to $7\frac{3}{4}$ in.; distance spindle to column, $3\frac{7}{16}$ in.; feed of spindle, $3\frac{1}{2}$ in.; speed, 800 r.p.m.; pulleys, $4\frac{1}{2}$ x $1\frac{1}{2}$ in.; weight, 240 lb.; bench space, $15\frac{1}{2}$ x 10 inches

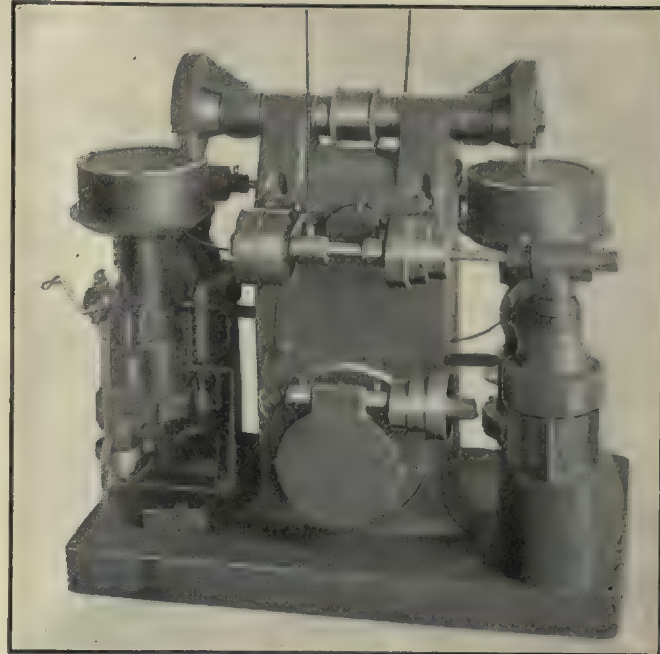
A vertical adjustment is supplied for the table, which has an oil groove around the edge. In case it is necessary to hold the work in a jig clamped to the table and there is danger that the holes to be tapped may not all line up with the spindle, an auxiliary flexible extension spindle is furnished, which is held in the regular tapping chuck, but allows the tap to find its own center. The Langelier Manufacturing Co., Providence, R. I., are the manufacturers.

Rotary Surface Grinder

The illustration shows a double rotary surface grinder that has recently been placed upon the market by the Globe Machine and Stamping Co., Cleveland Ohio. The machine is so constructed that each chuck and grinding wheel can be operated independently of the other, thus allowing continuous production, the operator setting the work on one chuck while the other is running. Simultaneous operation of the two fixtures is also possible.

The grinding-wheel head is secured to the frame in a fixed position in order to secure rigidity. Sliding surfaces have been eliminated, and the working parts are protected from dust and grit. An automatic feed and stop are provided, by means of which a feed of from 0.0005 to 0.005 in. per stroke can be maintained. The stop can be set to release the feed at any predetermined point.

The 12-in. magnetic chucks are mounted on counterbalanced swinging arms with ball-bearing thrusts. The swinging movement is accomplished by means of a cam and rocker-arm, and adjustment is provided for length and position of stroke. Three speeds are used for both the chucks and the work traverse.



ROTARY SURFACE GRINDER

Universal Curveograph

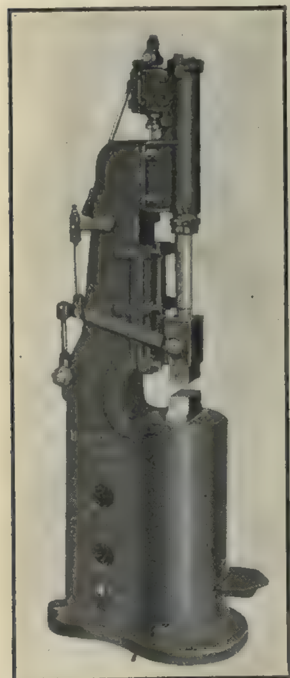
The "Universal Curveograph" shown in the illustration has been placed upon the market by W. G. Classon, Leominster, Mass., for the use of engineers and draftsmen. It is adapted for drawing simple, compound, reverse and irregular curves and will also adapt itself to drawing a curve and tangent.

The spline is held in position, with the desired curve, by means of the adjusting fingers shown at both sides of the center. These fingers are provided with graduations indicating the radius of the curve in inches. The spline is 18 in. long and may be set for curves of from 10- to 300-in. radius. The instrument will replace beam compasses, railroad curves, splines and weights for much of the work that is ordinarily done with these devices.

UNIVERSAL CURVEOGRAPH

Pneumatic Hammer

Several improvements have recently been made on the light pneumatic forging hammer built by H. Edsil Barr, Erie, Penn., and shown in the illustration. An automatic gear has been added to the machine to permit continuous striking, a feature that was not present in the original model. The hammer operates by compressed air at a pressure of from 80 to 90 lb. a square inch and strikes a maximum of 200 blows a minute. The consumption of air is about 30 cu.ft. of free air per minute with continuous operation. Stock up to 2 in. square may be handled. The cylinder is bolted, keyed, and doweled to the frame to insure permanent alignment. Heat-treated vanadium-alloy steel is used for the piston and rod; the piston rings are of cast iron. Openhearth steel is used for the ram head and guide shoe, which are machined from one piece of metal. The dies furnished are of tool steel for plain forging. They are annealed and hardened on the faces and can be readily removed for the substitution of others of special shape. The valve for controlling the operation of the piston and ram is of the slide type, and the cylinder is ported in such a manner as to allow the quick transfer of air to and from the cylinder.



PNEUMATIC FORGING HAMMER

Adjustable Reamer

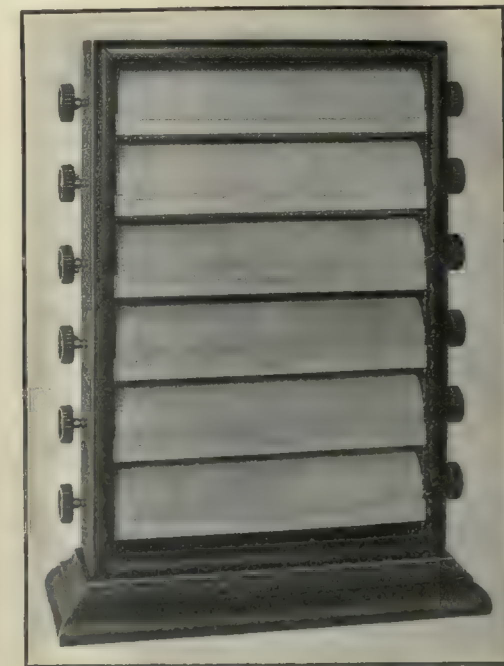
In the description of the adjustable reamer, manufactured by the Taft-Pierce Manufacturing Co., Woonsocket, R. I., on page 962, the tool was erroneously called the Mantell reamer. It should have been called the Martell reamer.

Payroll Computing Machine

With the idea of providing a device by means of which payrolls may be easily computed, the Porter-Cable Machine Co., Syracuse, N. Y., has placed on the market the "Payteller," which is shown in the illustration.

The device consists of six rolls, about 3 in. in diameter and 12 in. long, placed horizontally, one above the other. Arranged around the left end of each roll is a column of figures indicating the rate in cents per hour. The rates vary in steps of ½c. from 20 to 60c. In front of and parallel to each roll is a bar graduated by divisions representing tenths of hours for a period of 10 hours. The bodies of the rolls are filled with figures representing the product of the rate and the time, so that by setting the roll in such a position that the rate is opposite the bar and following out the bar to the division representing the time, the total amount is found on the roll.

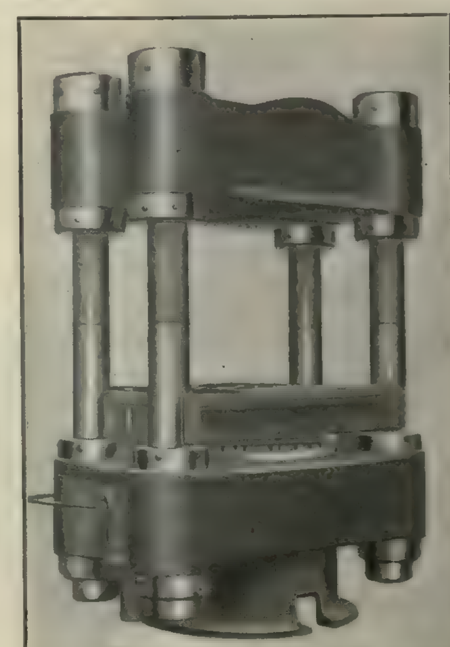
The first roll is used for times up to 10 hours, the second for times between 10 and 20 hours, etc., up to the sixth roll, which serves for times between 50 and 60 hours. The advantage claimed is that, as each result is a unit by itself, there is less chance of error than is likely where compounding operations are necessary. The device is also said to be a saver of time.



PAYROLL COMPUTING DEVICE

Hydraulic Press

For use in the manufacture of sheet-iron and steel parts the Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, has placed on the market the 1000-ton hydraulic press illustrated. Its capacity is from 18 to 36 in. The upper ends of the strain rods are fitted with threaded



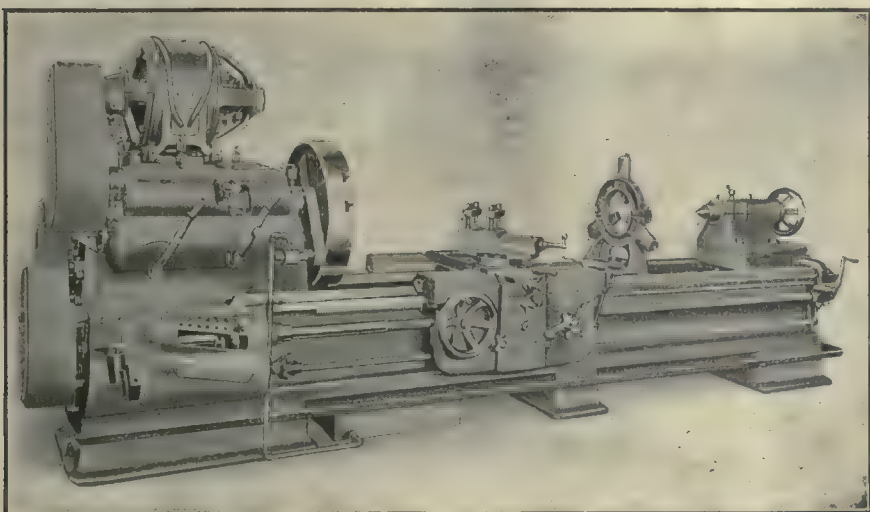
HYDRAULIC PRESS FOR METAL FORMING

forged nuts, while the lower ends are made with split collars and solid heads. The collars on both the upper and the lower ends of the strain rods are threaded, the upper collars permitting the head to be lowered and all clearance to be taken up, so that the head may be set true for close work. All clearance may be taken up by the lower collars in case the nature of the work makes this desirable.

Auxiliary push cylinders are used to hasten the return of the press platen and ram after the pressing operation. The push cylinders are made with differential rams. The press is of steel construction throughout and has a 42 x 48-in. working surface.

Geared-Head Lathe

The illustration shows a new heavy-duty geared-head lathe that is now being marketed by the Pittsburgh Machine Tool Co., Braddock, Penn. The lathe is made in both 32- and 36-in. sizes and with any reasonable length of bed desired. Heavy construction is used throughout, all gearing being of steel.



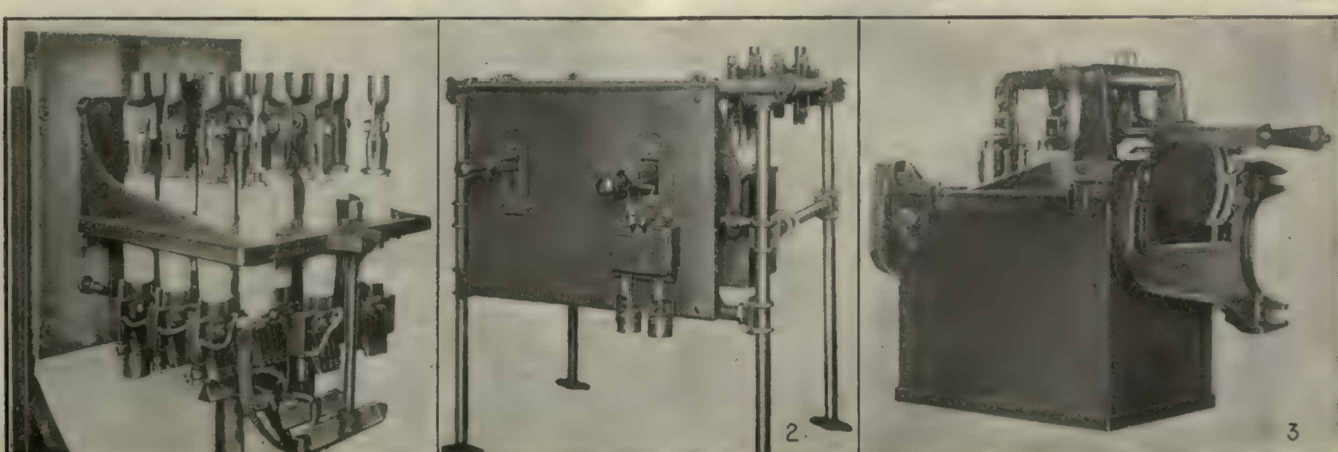
HEAVY-DUTY GEARED-HEAD LATHE

Twelve spindle speeds are provided for, together with 36 feeds. The apron gearing is also of steel, and all bearing studs are hardened and ground to size. The spindle is of hammered steel and has a gear ratio in the head of 63.5 to 1. Tumbler gears and clutches are case-hardened to prevent the occurrence of any undue wear.

Starters for Squirrel-Cage Induction Motors

The Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn., has recently put on the market the three types of motor starters shown in the accompanying illustration. Fig. 1 represents type QF, Fig. 2 type QF1, and Fig. 3 type Q. These starters are intended for use in connection with large squirrel-cage induction motors up to 650 hp. and serve to protect the motor machinery, line and operator by preventing excessive strain on the motor, disturbance on the line and the reduction of line voltage and current. The motor and the starter are protected against overloads and short-circuits. A high kilovolt-ampere capacity is used, and a heavy break capacity is included to prevent damage to the motor or the starter. Resistance can also be furnished to prevent the opening of the circuit when changing from the starting to the running position. Arcing at the contacts has been reduced by immersing all contacts in oil and by using auxiliary arcing tips with large contact area. These tips are removable to provide for easy replacement. Safety from overload is secured by a relay, which opens the switch at any predetermined overload; and by a low voltage relay, which opens the switch when the voltage fails. The type Q starter, Fig. 3, is used on two- and three-phase circuits of from 220 to 2200 volts at from 25 to 60 cycles. The starters in Figs. 1 and 2 differ from that in Fig. 3 mainly in their ability to handle larger current and in having larger kilovolt-ampere breaking capacity. The overload relays are so arranged that they operate very slowly on slight overloads and instantaneously on short-circuits, thus preventing the motor circuits from being opened by a momentary overload such as might occur during the moment of acceleration when the switch is changed from starting position to that used for continuous running.

The low voltage relays operate instantaneously and open the switch the moment the loss of voltage occurs, thus preventing damage when the current is turned on.

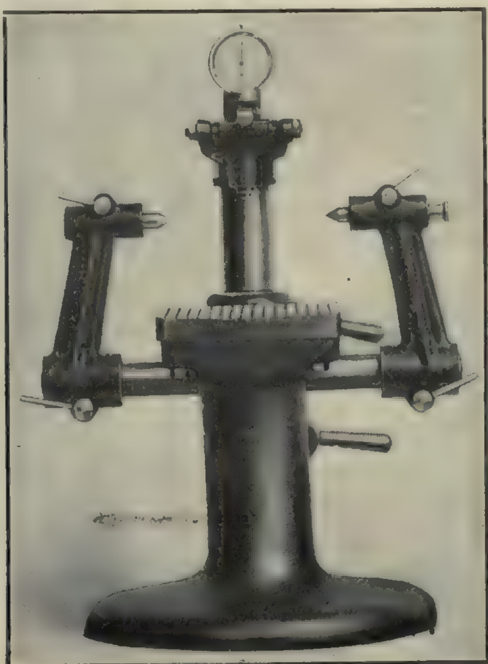


FIGS. 1 TO 3. WESTINGHOUSE MOTOR STARTERS
Fig. 1—Type QF starter. Fig. 2—Type QF1 starter. Fig. 3—Type Q starter

Amplifying Gage

The Northside Tool Works, Dayton, Ohio, are now manufacturing the universal amplifying gage shown in the illustration. The gage is built for simplifying gaging systems by providing an adjustable gage and thus eliminating a large percentage of the snap gages ordinarily required.

In operation the gage is set by the model or standard after which it is used in testing the ordinary line of work. On the gage shown, the maximum distance between centers is 8 in. The indicating dial at the top has divisions representing differences of 0.0001 in., and work up to 5½ in. high may be accommodated on the hardened plate, which measures 5 x 6 in. This plate can be removed and replaced by special fixtures if so desired. The weight of the machine is 54 lb. Another type of machine is made, on which the centers are omitted, the tool being used principally for thickness work.



UNIVERSAL AMPLIFYING GAGE

Meeting of the New England Foundrymen's Association

The regular meeting of the New England Foundrymen's Association was held at the Allyn House, Hartford, Conn., June 13. The afternoon was taken up with automobile trips into the surrounding country. Dinner was served at 7:30 p.m.

After reports on the activities of the society were read by members, the speaker of the evening, Mr. Vom Baur, was introduced. Owing to the previous delay, his talk on electric furnaces was of necessity somewhat fragmentary and consisted chiefly in the recitation of what had been done in the melting of steel and brass, very little if anything having been done in the melting of iron.

The speaker stated in connection with steel melting that, with electricity at from 1 to 1¼c. per kw.-hr. and with a furnace cap of 20 tons per day, the electric furnace could be operated more cheaply than the open-hearth or the crucible furnace.

In connection with melting nonferrous metals, he stated that all grades except yellow brass (40 per cent. zinc) could be cheaply handled in the electric furnace.

In the melting of cast-iron borings, the speaker said, the loss by the electric furnace was only 3 per cent. and with borings costing today $16 per ton they could, with current at 1c. per kw.-hr., be melted at a total cost of $28 per ton ($16 for the chips and $12 for furnace expenses). He further stated that, while the figures were authentic, they were not guaranteed.

New Aircraft Company

The Lawson Aircraft Co. was recently organized at Green Bay, Wis., and has already begun active operations with 8000 sq.ft. of available factory floor space well equipped in the most modern way for aircraft construction. The force will be increased, and it is expected to have 1000 men employed within three months.

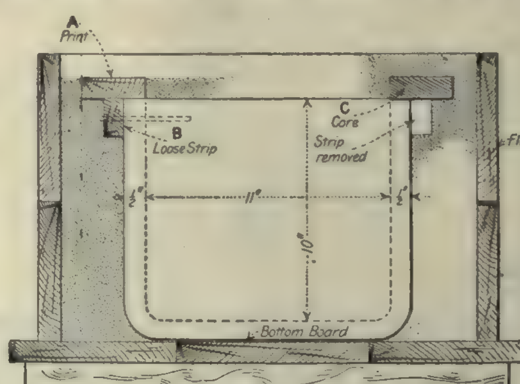
With the company are Alfred W. Lawson, vice president and general manager; Lawrence Allison, chief engineer; Lee Wallace, designer; Rudy Sanders, assistant designer; Frank Schober, Andrew Surini and Harry Graulich.

Casting Annealing Pots

By M. E. Duggan

On page 430, A. E. Holaday shows the molding of an annealing pot. I am particularly interested to learn the molders' methods for removing the sand to form the thickness of the bottom of the casting. This operation, also the making of "40 molds" as a day's work, has created a doubt in the minds of some molders. However, Mr. Holaday may have a little trick in the molding game that is worth knowing.

I would make and mold the pattern as follows: In the illustration are shown the bottom board, the flask and the pattern. At A is the loose print, and at B the loose strip. Sand is filled in up to the top of the print, then stopped. Next, the print A is removed and the loose strip B lifted out of the mold. A slab core is put in the place of the print; the filling in of the sand is continued and the drag finished and rolled over to receive the cope. This operation is shown at C. Making the pattern with core prints is the method followed by a great many patternmakers. I never use a core print when I can make the core answer the double purpose.



PATTERN AND MOLD

LATEST ADVICES FROM OUR WASHINGTON EDITOR

Washington, D. C., June 23, 1917—A small-shop owner writes in to Washington to know what sort of equipment is needed to build airplane motors and what alloys and materials enter into their construction. There is a crying need for airplane-motor capacity; but it is not a job to be tackled lightly, and the small shop can hardly hope to do more than to make parts, even if it has an equipment that may be very good for a small shop. While airplane-motor building has not been standardized to anywhere near the extent that is true of the automobile motor, production on the scale that we must eventually reach requires a large and well-organized plant and is not the job for the small shop, except perhaps for some of the smaller parts.

The lightness of the cylinders, where they are of cast iron, requires the most careful machining; and heavy cuts are out of the question, as deflection must be avoided. Similar care must be exercised on many of the parts, and the crankshaft is particularly delicate, owing to its being subjected to continuous stresses for long periods. Great care must be taken to avoid internal strains caused by straightening the shaft cold, as is perfectly permissible in many kinds of motors, where the weight is not cut down to such a fine point and the continued stresses are not so severe.

One Cause of Motor Failures

One of the causes of a large number of motor failures was found on investigation to be due to cold straightening of the crankshaft after turning and before grinding. With the alloy steels now used for this purpose, this cold straightening is very apt to cause incipient cracks that develop into real flaws after the motor is in use for some time. A cracked crankshaft in an airplane motor is a very serious thing, especially when it lets go several thousand feet in the air, as it usually does, and leaves the aviator at the mercy of the enemy, who is equipped with a rapid-fire machine gun. This requirement also applies, only in a lesser degree, to a number of the other parts of the motor, which are made of alloy steel.

At the present time some of the largest airplane-motor builders are having many small parts made outside, such as connecting-rods, pistons, valve parts, piston pins and similar pieces. Any shop that can handle accurate work and is not too far from some of the larger motor builders may be able to help by getting into communication with them. But it must be remembered that very accurate work is required, that tolerances are very close, inspection very rigid and that only shops which are accustomed to fine measurements have much chance in this work. There is much to be done; and if any shop feels that it can turn out work of this kind satisfactorily, its owner can do no better service than to get in touch with any of the large motor builders at once. Or if any small motor builder, whose motors are accepted by Government tests, is in your vicinity, he may be able to turn over a lot of work that you can handle.

What Some Engineers Are Doing

Washington is full of engineers and others who want to do their bit as best they can. Those who are so fixed financially as to afford the luxury are giving their services; others are endeavoring to find something that will keep their families going, but with no thought of financial gain. The latter men are naturally in the majority, and the present organization of the business of making war makes it difficult to take care of them. There are many difficulties to the volunteer system, just as in the army, and it would seem better in every way to hire at fair salaries the men needed, hold them absolutely responsible for their work, enlisting them for the duration of the war, if necessary, and run things on a strictly business basis. Any man who did not need the money could turn it back to the Government or to the Red Cross, so that he would be working without pay if he desired. And if we could prevent graft and inordinate profits in all supplies, as we are doing very successfully in some lines, there would be ample funds to pay all.

Many well-known engineers are at work systematizing the securing of supplies of various kinds, keeping tabs on delivery dates, planning for the movement of supplies from their point of production to the nearest depot or cantonment and doing an immense amount of work which does not show on the surface and which will never show at all, if things move along as smoothly as they should when the wheels get really in motion. For it is not the man who so plans the work as to prevent confusion who gets into the limelight, but the man who untangles a snarl that someone else has allowed to occur. So if the plans go as they should and probably will, we shall never appreciate the work that is being done right at this minute, when it sometimes seems as though nothing is being accomplished. If careful planning as to the movement and storage of supplies will prevent a recurrence of the trouble of 1898, we ought to be able to show the world that system and organization can take place outside of the German empire. But this cannot be accomplished except by complete coöperation of all who have to do with production and distribution.

Without going into details at this moment, because the time is not yet ripe to do so, it is gratifying to be able to report that very satisfactory progress is being made in some of the lines that seemed most difficult. The manufacture of field artillery, which was one of our weakest spots, is being very well organized when all the difficulties are considered; and those who have this directly in charge are well pleased with the progress made. It is no easy problem, as it involves the forging and heat-treatment of the guns as well as a consideration of the machining operations which differ enough from the ordinary machine-shop practices to make special tools and equipment necessary in most cases. But these are coming along, and we shall hear some of these fine days of heavy artillery arriving on the other side before we knew it had started.

In the same way the Bureau of Standards is getting into shape to handle the testing of munition gages as they arrive from the various manufacturers. The bureau reports a hearty coöperation on the part of builders of the measuring instruments and other devices which will be used, and in some cases manufacturers offer to lend the services of some of their best men in certain lines while the bureau's new organization is being completed.

This statement must not be taken as an indication that the organization of the new department is not going forward, but those who know present conditions realize how difficult it is to get just the right men on short notice. This is a new department, and it has had to be organized with very little assistance from Congress or elsewhere.

Thorough Coöperation Absolutely Necessary

This lending of men experienced along certain lines is one of the ways in which large firms can be of service at this time, not only to the Bureau of Standards, but to other departments or even to other firms manufacturing munitions or Government supplies of any kind. This is a time when we must learn what coöperation really means, when we must learn to appreciate that the first thing necessary to win this war and win it quickly is to have munitions and supplies and to have them quickly. It does not matter whether they come from Boston or Kalamazoo, from one shop or another—they all look alike to the army at the front and help it to win. There is work enough for us all; and no shop will lose a cent of dividend by helping out its neighbor, if all hands pitch in and do the same thing.

This suggestion brings up a point which Government and other inspectors must learn, that inspection is just as much, or more, to pass acceptable work as to reject work that is bad. Inspection and production should go hand in hand instead of being antagonistic, as is too often the case at present. What we need is production, and the more serviceable product we can get to the armies in the field the sooner we can get back to normal conditions. If inspectors are praised for the amount of work they reject, as is sometimes the case, they are naturally looking for every excuse to throw out product as being unfit for use. I know of one case where the inspector admitted that he could find nothing wrong with the piece; but there had not been a rejection that morning, and he knew it was time for one.

An inspector of this kind can do more to kill production than all the bonus systems devised can overcome. Unless the inspectors have mechanical sense enough to know when a piece is fit for use, or if they depend entirely on hard-and-fast rules and gages, it is a difficult proposition to get out large quantities of perfectly satisfactory work. Unless we can teach them that the proper functioning of the piece is the main requirement, and can give tolerances enough in the gages to pass all work that ought to be passed, we shall have the same difficulties that beset the makers of shells and fuses in the early days of the foreign contracts. But it is gratifying to note that there is a tendency toward a more rational inspection, and this should be productive of good results.

Showing How Gages Pay

An interesting tale that shows the value of carefully planning things beforehand, and particularly of making proper gages before starting a big job, comes from our friends in the British army. A large contract for a certain device that was used very extensively in the great Somme drive was given to a firm that had real system in its factory. The contract date of delivery was very important, and heavy penalties were attached. Still, the Government inspectors kept reporting that no progress was being made on this work; and the War Office began to get anxious, as this device was a very important part of the preparation for the great drive.

Weeks passed, and no product was turned out. All the time was taken in the making of drawings and gages, principally the latter, so far as time was concerned. At last, when the officials were getting desperate and threatening all sorts of dire reprisals, production started—and not only started, but kept on at such a rate that the inspectors were kept working almost night and day. But the work had been so carefully planned and the gages so well designed and followed that there were practically no rejections; and the contract was delivered on time, though with little to spare. The result is known to us all. We are also awake to the need of gages, as the following resolution adopted by the American Society of Mechanical Engineers at its semiannual convention held at Cincinnati, May 24, 1917, will show:

Whereas, Serious delays have been experienced in other countries and in this country in the production of munitions work; and rejection and unnecessary loss, with its consequent shortage of labor and material, have resulted due to lack of control of data and of standards of measurement, and

Whereas, Great Britain and Canada have found standardization of measurement of all war material for both army and navy imperatively necessary to obtain uniform and reliable results and have constructed efficient organizations which have proved successful in overcoming these difficulties, and

Whereas, Increased efficiency of our manufacturers would be promoted by the establishment of proper standards, be it

Resolved, That the Congress be urged to appropriate funds for expenditure through a suitable agency, to provide standards and adequate means of calibration of working and inspection standards in the different centers of manufacture.

Everyone who realizes the value of gages in rapid and economical production should try to impress on his Congressional representatives the need for these instruments. It is a vital question that must not be overlooked, yet many members of Congress do not understand its importance.

Among the inquiries which come to me are those from firms in various parts of the country who are anxious to do their part by manufacturing some of the many things used by the army and navy in their various activities. The navy publishes a list of its needs, which are perhaps less varied than those of the army, and I

suggest that anyone who is interested send for this list. Specifications of any of these articles may be had, by application to the Department of Naval Stores and Materials, State, War and Navy Building, Washington, D. C.

For army supplies, outside of ordnance, send to the nearest Depot Quartermaster in the following list, in regard to miscellaneous supplies. Tell him what you make regularly and ask him to notify you when bids are to be asked for on any supplies at all in your line. A personal visit might give you a better idea as to just how you could be useful now or in the future.

LIST OF OFFICERS OF THE QUARTERMASTER CORPS, UNITED STATES ARMY, MAKING PURCHASES OF MISCELLANEOUS SUPPLIES

Depot Quartermaster, Army Building, 39 Whitehall St., New York City.
Depot Quartermaster, 26th and Grays Ferry Road, Philadelphia, Penn.
Depot Quartermaster, Jeffersonville, Ind.
Depot Quartermaster, Second and Arsenal Sts., St. Louis, Mo.
Depot Quartermaster, 3615 Iron St., Chicago, Ill.
Depot Quartermaster, Army Building, Omaha, Neb.
Depot Quartermaster, Fort Mason, San Francisco, Calif.
Depot Quartermaster, 305 Arcade Annex, Seattle, Wash.
Depot Quartermaster, 17th and F Sts., N.W., Washington, D. C.
Quartermaster, N.E. Cor. Third and Oak Sts., Portland, Ore.
Depot Quartermaster, Atlanta, Ga.

We must not overlook the fact, however, that in many cases we can serve best by doing our regular work better and more efficiently than ever before. The elimination of waste of every kind—of material, of effort, of time, of everything, in fact—will not only be of greater value than anything else, but it will leave us in a better position to recuperate after the war is over. No matter how busy we may be or how good business may seem to be and will be, the waste of war in material wealth as well as in the men of the nation must be made good by the generations that follow. We must reorganize many of our ideas of manufacturing, must find better and cheaper methods, which usually means preventing wastes that we have overlooked or considered as not being worth while bothering about. An earnest endeavor to improve the conditions in our own shops will be one of the best contributions that any of us can make at the present time.

The question of aircraft is receiving the most careful attention, and it is gratifying to note that production is being pushed as rapidly as seems possible. It is fully expected that the figures given out by Mr. Coffin in a recent address will be exceeded. Various plans are in the air, among them one to send a large number of mechanics to France to build motors and planes in the factories already established in that country. There is no question as to their ability to build machines, but the problem of getting sufficient additional equipment and of feeding any men we send over there seems to make it advisable to build the motors and planes in this country, if possible. It would seem an easier problem to get the machines here and to feed the men in this country, saving the shipping tonnage for transporting food and necessary supplies to our allies abroad. But we must be ready to do whatever seems best, for it matters very little whether we make airplanes here, or other things that are just as urgently needed. There is work enough for us all, and no personal preferences must be allowed to stand in the way or to delay the progress of the job we have set out to accomplish.

At least three of the successful English and French motors are now being built in this country, and the output of these can be increased by impressing, commandeering or otherwise inducing a few of the large builders of high-grade automobiles—pleasure cars, not trucks—to turn their attention to these motors for as long a period as necessary. It takes a shop accustomed to very high-grade work, and this requirement cuts out a great many shops that perhaps count themselves in the high-grade class.

The upheavals in the Shipping Board have not and probably will not delay the production of ships. New contracts are being placed, and more and more tonnage is being ordered. New yards are being established, and the work is being pushed as fast as the conditions of the labor, materials and machinery markets will allow. We cannot do the impossible, but we shall have ships in quantity as soon as it is possible to get them into the water.—FRED H. COLVIN, Hotel Powhatan.

Trade Catalogs

Bevel Gear Planers. Gleason Works, Rochester, N. Y. Catalog. Pp. 62; 6 x 9 in.; illustrated.

Gears, Chains, Sprockets, etc. Grant Gear Works, 151 Pearl St., Boston, Mass. Catalog. Pp. 50; 5 x 8 in.; illustrated.

Steel Hoists, Hand Cranes, Steel Trolleys. Wright Manufacturing Co., Lisbon, Ohio. Catalog No. 8. Pp. 32; 6 x 9 in.; illustrated.

Air Operated Chucks, Mandrels, Vises, etc. Hannifin Manufacturing Co., Chicago, Ill. Catalog. Pp. 40; 4½ x 7 in.; illustrated.

Sprague Electric Monorail Hoists. Sprague Electric Works, 527-31 W. 34th St., New York. Bulletin No. 48700A. Pp. 32; 8 x 10½ in.; illustrated.

Portable Grinders, Drills, Flexible Shaft, Oilers, etc. Gem Manufacturing Co., 1229-43 Goebel St., N. S., Pittsburgh, Penn. Catalog No. 9. Pp. 36; 6 x 9 in.; illustrated.

Personal

E. E. Arnold, chief engineer of the New Departure Manufacturing Co., Bristol, Conn., has resigned to become general manager of the Iron City Products Co., Pittsburgh, Penn. This company manufactures a line of automobile accessories.

Forthcoming Meetings

The twelfth annual exhibit of foundry and machine-shop equipment and supplies will be held under the auspices of the American Foundrymen's Association in the Mechanics Building, Boston, Mass., from Sept. 25 to 28, 1917. The officers of the exhibit committee are: President, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; vice president, Benjamin D. Fuller, Westinghouse Electric and Manufacturing Co., Cleveland, Ohio; secretary and treasurer, A. O. Backert, 12th and Chestnut Sts., Cleveland, Ohio; manager of the department of exhibits, C. E. Hoyt, 123 West Madison St., Chicago, Illinois.

American Society of Mechanical Engineers. Monthly meeting, first Tuesday. Calvin W. Rice, secretary, 29 West 39th St., New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's Hotel. W. W. Poole, secretary, 40 Central St., Boston, Mass.

Providence Engineering Society. Monthly meeting, fourth Wednesday of each month. A. E. Thornley, corresponding secretary, P. O. Box 796, Providence, R. I.

New England Foundrymen's Association. Regular meeting, second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania. Monthly meeting, third Tuesday; section meeting, first Tuesday. Elmer K. Hiles, secretary, Oliver Building, Pittsburgh, Penn.

Rochester Society of Technical Draftsmen. Monthly meeting, last Thursday. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester, N. Y.

Superintendents' and Foremen's Club of Cleveland. Monthly meeting, third Saturday. Philip Frankel, secretary, 310 New England Building, Cleveland, Ohio.

Western Society of Engineers, Chicago, Ill. Regular meeting, first Wednesday evening of each month, except July and August. E. N. Layfield, secretary, 1785 Monadnock Block, Chicago, Ill.

Philadelphia Foundrymen's Association. Meetings, first Wednesday of each month. Manufacturers' Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

Technical League of America. Regular meeting, second Friday of each month. Oscar S. Teale, secretary, 35 Broadway, New York City.

The American and Canadian engineers and architects of Norwegian birth and descent will hold an informal congress and reunion at the Chicago Norske Klub, Logan Square, Chicago, Ill., Sept. 27 to 29, 1917.

WEEKLY PRICE GUIDE OF

IRON AND STEEL

PIG IRON—Qutations were current as follows at the points and dates indicated:

	June 22, 1917	One Month Ago	One Year Ago
No. 2 Southern Foundry, Birmingham..	$44.00	$40.00	$14.50
No. 2X Northern Foundry, New York..	49.25	44.00	19.75
No. 2 Northern Foundry, Chicago......	50.00	44.00	19.00
Bessemer, Pittsburgh	55.95	44.95	21.95
Basic, Pittsburgh	50.00	42.00	18.95
No. 2X, Philadelphia............	49.75	42.50	19.75
No. 2, Valley............	53.00	42.00	18.50
No. 2, Southern Cincinnati...........	46.90	42.90	17.40
Basic, Eastern Pennsylvania..........	48.00	38.00	19.50
Gray forge, Pittsburgh............	47.95	40.95	18.70

STEEL SHAPES—The following base prices in cents per pound are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses at the cities named:

	New York			Cleveland		Chicago	
	June 22, 1917	One Month Ago	One Year Ago	June 22, 1917	One Year Ago	June 22, 1917	One Year Ago
Structural shapes ...	5.00	5.00	3.50	5.00	3.25	5.00	3.10
Soft steel bars.....	4.75	4.75	3.55	4.50	3.25	4.50	3.10
Soft steel bar shapes	4.75	4.75	3.50	4.50	3.25	4.50	3.10
Plates	8.00	7.00	4.00	7.00	3.65	8.00	3.50

BAR IRON—Prices in cents per pound at the places named are as follows:

	June 22, 1917	One Year Ago
Pittsburgh, mill	4.25	2.60
Warehouse, New York............	4.60	3.25
Warehouse, Cleveland	4.95	3.25
Warehouse, Chicago	4.50	3.10

STEEL SHEETS—The following are the prices in cents per pound from jobbers' warehouse at the cities named:

	Pittsburgh, Mill, in Carloads	New York			Cleveland		Chicago	
		June 22, 1917	One Month Ago	One Year Ago	June 22, 1917	One Year Ago	June 22, 1917	One Year Ago
*No. 28 black......	8.25	10.00	9.25	3.65	9.00	3.20	9.00	3.20
*No. 26 black......	8.15	9.90	9.15	3.55	8.90	3.10	8.90	3.10
*Nos. 22 and 24 black	8.10	9.85	9.10	3.50	8.85	3.05	8.85	3.05
Nos. 18 and 20 black	8.05	9.80	9.05	3.45	8.80	3.00	8.80	3.00
No. 16 blue annealed.	8.60	9.70	8.50	4.70	8.20	3.70	9.20	3.60
No. 14 blue annealed.	8.35	9.60	8.50	4.60	8.10	3.60	9.10	3.50
No. 12 blue annealed.	8.10	9.55	8.50	4.50	8.05	3.50	9.05	3.45
No. 10 blue annealed.	7.85	9.50	8.50	4.55	8.00	3.55	9.00	3.50
*No. 28 galvanized..	10.25	13.00	10.75	5.65	10.50	5.50	11.00	5.50
*No. 26 galvanized..	9.95	12.70	10.45	5.35	10.20	5.10	10.70	5.20
*No. 24 galvanized..	9.80	12.55	10.30	5.20	10.55	5.05	10.55	5.05

*For corrugated sheets add 25c. per 100 lb.

COLD DRAWN STEEL SHAFTING—From warehouse to consumers requiring fair-sized lots, the following quotations hold:

	June 22, 1917	One Year Ago
New York	List plus 25%	List plus 20%
Cleveland	List plus 10%	List plus 20%
Chicago	List plus 10%	List plus 10%

DRILL ROD—Discounts from list price are as follows at the places named:

	Extra	Standard
New York	40%	45%
Cleveland	40%	45%
Chicago	45%	50%

SWEDISH (NORWAY) IRON—This material per 100 lb. sells as follows:

	June 22, 1917	One Year Ago
New York	$20.00@26.00	$6.00
Cleveland	12.30	6.30
Chicago	12.00	5.25

In coils an advance of 50c. usually is charged.
Note—Stock scarce generally.

WELDING MATERIAL (SWEDISH)—Prices are as follows in cents per pound f.o.b. New York:

Welding Wire*

3/8, 11/32, 5/16, 1/4, 7/32, 3/16	21.00@30.00
No. 8, 5/32 and No. 10	
1/8	
No. 12	
3/32, No. 14 and 1/16..	
No. 18	
No. 20	

*Very scarce.

Cast-Iron Welding Rods

3/16 by 12 in. long.........	16.00
1/4 by 19 in. long.........	14.00
3/8 by 19 in long.........	12.00
1/2 by 21 in. long.........	12.00

*Special Welding Wire

1/8	33.00
5/32	30.00
3/16	38.00

MISCELLANEOUS STEEL—The following quotations in cents per pound are from warehouse at the places named:

	New York June 22, 1917	Cleveland June 22, 1917	Chicago June 22, 1917
Tire	5.00	5.00	4.50
Toe calk	5.00	5.50	4.75
Openhearth spring steel...	7.00	8.25	7.50@ 8.50
Spring steel (crucible analysis)	8.00	11.25	12.00
Carbon tool steel, base price	10.00	13.00	....
Special best cast steel....	14.00@18.00	20.00	....

*In bars.

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh basing card in effect May 1, 1917:

Steel Inches	Black	Galvanized	Iron Inches	Black	Galvanized
BUTT WELD					
1/8, 1/4 and 3/8..	42%	15½%	3/4 to 1½.....	38%	22%
1/2	46%	31½%			
LAP WELD					
2	42%	27½%	1¼	23%	8%
2½ to 6......	45%	35½%	1½	30%	16%
			2	31%	17%
			2½ to 4......	33%	20%
			4½ to 6......	33%	20%
BUTT WELD. EXTRA STRONG PLAIN ENDS					
1/8, 1/4 and 3/8..	38%	20½%	3/4 to 1½.....	38%	23%
1/2	43%	30½%			
3/4 to 1½.....	47%	34½%			
LAP WELD. EXTRA STRONG PLAIN ENDS					
2	40%	28½%	1¼	24%	8%
2½ to 4......	43%	31½%	1½	30%	16%
4½ to 6......	42%	30½%	2	32%	19%
			2¼ to 4......	34%	22%
			4½ to 6......	33%	21%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
3/4 to 3 in. steel butt welded	38%	22%	43%	28%	43%	28%
3½ to 6 in. steel lap welded	28%	10%	39%	25%	39%	25%

Malleable fittings, Class B and C, from New York stock sell at 5% from list price. Cast iron, standard sizes, 27 and 5%.

METALS

MISCELLANEOUS METALS—Present and past New York quotations in cents per pound:

	June 22, 1917	One Month Ago	One Year Ago
Copper, electrolytic (acrload lots)*....	30.50	33.00	28.00
Tin	64.00	65.00	40.00
Lead	12.00	11.00	7.00
Spelter	9.25	9.50	12.25

*Third-quarter copper; for spot copper the market price is 33c.

ST. LOUIS

Lead	12.00	10.75	6.85
Spelter	9.25	9.25	12.25

At the places named, the following prices in cents per pound prevail:

	New York			Cleveland		Chicago	
	June 22, 1917	One Month Ago	One Year Ago	June 22, 1917	One Year Ago	June 22, 1917	One Year Ago
Copper sheets, base.	42.00	42.00	37.50	42.00	37.50	42.50	37.00
Copper wire (carload lots)	39.50	39.50	37.50	39.00	33.00	40.00	38.00
Brass pipe, base...	47.50	47.50	46.50	46.00	45.00	47.50	46.00
Brass sheets	45.00	45.00	44.50	38.00	42.00	43.50	38.00
Solder ½ and ½ (case lots)	39.75	41.25	30.62½	39.50	28.75	39.50	27.00

Copper sheets quoted above hot rolled 16 oz., cold rolled 14 oz. and heavier, add 1c.; polished takes 1c. per sq.ft. extra for 20-in. widths and under; over 20 in., 2c.

BRASS RODS—The following quotations are for large lots, mill, 100 lb. and over, warehouse; 25% to be added to mill prices for extras; 50% to be added to warehouse price for extras:

	June 22, 1917	One Month Ago	Six Months Ago
Mill	$42.00	$42.00	....
New York	45.50	45.50	$44.50
Cleveland	38.00	42.00	38.00
Chicago	42.50	42.50	40.00

ZINC SHEETS—The following prices in cents per pound prevail:

Carload lots f.o.b. mill............ 19.00

	In Casks		Broken Lots	
	June 22, 1917	One Year Ago	June 22, 1917	One Year Ago
New York	21.00	21.50	21.50	22.00
Cleveland	23.00	22.75	23.25	23.25
Chicago	22.50	20.00	23.50	21.00

ANTIMONY—Chinese and Japanese brands in cents per pound for spot delivery, duty paid:

	June 22, 1917	One Year Ago
New York	19.50	18.00
Cleveland	21.50	24.00
Chicago	24.00	23.00